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CHARACTERISTICS OF THE AREAS IN WHICH FAST CURRENT OIL CONTROL IS NEEDED

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Coast Guard
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16. Abstract

Present oil spill control measures are effective only in currents up to between 0.3 and 1.0 knot, depending on the characteristics of the oil and ocean conditions. There are, however, a number of high oil pollution risk areas in which faster currents prevail, or where it is desirable to tow control equipment at higher speeds.

The Atlantic, Pacific and Gulf Coasts, the Inland Area, and the Great Lakes were examined. Forty-four high risk areas were located, determined on the basis of a composite of oil concentration and spill frequency. These included inland rivers (12 of them), open rivers (13), bays (5), channels (5), harbors (4), canals (3), and intracoastal waterways (2). Their specific environmental characteristics -- current, tide, water and air temperature, wave heights, and wind -- are identified, discussed and analyzed. From this, the necessary environmental performance characteristics of fast current oil spill control systems are described, in relation to their expected use.

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CHARACTERISTICS OF THE AREAS IN WHICH FAST CURRENT OIL CONTROL IS NEEDED

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SUMMARY OF FINDINGS

The general purpose of this study is to survey the characteristics of the geographic areas in which fast current oil control systems are currently required, in order to define the requirements for such a system. More specifically, the objectives of this study are:

1. Examine the natural geographic areas of the U. S., establishing those with high oil concentrations and spill frequencies, using data available as of mid-1973.
2. Identify a representative sample of present high pollution risk areas, and categorize them by hydrographic type.
3. Define the environmental characteristics within each selected risk area and hydrographic type.
4. Provide results which can be used to help define requirements to be used in development of a fast current oil control system.

High Risk Areas:

An original 131 specific geographic areas showed a concentration of oil (combined production, traffic and storage) mounting to more than 3 million barrels each. These were compared with areas showing a high spill frequency, and therefore a high spill potential. Geographic characteristics were fed into the calculation, and a representative sample of 44 high risk areas were chosen:

General Areas	High Risk Locations
Atlantic	17 areas
Gulf	5 areas
Pacific	10 areas
Inland	9 areas
Great Lakes	3 areas
	44 areas

Sorted another way -- by type of water body -- the breakdown is as follows:

Waters	
Inland Rivers	12
Open Rivers	13
Bays	5
Channels	5
Harbors	4
Canals	3
Intracoastal Waterways	2
	44

The Atlantic Coast area experiences almost half (44.3 percent) of all oil spilled, by volume. The Gulf Coast, Great Lakes, Inland area, and Pacific Coast account for about 14 percent each. Rivers were found to be the waters with the greatest quantities of pollutant oil, carrying 40 percent of the total volume. Harbors were next with almost 15 percent; followed by bays, estuaries and sounds with 13 percent; and the contiguous zone open waters with 10 percent. Channels and other miscellaneous waters such as beaches and non-navagable streams accounted for the remaining 22 percent between them.

The statistics on spill frequency show that the Gulf Coast averages the greatest number of spills, with almost half (44.8 percent) of the total. The Atlantic Coast was second, with a quarter (24.3 percent) of the spills, and the Pacific Coast had a fifth. It was found that the harbors had the greatest spill frequency, almost a third (31.2 percent) of the total. Bays, estuaries and sounds were a high second (28.1 percent). Rivers and contiguous open waters followed with a little over 14 percent each.

It should be noted that the statistical positioning above could be either in whole or part the combined result of better reporting procedures in one area over another, greater volume of oil flow, and/or operational carelessness. Since these relationships have continued for years, however, they appear to be valid characteristics of the geographic areas in question.

Environmental Characteristics:

Next in this study, environmental parameters in the selected high risk areas were identified, as were those in the hydrographic categories ("waters") within the areas. The study reveals sets of applicable and significant data relative to each parameter.

The average of the highest currents in the areas was found to be 5.8 knots. The extreme high current was 12 knots. The tide results show extremes of as high as 15.3 feet; average highs of from 9.5 feet to 7.2 feet were found. The water temperatures (F) reveal extremes of as high as 93^{o} and as low as 33^{o}. The air temperature (F) ranged in its extremes from 114° to -39°, with record average mean temperatures of 58°-59°. The data shows that the waves can be expected to be less than 5-6 feet 79 to 80 percent of the time. The highest wind found was 104 knots; a wind of between 7 and 17 knots can be expected 51 to 52 percent of the time.

Nothing in this study deals with future long-range shifts in the oil concentration areas. These shifts may be major, and they could significantly modify the findings of this paper. Battelle Columbus Labs is conducting two studies that consider the effects of these changes, and the results will be combined with the present paper to develop the actual oil control design goals.

The study also does not attempt to categorize the types of oils shipped or otherwise handled in the selected high risk areas. Battelle, in its two oil traffic pattern studies conducted for the Coast Guard, analyzes four petroleum commodities (gasoline, distillate fuel oils, residual fuel oils and crude oil) for several of the high risk locations. These reports are available to the public through the National Technical Information Service, Springfield, Virginia 22151.

APPROACH TO THE PROBLEM AND METHODS UTILIZED

Research, tests and evaluations by the Office of Research and Development indicate that in high currents, oil cannot now successfully be either contained or recovered from the ocean surface. The maximum current in which oil can be contained is about one knot, dependent on the ocean environment and the type of oil spilled. High pollution risk areas exist where either the currents are greater than one knot or it may be desirable to tow response equipment at fast speeds. Performance of existing off-the-shelf and developed prototype equipment has proven inadequate in these situations. Equipment whose operational envelope permits higher speeds is necessary.

Specifically, the methodology for this project included the following tasks:

1. Determination of the high risk oil pollution areas.
2. Determination of those environmental characteristics of interest.
3. Identification of data resources; formulation of a search system; and extraction of the data.
4. Development of documentation, analysis and synthesis techniques; and summarization of the findings.

Procedure:

The object of the project being to develop environmental design goals for a fast current oil control system, first, those geographic areas in which such a system was required were determined. The procedure followed in selecting these areas involved an analysis of a composite called oil concentration areas, through a review of annual volumes of oil handled, oil stored, and oil transit traffic. The base years for this were 1970-1971. This analysis was contrasted with annual oil spill frequency in 1970-71-72.

These years represent the latest available data. This data is the result of at least five years of intensive oil pollution data collection experience. The data -- and conclusions properly drawn therefrom -- should be valid.

The contrast of oil concentration areas with oil spill frequency allowed for a rank ordering of geographic areas and a selection of high risk areas. It was assumed that where high oil concentrations and high spill frequencies coincided, these were the high risk areas. Thus a high risk area was one where the objective evidence indicated a fast current control system might be needed.

Environmental parameters were selected such that the widest environmental data past or present could be shown. The resources used to obtain data were in-house literature, in-house interview, other agencies, district marine environmental protection officers, and regional oil cooperatives.

Finally, a synthesis of the documented evidence was made, through a series of graphs, tables, and figures illustrating the results of the study. The data was summarized textually, with the object of providing the executive reader with the findings in a convenient form. What emerged was a foundation from which environmental design goals for a fast current control system could be established.

GEOGRAPHICAL AREAS

The geographical areas were determined according to the general marine areas of the United States. These areas included the Atlantic Coast from Maine to Florida's East coast, Gulf Coast from Florida's West Coast to the Texas - Mexico border, Pacific Coast from Southern California to the Washington - Canadian border, Great Lakes area at the U. S. border, and the Inland Water area from Minneapolis-St Paul, Minn. to Baton Rouge, Louisiana.

OIL CONCENTRATION AREAS

To develop the composite called oil concentration areas, the volume of oil handled, stored, or transported was considered. The principle sources of data were: The Corps of Engineers annual five volume publication titled Waterborne Commerce of the United States (1970-71); Corps of Engineers "Port Series" publications; the American Petroleum Institute's Information on Offshore and Inland Facilities and Pipeline Crossings (1972). Further data was extracted from in-house publications such as the Dillingham Analysis of Oil Spills Study of 1970; Analysis of Coastal Tank Vessel & Barge Traffic (1973); The Purdue Study in Internal Movements, Imports & Exports of Petroleum Products (1973); Where Trends the Flow of Merchant Ships - Bates Paper (1973); Water Transportation of Petroleum Products in the Future - Ames Paper (1973); Report in U. S. Energy Outlook - National Petroleum Council (1972); and Support Systems to Deliver and Maintain Oil Recovery Systems and Disposal of Recovered Oil - Battelle (Draft) (1973). An investigation was also made into the reprocessing or re-refining of used oil.

The areas of oil concentration were categorized into five general groups according to concentrations per year of 100 million barrels or over, 50-100 million barrels, 25-50 million barrels, 10-25 million barrels and 3-10 million barrels. One hundred and thirty one locations were determined under these categories. When areas with concentrations of less than 3 million barrels per year were considered, an additional 140 locations were identified.

OIL SPILL FREQUENCY

The publication titled Polluting Incidents In and Around U. S. Waters, COMDT (G-WEP) U. S. Coast Guard, calendar years 1970-71-72 was used to determine spill frequency. Figure 1 reveals the averages of spill history for 1971-72, showing the percent of spills and percent of volume in the five geographic areas. The same data for types of waters within the areas, including rivers, contiguous open waters, harbors, bays, estuaries, sounds, channels & canals and non-navigable waters are reflected in Figure 2. Sources of polluting spills may be found in Figure 3. The average percentage of spills by Coast Guard District, including percentage of volume is further refined in Figure 4. This compilation allowed for a ranking of the districts according to percent of volume. The ranking shows the Eighth Coast Guard District to be number one, followed by the Third District and the others as shown. Number of spills was assumed to be more important than volume of spills in making the rankings. This assumption was made on the basis that 6 out of 10 of the districts had a combined volume of only 3.+ percent of the total volume of oil spilled, whereas each of the 10 districts considered had a percentage of total number of spills greater than 3.+ percent. This assumption allowed a wider geographical representation of high risk areas.

CONTRASTING SPILL FREQUENCY WITH OIL CONCENTRATION

A comparison of oil spill frequency with locations of high oil concentrations is reflected in Table B. High risk areas were selected in terms of (1) the established evidence, (2) the short term projections of oil concentration development, (3) the various and differing marine environments, (4) recommendations of the district marine environmental protection offices, and (5) in consultation with the project manager of the fast current oil control system. Out of the 131 original locations 44 were selected as high risk areas. Those areas are shown in Table A, as the sample used in the study. Locations are subheaded by the type of water involved. Limits of area miles to be considered in each location are approximate points and figures, used in the context that within the limits required data would be found.

Figure 5 illustrates the principal oil spill control areas, and the general volume of traffic and locations of the selected high-risk locations. Referring to Table A, it is noted that each location is numbered and indicated in graphic display in the figure mentioned.

THE ENVIRONMENTAL PARAMETERS

The environmental parameters to be considered included currents, waves, temperature, wind and tides. Gathering of the data was accomplished through use of a work sheet shown in Appendix 2. For each item, where applicable, the annual high-low-mean values were determined. Otherwise the record annual data was determined on average maximums, average minimums, and average means.

The basic sources for waves, sea temperatures and winds were Tables 1,9,20,3A and 15 respectively, from the Summary of Synoptic

Meteorlogical Observations - USN Weather Command, 1970. Where data needed amplification, the following sources were consulted: The Oceanographic Atlas - USNOO Pub. No. 700; Graphic Construction of Wave Refraction Diagrams - H. O. Pub. No. 605; Serial Atlas of the Marine Environment - Folio 15 - American Geo. Society, 1973; Local Climatology Data - USDC NOAA, 1972; and, Corps of Engineers, San Francisco Bay Model, Sauselito Ca. The sources for tides and currents were the Tidal Current Tables and Tide Tables, and Marine Weather Service Charts, USDC NOAA, 1973. In computing tides and currents, standard conversion procedures were used in identifying figures away from given reference points. Annual high-low figures were obtained by an inspection of the annual tables for 1972. Air temperatures were obtained from the publication: Local Climatological Data, USDC NOAA, 1972. Average maximums, minimums and means were from the record over the years, as were the extreme high and lows.

The Summary of Synoptic Meteorological Observations as a basic source of reference material needs comment. The data compiled in this publication is gathered in 1^{o} quadrants. Thus it is conceivable that shoreside data may be a composite of data anywhere within 60 miles. To assure a better measure of accuracy, the following publications were reviewed, namely Oceanographic Report #53, C. G. 373-53 (East Coast) 1973; Climatological Study Southern California Operating Area, NWSED - Asheville N. C., 1971; and Corps of Engineers periodicals.

Where information appeared unavailable from published and documented sources, contact was made with the Corps of Engineers Hydrology Offices in each of the locations concerned. The U. S. Geodetic Survey was also contacted, usefully.

FINDINGS

Summarization of environmental parameters for input into the design of fast current oil control system requires a knowledge of the geographic areas in which such a system is needed. To determine the geographic areas of concern, the areas of heavy oil concentration (production, traffic and storage) were contrasted with oil spill frequency. This permitted the identification of high risk oil control locations within geographic areas.

The high risk oil control locations were further identified by hydrographic categories ("waters"): harbors, bays, inland rivers, open (tidal) rivers, canals, channels and inter-coastal waterways.

Environmental data were obtained for the high risk geographic locations. From this, design parameters resulted. The data is presented here in sets and subsets, descriptive of the areas studied.

GEOGRAPHIC AREAS

Table A shows the sample of areas of high oil pollution risk that was selected. These 44 areas were chosen from an original 131 areas which showed combined concentrations of oil amounting to more than 3 million barrels per year each. A categorization by hydrographic type shows:

WATERS SELECTED FOR ENVIRONMENTAL ANALYSIS

Map Ref	Region	Location	Map Ref	Region	Location
30	Inland Rivers	Portland(Oregon)	3	Open Rivers	Albany
31	"	Tri-Cities	4	"	Newburgh
33	"	Pittsburgh	5	"	East R.
34	"	Huntington	6	"	N. London
35	"	Cincinnatti	7	"	Delaware
36	"	Louisville	10	"	Washington(D.C)
37	"	Evansville	11	"	Richmond (VA)

Map Ref	Region	Location	Map Ref	Region	Location
	Inland Rivers			Open Rivers	
37	"	Evansville	12	"	York R.
38	"	Nashville	14	"	Wilminton
39	"	Memphis	15	"	Savannah
40	"	Helena	16	"	Jacksonville
41	"	Minn- St.Paul	19	"	N. Orleans
44	"	St. Clair	25	"	Suisan
1	Harbors	Portland, ME	2	Bays	Penobscot
9	"	Baltimore	8	"	Delaware
13	"	Norfolk	18	"	Tampa
23	"	LA/LB	26	"	Benecia
			29	"	San Francisco
17	Canals	PortEverglades	21	Channels	Houston
42	"	Chicago	24	"	Santa Barbara
43	"	Indiana	27	"	Carquinez
			28	"	Richmond
			32	"	Rosario
20	IWW	Morgan City			
22	"	Corpus Christi			

OIL SPILL DISTRIBUTION

Oil spill history is reflected in Figures 1,2,3,4 and Tables C and D. This data shows the averages of spills by geographic area, region, source and district. An examination of the spill data allowed for a ranking of districts in respect to percent of total spills and percent of total volume. Figure 4 shows the rank order, placing District 8 as first with 46.6% of all spills and District 3 as second with 12.2%. Table C indicates that nearly 52% of all spills reported during 1971-1972 were of less than 100 gallons in volume, whereas only 0.2% were reported in the over 100,000 gallon size category. Spill quantities by size, number of incidents and source are reflected in Table D. This data shows tank ships and tank barges to be the greatest sources of pollution in terms of total volume spilled.

Quantities of pollutant oil are greatest in the area of the Atlantic Coast where 44.8 percent of the total volume is spilled. The Gulf Coast area accounts for 15 percent of the total and next highest is the Great Lakes where 14.7 percent has been reported. The Inland area is responsible for 14 percent and the Pacific Coast accounts for the remaining 13 percent. Figure 1 shows this data in graph form.

Refering to Figure 2, where "waters" are considered, it is shown that rivers are the source of the greatest quantites of pollutant oil at 39.9 percent of the total volume. The second category of greatest concern is the harbors (ports, docks, terminals) at 14.4 percent, closely followed by bays, estuaries and sounds with 13 percent of the total volume. The contiguous zone of open waters including the Great Lakes accounts for 10 percent of quantites spilled and channels, coastal inlets and inland waterways account for 8.9 percent. The remainder occurs on beaches or non-navagable waters.

Onshore oil facilities produce nearly one-half the quantity of pollutant oil (49.5%), whereas vessels contribute 39.3 percent of the total quantity. In Figure 3, the all vessel breakdown of quantities is: tank ships at 16.3 percent, tank barges at 16.8 percent and other vessels at a quantity of 6.3 percent.

CONTRAST OF OIL SPILL FREQUENCY AND OIL CONCENTRATION

Table B indicates the contrast of oil concentration and oil spill frequency. The rank order derived is shown by district. Coast Guard District Eight has over 4 times as many spills as the second ranking district which is shown to be District Three. The second ranking district has almost twice as many spills as District 11, the 3rd ranked district. The remaining rankings were determined on much narrower differences.

Figure 5 graphically illustrates the high risk areas by oil concentration, and by geographical location. Table A provides the map references, locations, districts and other study information related to the map.

ENVIRONMENTAL PARAMETERS

The results of the environmental study may be found in Tables E through R, and Figures 6 and 7. For the purposes of this study the area and waters high-low and average (av), high-low and extremes (ex) are given. The locations of the selected waters within geographic areas may be found in Table E3.

CURRENTS (Knots) (Tables E, E2, E3, F, I, L)

Locations	HI	LO	AvHI	AvLO	ExHI	ExLO
Areas	5.8	0.2	3.2	0.6	12	0.
Waters	4.7	0.2	2.7	0.4	12	0.

The currents results indicate that the design criteria would be between 5.8 and 4.7 knots if averages of the high figures of areas and waters are considered, and between 3.2 and 2.7 knots if averages all high figures of the areas and waters are considered.

TIDES (Feet) (Tables ", E2, E3, F, I, L)

Location	HI	LO	AvHI	AvLO	ExHI	ExLO
Areas	9.5	-1.8	4.5	1.1	15.3	-2.9
Waters	7.2	-1.3	4.9	0.6	15.3	-2.9

The tides results show that the system must be able to withstand tide effects as extreme as 15.3 feet, as average high as from 9.5 to 7.2 feet and an average of all high figures between 4.9 to 4.5 feet.

TEMPERATURES (Sea F°) (Tables E, E2, E3, G, J, M)

Location	HI	LO	AvHI	AvLO	ExHI	ExLO
Areas	86	33	81	39	93	27
Waters	91	39	81	38	93	27

Water temperatures show that the system should be capable of operation in temperatures as high as 93° as well as those sub freezing; as high or average as 86°-91°.

TEMPERATURES (Air F°) (Tables E, E2, E3, G, J, M)

Air temperatures to be considered in the design of the system range from an extreme high of 114° to a low of -39°. The maximum average for areas and waters was 67°-68°, the minumum average was 49°-50° and the record average mean temperature was 58°-59°.

WAVES (Feet) (Tables E, E2, E3, H, K, N)

The waves data is reliable. It was derived from 60 mile area quadrants, contiguous to the continental shores of the U. S. The results show that the designer of the system can assume that in areas and waters studied that the mean height of the waves may be 3.1 feet. Waves will be 3-4 feet, or less, 61 percent of the time and 5-6 feet, or less, 79 to 80 percent of the time.

WINDS (Knots) (Tables E, E2, E3, H, K, N)

Location	HI	LO	Annual Mean	ExHI	Av % of Speed
Areas	78	43	7.8	104	52 at 7-16
Waters	73	42	8.5	104	41 at 7-16

Wind data was derived from figures based on the fastest mph recorded and converted to knots. If extreme winds are considered the system must be able to survive in winds as high as 104 knots.

Otherwise the fastest average high for areas and waters was 78-73 knots and the fastest average lower limits of wind were 43-42 knots. Within the areas, the annual mean wind was 7.8 knots and within the waters, 8.5 knots. The designer can assume that 51 to 52 percent of the time the wind will have a force of from 7-16 knots.

CONCLUSIONS

On the basis of the risk areas investigated in this study, the following fast current oil control system design requirements can be specified:

1. The system should be capable of effective operation on rivers, bays, harbors, channels, canals, and intracoastal waterways.

2. The system should perform effectively in current velocities ranging from 1 to at least 6 knots.

3. The system should be capable of operating effectively through a complete reversal of tidal current with a maximum value of from 1 to 8 knots in either direction.

4. The system should perform effectively in sea states ranging from those with no waves and extreme surface turbulence, as found on fast moving rivers, to a sea state 5, as found on bays.

5. The system should perform effectively in winds of up to 20 knots.

6. The system should perform effectively in air temperatures ranging from -39°F to +114°F, and in sea temperatures ranging from +33°F to +93°F.

LIMITS OF THE STUDY AND FUTURE WORK

This study has so far focused on oil pollution risk areas selected on the basis of 1970-72 data. It has not attempted to analyze future energy demands, refinery or port growth and expansions. Such long-run changes will alter the pollution risk areas considerably, and in view of the normal 8 to 10 year R&D cycle, must be considered now.

At the present time, the major refinery locations in the continental U. S. are:

1. East Coast:
   a. Arthur Kill (N.Y.)
   b. Delaware River

2. Gulf Coast:
   a. Houston-Baytown
   b. Beaumont-Port Arthur
   c. New Orleans
   d. Baton Rouge
   e. Corpus Christi
   f. Lake Charles
   g. Pascagoula

3. West Coast:
   a. Los Angeles-Long Beach
   b. Richmond-Avon

It is expected that increases in refinery capacity throughout the U.S. through the year 2000 will occur primarily through expansion of existing refining complexes, rather than by construction of new refineries. A Battelle study cites the problems Shell Oil has had in finding a site for a new refinery anywhere in the Middle Atlantic area as symptomatic of the environmental problems all along the East Coast. The Army Corps of Engineers predicts that Gulf Coast refining capacity will increase by 300 percent by the year 2000, chiefly through expansion of present complexes. The Corps of Engineers estimates a 400 percent increase in Pacific Coast capacity by 2000, again through expansion.

In order to supply these increased refinery demands, either U.S. crude oil production must be increased or foreign crude oil imports will have to be markedly stepped up. The scope of this report does not cover an analysis of the potential sources of this crude oil. The assumption is made that through the year 2000 substantial crude oil will be imported to the continental United States and that in order to keep transportation costs to a minimum, this crude will be brought into the U. S. in very large crude carriers (VLCC's).

Several studies have been conducted that investigate the feasibility of various deepwater port alternatives. The Nathan study lists the deepwater port possibilities, and the rationale for each. According to Nathan, the following area seem the most promising:

1. New York Area
   a. Romer Shoal (off Sandy Hook)
   b. Long Branch (N. J.)

2. Delaware Bay
   a. Big Stone Beach
   b. area ten miles off Delaware Capes

3. Mobile-Pascagoula Area

4. Mississippi River Delta (Garden Island Bay)

5. Freeport (Texas)

6. Los Angeles-Long Beach Area

7. San Francisco Bay

8. Ferndale-Bellingham (Wash)

For each of these locations, offshore artificial islands, single point mooring systems, and dredged channels are considered.

The areas described above represent likely future high oil spill risk areas. A subsequent independent Coast Guard study will investigate these future risk areas and determine the key environmental parameters associated with them. The present study and the follow-on will then be correlated. Final design goals for the fast current oil control system will then be established.

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The majority of data for this study was obtained from Coast Guard Headquarters and field personnel, Coast Guard-funded studies and other developmental efforts, and the Department of Transportation Library.

The reference section of this study provides complete information on data sources.

RAW DATA

TABLE A

SELECTED SAMPLE OF GEOGRAPHIC AREAS OF HI-RISK OIL POLLUTION

Sources: U. S. Army Corps of Engineers, Waterborne Commerce of the United States (1970-71)

U. S. Army Corps of Engineers, Port Series

American Petroleum Institute, Information on Offshore and Inland Facilities and Pipeline Crossings (1972)

U. S. Coast Guard, Polluting Incidents In and Around U. S. Waters (1970-71-72)

Table A

SELECTED SAMPLE OF GEOGRAPHIC AREAS OF HI-RISK OIL POLLUTION

Map Reference	Area	State	District	Traffic&Storage (bbls x 10^{-3})	# of Terminals	(miles) Area Study	Area Study Limits
1	Portland (Harbor)	ME	1	216,440	14	35	Pemaquid Pt. to Cape Elizabeth
2	Penobscot (Bay)	ME	1	16,408	5	50	Bangor to Rockland
3	Albany (Hudson River)	NY	3	73,528	19	12	Island Creek to Troy Locks
4	Newburgh (Hudson River)	NY	3	3,840	13	21	Cornwall to North Poughkeepsie
5	East River	NY	3	124,110	17	15	Bklyn. Batt. Tun to Troburgh Br.&Throgs Neck Br.
6	New London (Thames River/Bay)	CONN	3	26,880	12	25	Norwich to Avery Pt.
7	Delaware (River)	PA	3	2,074	unkn	20	Trenton to Philadelphia
8	Philadelphia (Delaware Bay)	PA	3	169,974	10	25	Darby Creek to Poquessing Creek
9	Baltimore (Harbor)	MD	5	110,920	39	15	Sparrows Pt to Hawkins Pt.
10	Wash. D. C. (Potomac River)	DC	5	12,838	10	15	Key Bridge to Alexandria
11	Richmond (River)	VA	5	5,432	14	10	James River, Falling Creek to Richmond
12	York (River)	VA	5	23,309	3	5	West Point to Yorktown
13	Norfolk (Harbor/Roadstead)	VA	5	96,873	22	20	Norfolk/Portsmouth Harbor, Hampton Roads
14	Wilmington (Bay/River)	NC	5	27,251	15	15	Cape Fear&N.E.Cape Fear Rivers
15	Savannah (Harbor/river)	GA	7	24,920	9	10	St. Augustine Creek to Fort Jackson

Table A con't

Map Reference	Area	State	District	Traffic&Storage (bbls x 10^{-3})	# of Terminals	(miles) Area Study	Area Study Limits
16	Jacksonville (Harbor/River)	FLA	7	57,274	18	20	St. Johns River,Jax vicinity
17	Port Everglades (Harbor/Canal)	FLA	7	65,898	14	10	Ft.Lauderdale-Everglades vic. Nor. New River Canal
18	Tampa (Bay/Estuary)	FLA	7	66,661	15	30	Tampa Bay, Tampa-St.Peters-burg
19	New Orleans (River,Canal,IWW)	LA	8	130,767	16	25	Miss.R;IWW, Harvey Canal,St. Rose to Lk.Borgne Canal
20	Morgan City (IWW,Canal,River)	LA	8	78,043	20	50	Gulf to Plaquemine;IWW,Lake Hackberry to W.Cate Blanche Bay,Chapalia River to Basin
21	Houston (channel)	TX	8	274,568	25	20	Houston Turning Basin to LaPorte, Baytown
22	Corpus Christi (IWW/Canal)	TX	8	138,838	20	30	Port Ingleside to Rt.P22
23	LA/Long Beach (Harbor/Bay Approaches)	CA	11	191,656	61	15	Pt. Fermin to Anaheim
24	Santa Barbara (Channel)	CA	11		Platforms	18	Pt. Concepion East 18 miles
25	Suisan Bay (River,Delta)	CA	12	26,978	7	20	Antioch Lift Bridge to Suisan Pt.
26	Benecia Bay	CA	12	MEP Recommendation		10	West End Suisan Bay,Benecia Bridge to Martinez
27	Carquinez St. (Strait)	CA	12	103,887	12	15	Suisan Pt.to Pinole Pt.
28	Richmond (Channel)	CA	12	108,444	13	15	Pinole Pt. to Berkeley Pier
29	San Francisco (Bay)	CA	12	MEP Recommendation		10	5 miles E-W Golden Gate
30	Portland (River)	OR	13	37,828	15	15	Willemette River, Kelby Pt. to Stevens Pt;Confluence with Columbia

Table A con't

Map Reference	Area	State	District	Traffic&Storage (bbls x 10^{-3}) MEP Recommendation	# of Terminals	(miles) Area Study	Area Study Limits
31	Tri-Cities (River)	WA	13	3,300	1	100	Snake River Confluence with Columbia to the Dalles
32	Rosario (Strait)	WA	13	34,828	6	35	Bellingham Bay to Fidalgo Bay to Sound approaches
33	Pittsburgh (Rivers)	PA	2	7,511	13	30	Dams #2 on Allegheny & Monongahela Rv.toDashiell Dam
34	Huntington (River)	WVA	2	59,262	13	38	Ohio Rv.,Mile 302-Greenup Dam
35	Cincinnatti (River)	OH	2	26,348	23	50	Ohio Rv. Mile 450-500
36	Louisville (River)	OH	2	28,980	16	44	Ohio Rv, Mile 600-644
37	Evansville (River)	IND	2	20,559	11	42	Ohio Rv, Mile 790-832
38	Nashville (River)	TENN	2	10,423	11	25	Cumberland River-Miles 220-165
39	Memphis (River)	TENN	2	32,802	13	20	Miss. R. Cows-Id Bend to Loosatchia River
40	Helena (River)	ARK	2	9,324	4	24	Miss. R. Stumpy Pt to Old Town Bend
41	Minn-St.Paul (Rivers)	MINN	2	10,241	13	35	Miss. R, Miles 15&859-811
42	Chicago (San. Ship Canal)	ILL	9	62,895	12	20	Chicago,Ashland St. to State Hwy #83 Bridge
43	Indiana (Canal)	IND	9	55,111	8	10	Lake Michigan, Illinois line to E, Chicago Beach
44	St. Clair (River)	MICH	9	MEP Recommendation		30	Blue Water Bridge South to Lake St. Clair

Table B

RANK ORDER OF PETROLEUM CONCENTRATION AREAS BY VOLUME, DISTRICT AND SPILL INCIDENT (% totals 1971-72)

Sources: U.S. Army Corps of Engineers, Waterborne Commerce of the United States (1970-71)

U.S. Army Corps of Engineers, Port Series

American Petroleum Institute, Information on Offshore and Inland Facilities and Pipeline Crossings (1972)

U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1970-71-72)

Table B
RANK ORDER OF PETROLEUM CONCENTRATION AREAS BY VOLUME, DISTRICT
AND SPILL INCIDENT (% totals 1971-72)

Total Areas = 131
Total Districts = 10
Total % Spills = 100

Rank Order	District	% of Total Spills 1971-1972	Vol.&Traf. >100 mil. bbls Area (14)	Vol.&Traf. >50-100 mil.bbls Area (15)	Vol.&Traf. >25-50 mil bbls Area 21)	Vol.&Traf. >10-25 mil.bbls Area 29)	Vol.&Traf. >3-10 mil.bbls Area 52)
1	8th	47.7%	New Orleans,LA	Morgan City,LA	Mobile,AL	Plaquemines,LA	Birmingham,ALA
			Baton Rouge,LA	Lake Charles,LA	Pascagoula,MISS	Baratavia,LA	St.Bernard,LA
			Pt. Arthur,TX	Texas City,TX	Aransas Ch.,TX	Houma,LA	Raceland,LA
			Beaumont,TX		Brownsville,TX	Lake Arthur,LA	Lafayette,LA
			Houston,TX				Johnsons Bayou,LA
			Corpus Christi,TX				Freeport,TX
							Laguna Madre,TX
							Vicksburg,LA
							Port Lavaca, TX
2	3rd	11.7%	East River,NY	New Haven, CT	Fall River, MASS	Raritan,NJ	Stamford,CT
			Bayonne,NJ	Albany,NY	New London,CT	Bridgeport,CT	Burlington,VT
			Arthur Kill,NJ	Passaic River,NJ	Conn. River,CT	Wilmington,DEL	Plattsburgh,NY
			Phila., PA	Chester-Marcus,PA	Pt.Jefferson,NY	Newtown Cr.,NY	Flushing Bay,NY
						Oceanside,NY	Manhassett Bay,NY
						Jamaica Bay,NY	Camden,NJ
						Hackensack R.NJ	Hempstead,NY
						Mt.Vernon,NY	Kingston,NY
						Brooklyn,NY	Newburgh,NY
3	11th	6.8%	Los Angles,CA				San Diego,CA
4	7th	5.7%		Pt.Everglades,FL		Savannah,GA	Palm Beach,FL
				Tampa,FL		Canaveral,FL	Charlotte Hbr,FL
				Jacksonville,FL		Miami,FL	Panama City,FL
							Pensacola,FL
							St.Marks,FL
							Port St.Joe,FL
5	12th	5.3%	Carquinez Strait,CA	Richmond,CA	Mare Island,CA	SanFrancisco,CA	Oakland,CA
						Suisan Bay,CA	SanLuis Obispo,CA
6	9th	4.8%			Indiana Hbr,IL		Syracuse,NY,Toledo,OH
					Sanitary Ship Canal,IL		Rochester,NY,Detroit,MI
							Buffalo,NY,Duluth,MINN
							BayCity,MI,ChicagoR.IL
							Calumet S.Ch,IL,Mil.WI
							SaultSt.Ma.MI,Muskegon
							MI,Grand Haven,MI

Table B con't

Rank Order	District	%of Total Spills 1971-1972	Vol.&Traf. >100 mil. bbls Area (14)	Vol.&Traf. >50-100 mil.bbls Area (15)	Vol.&Traf. >25-50 mil.bbls Area (21)	Vol.&Traf. >10-25 mil.bbls Area (29)	Vol.&Traf. >3-10 mil.bbls Area (52)
7	2nd	4.1%		Huntinton,WVA	Louisville,KY Memphis,TENN Cincinnati,OH Owensboro,KY	St.Louis,MO Paducah,KY Minneapolis,MINN Nashville,TENN Evansville,IND	Helena,ARK Greenville,ARK Charleston,WVA Lower MonongahelaRi.PA Pittsburgh,PA Aliquippa,PA
Other (Non-Correlated)Districts in parens(1)		13.9%/5dist. 2.8%/Dist.	Portland,ME(1) Boston,MASS(1)	Providence,RI(1) Baltimore,MD(5) Norfolk,VA(5)	Charleston,SC(5) Portland,OR(13) Seattle,WA(13) Anacortes,WN(13) Oahu,HA(14) YorkRiver,VA(5)	PenobscotBay,ME(1) Portsmouth,NH(1) Quincy,MASS(1) Wash.D.C (5) Wilmington,NC(5) Tacoma,WN(13)	Salem,MASS(1) NewBedford,MASS(1) Salisbury,MD(5) Richmond,VA(5) The Dalles,OR(13) Anchorage,ALASKA(17)

Table C

QUANTITIES OF OIL PER SPILL 1971-1972

Source: U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1971-72)

TABLE C

QUANTITIES OF OIL PER SPILL
1971-1972

Year	Size Gallons	Number Incidents	% Total	Volume Gallons	% of Total	Gal Per Spill
71		2,867	32.9	-	-	-
72	Unknown	2,791	28.2	-	-	--
	Totals	5,658	30.5			
71		4,272	49.1	94,322	1.1	22 +
72	1-99	5,412	54.7	107,729	0.6	19 +
	Totals	9,684	51.9	202,051	.85	20 +
71						
72	100-999	1,203	13.8	336,640	3.8	279 +
		1,309	13.2	356,474	1.9	27[illegible] +
	Totals	2,512	13.5	693,114	2.85	275 +
71						
72	1K-9,999	285	3.3	830,595	9.4	2914 +
		299	3.0	866,645	4.6	2898 +
	Totals	584	3.2	1,697,240	7.0	2906 +
71						
72	10K-99,999	65	0.7	1,604,580	18.1	24,685+
		63	0.7	2,086,684	11.1	33,121+
	Totals	128	0.7	3,691,264	14.6	28,838+
71		17	0.2	5,973,386	67.6	351,375+
72	100K +	19	0.2	15,388,200	81.8	809,905+
	Totals	36	0.2	21,361,586	74.7	593,377+

Average Quantity/Spill = 125,083 + gallons

Table D

SPILL QUANTITIES BY SIZE AND SOURCE (Marine Oriented Only)
1971 and 1972

Source: U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1971-72)

TABLE D

SPILL QUANTITIES BY SIZE & SOURCE
(Marine Oriented Only)
1971 & 1972

Source	No. of Incidents	Volume Gallons	Gal Per Spill
Vessels			
Tankships			
71	386	1,665,264	4314 +
72	453	2,583,952	5704 +
Total	839	4,249,216	5064 +
Tankbarges			
71	828	1,197,819	1446 +
72	830	3,739,144	4504 +
Total	1658	4,936,963	2977 +
Combatant			
71	261	440,849	1689 +
72	294	40,923	139 +
Total	555	481,772	868 +
Waterfront Transport Facilities			
71	382	613,970	1607 +
72	478	943,264	1973 +
Total	860	1,557,234	1810 +
Offshore Facilities			
71	2595	662,203	255 +
72	2317	237,063	102 +
Total	4912	899,266	183 +

Average Quantity per Spill = 2180 gals.

Table E

ENVIRONMENTAL CRITERIA RESULTS (Averages)

Sources: U.S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

U.S. Department of Commerce, Tidal Current Tables (1973)

U.S. Department of Commerce, Tide Tables (1973)

U.S. Department of Commerce, Marine Weather Service Charts (1973)

U.S. Department of Commerce, Local Climatological Data (1972)

TABLE [illegible]

ENVIRONMENTAL CRITERIA RESULTS (Averages)
GEOGRAPHIC AREAS

	CURRENT (Knots)						TIDE (Feet)					
AREA	HI	LO	Av. HI	Av. LO	Av. Mean Flood	Av. Mean Ebb	HI	LO	Av. HI	Av. LO	Av. Mean	Av. Range
Atlantic	4.7	0.2	1.9	0.6	1.1	1.4	15.3	-1.7	5.7	-0.6	2.6	6.6
Gulf	3.5	0.2	2.9	0.2	1.1	1.3	3.5	-0.9	2.3	-0.9	0.8	3.1
Pacific	5.6	0.2	3.0	0.5	1.5	2.1	9.6	-2.9	5.5	-1.7	3.2	7.9
Inland	12.0	0.0	6.2	0.8	1.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G.Lakes	3.2	0.0	2.0	0.8	0.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Areas Av	5.8	0.2	3.2	0.6	1.2	1.6	9.5	-1.8	4.5	1.1	2.2	5.9

	TEMP (Sea F^o)					TEMP (Air F^o)						
						Record (Av.)				Extreme		
AREA	HI	LO	Av HI	Av LO	Av. Mean	Max	Min	Mean	HI	LO	Av. HI	Av. LO
Atlantic	93	27	87	33	62	65	47	57	107	-39	102	-04
Gulf	92	41	90	49	72	79	60	70	102	10	100	18
Pacific	76	35	72	42	56	67	48	57	114	-16	107	15
Inland	87	30	85	37	54	66	47	56	109	-20	102	-13
G.Lakes	80	32	73	32	49	57	41	49	101	-14	100	-15
Areas Av.	86	33	81	39	59	67	49	58	107	-20	102	.05

	WAVES (feet)			WIND (Knots)					
				Fastest Mile				Average of	
AREA	Av.% & Ht	Av.% & Ht	Mean Ht.	HI	LO	Av.	Mean	% of Speed	
Atlantic	67 < 3-4	83 < 5-6	3.3	77	52	64	8.4	53	7-16
Gulf	69 < 3-4	87 < 5-6	3.0	104	40	62	7.7	58	7-16
Pacific	48 < 3-4	67 < 5-6	2.9	77	38	48	6.3	45	7-16
Inland	N/A	N/A		80	41	54	7.4	N/A	
G.Lakes	N/A	N/A		52	45	50	9.0	N/A	
Areas Av.	61 < 3-4	79 < 5-6	3.1	78	43	56	7.8	52	7-16

TABLE EE

ENVIRONMENTAL CRITERIA RESULTS (Averages)
WATERS

WATERS	CURRENT (Knots) HI	LO	Av HI	AV LO	Av Mean Flood	Av Mean Ebb	TIDE (feet) HI	LO	Av HI	Av LO	Av Mean	Av Range
Inland Rivers (12)	12.0	0.0	5.6	0.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Open River (12)	4.7	0.1	2.2	0.6	1.2	1.5	9.2	0.4	4.9	-0.4	2.0	5.0
Canals (3)	2.0	0.0	1.6	0.3	0.7	0.5	2.8	-0.9	0.9	0.4	0.4	1.2
Channel (5)	4.2	0.2	2.9	0.3	1.1	1.4	9.6	-2.9	7.6	0.2	2.8	8.7
Inland W Way (1)	2.1	0.2	2.1	0.2	0.9	1.2	2.1	-0.8	2.1	-0.8	0.8	2.9
Harbor (4)	2.6	0.2	1.8	0.3	0.9	1.0	11.2	-1.8	5.9	1.2	3.2	7.0
Bays (5)	5.6	0.2	2.6	0.5	1.5	1.4	15.3	-1.7	8.1	1.2	6.2	9.3
RegionAv.	4.7	0.2	2.7	0.4	1.0	1.1	7.2	-1.3	4.9	0.6	2.6	5.7

WATERS	TEMP (Sea F°) HI	LO	Av HI	Av LO	Av Mean	TEMP (Air F°) Record (Av) Max	Record (Av) Min	Mean	Extreme HI	Extreme LO	Av HI	Av LO
I-Rivers	88	30	75	34	49	64	46	55	113	-34	103	-16
O-Rivers	93	27	86	35	63	67	48	60	114	-28	103	02
Canals	92	70	71	42	59	66	50	58	101	-16	99	01
Channels	92	35	76	43	60	68	50	59	110	-07	102	24
IWW	90	57	N/A	N/A	77	78	64	71	101	25	N/A	N/A
Harbors	93	27	83	34	57	65	45	55	111	-39	104	-03
Bays	92	27	82	39	60	67	48	58	114	-39	85	06
RegionAv.	91	39	81	38	61	68	50	59	109	-36	99	07

WATERS	WAVES (Feet) Av % & Ht	Av % & Ht	Mean Ht	WIND (Knots) Fastest Mile HI	Fastest Mile LO	Fastest Mile Av.	Annual Mean	Average of % of Speed
I-Rivers	N/A	N/A	N/A	80	41	55	7.2	N/A
O-Rivers	56 < 3-4	80 < 5-6	3.2	77	40	61	8.4	53 at 7-16
Canals	N/A	N/A	N/A	64	52	56	8.7	N/A
Channels	53 < 3-4	71 < 5-6	3.2	52	40	46	6.4	47 at 7-16
IWW	67 < 3-4	86 < 5-6	3.0	104	N/A	N/A	10.3	58 at 7-16
Harbors	68 < 3-4	83 < 5-6	3.3	70	38	61	7.8	50 at 7-16
Bays	62 < 3-4	78 < 5-6	3.0	66	40	54	7.5	49 at 7-16
RegionAv	61 < 3-4	80 < 5-6	3.1	73	42	56	8.5	51 at 7-16

TABLE EEE

ENVIRONMENTAL CRITERIA RESULTS (Averages)
GEOGRAPHICAL AREAS AND WATERS

CURRENTS (Knots)

Location	HI	LO	Av HI	Av LO	Av Mean Flood	Av Mean Ebb
Area	5.8	0.2	3.2	0.6	1.2	1.6
Waters	4.7	0.2	2.7	0.4	1.0	1.1

TIDE (Feet)

Location	HI	LO	Av HI	Av LO	Av Mean	Av Range
Area	9.5	-1.8	4.5	1.1	2.2	5.9
Waters	7.2	-1.3	4.9	0.6	2.6	5.7

TEMP (Sea F°)

Location	HI	LO	Av HI	Av LO	Av Mean
Area	86	33	81	39	59
Waters	51	39	81	38	61

TEMP (Air F°)

Location	Record Max	Average Min	Mean	Extreme HI	Extreme LO	Av HI	Av LO
Area	67	49	58	107	-20	102	.05
Waters	68	50	59	109	-36	99	7.0

WAVES (Feet)

Location	Av % & Ht	Av % & Ht	Mean Ht
Area	61 < 3-4	79 < 5-6	3.1
Waters	61 < 3-4	80 < 5-6	3.1

WIND (Knots)

Location	Fastest Mile HI	Fastest Mile LO	Fastest Mile Av	Mean	Average of %	Average of Speed
Area	78	43	56	7.8	52	7-16
Waters	73	42	56	8.5	51	7-16

Table F

ENVIRONMENTAL CRITERIA - ATLANTIC (Current and Tide)

Sources: U.S. Department of Commerce, Tidal Current Tables (1973)

U.S. Department of Commerce, Tide Tables (1973)

U.S. Department of Commerce, Marine Weather Service Charts (1973)

TABLE F

ENVIRONMENTAL CRITERIA ATLANTIC

Geog. Area	Map Ref	Location	State	Dist.	Current (Knots) HI	Current (Knots) LO	Current (Knots) Mean Flood	Current (Knots) Mean Ebb	Tide (feet) HI	Tide (feet) LO	Tide (feet) Mean	Tide (feet) Rng.
ATL	1	Portland	ME	1	2.0	0.4	1.0	1.1	11.2	-1.7	6.5	12.9
ATL	2	Penobscot	ME	1	0.5	0.2	0.3	0.6	15.3	-1.7	6.5	17.0
ATL	3	Albany	NY	3	0.5	0.2	0.3	0.8	6.3	- .5	2.3	6.8
ATL	4	Newburg	NY	3	1.3	0.5	0.9	1.1	4.5	-1.3	1.5	5.8
ATL	5	East R-Bklyn	NY	3	4.7	2.5	2.9	3.5	6.1	-1.2	2.2	7.3
ATL	6	NewLondon	CT	3	0.5	0.2	0.1	0.2	3.1	-0.8	2.0	3.9
ATL	7	DelawareR	PA	3	1.1	1.0	0.9	1.8	8.5	0.6	3.4	9.0
ATL	8	Philadelphia	PA	3	2.0	1.0	1.7	1.6	7.6	-0.5	4.1	8.1
ATL	9	Baltimore	MD	5	1.3	0.2	0.7	0.9	2.0	-0.7	1.4	2.1
ATL	10	Washington	DC	5	2.0	0.2	1.0	0.9	3.7	0.9	1.4	4.6
ATL	11	Richmond	VA	5	1.6	0.2	.8	.9	4.1	0.7	1.6	5.0
ATL	12	Yorkriver	VA	5	2.4	0.3	1.2	1.6	3.4	0.7	1.2	4.1
ATL	13	Norfolk	VA	5	2.6	0.4	1.3	2.0	3.3	0.7	2.0	4.0
ATL	14	Wilmington	NC	5	3.0	0.5	1.7	1.5	4.4	-0.8	2.6	5.2
ATL	15	Savannah	GA	7	3.3	0.6	1.6	2.2	9.2	-1.2	3.8	10.4
ATL	16	Jacksonville	FL	7	2.3	0.7	1.6	1.7	2.6	-0.4	0.7	3.1
ATL	17	PtEverglades	FL	7	2.0	0.9	1.3	1.7	2.8	-0.9	1.2	3.7

Table G

ENVIRONMENTAL CRITERIA - ATLANTIC (Sea and Air Temperature)

Sources: U.S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

U.S. Department of Commerce, Local Climatological Data (1972)

TABLE G

ENVIRONMENTAL CRITERIA - ATLANTIC

Geog. Area	Map Ref	Location	State	Temp Sea (F°) HI	Temp Sea (F°) LO	Temp Sea (F°) Mean	Temp Air (F°) Record Average Max	Temp Air (F°) Record Average Min	Temp Air (F°) Record Average Mean	Temp Air (F°) Extreme HI	Temp Air (F°) Extreme LO
ATL	1	Portland	ME	84	27	48	54	37	46	100	-39
ATL	2	Penobscot	ME	84	27	48	54	37	46	100	-39
ATL	3	Albany	NY	84	27	55	57	20	48	98	-28
ATL	4	Newburg	NY	84	27	55	62	47	54	107	- 2
ATL	5	East R Bklyn	NY	70	36	53	62	47	55	107	- 2
ATL	6	NewLondon	CT	84	27	55	60	42	54	100	- 3
ATL	7	Delaware R	PA	89	27	59	62	45	54	106	-14
ATL	8	Philadelphia	PA	89	27	59	63	46	56	104	- 5
ATL	9	Baltimore	MD	77	38	59	65	45	51	101	- 3
ATL	10	Washington	DC	93	27	63	66	48	57	101	- 3
ATL	11	Richmond	VA	93	27	63	69	47	58	104	-12
ATL	12	YorkRiver	VA	93	27	63	68	52	60	103	8
ATL	13	Norfolk	VA	93	27	63	68	52	60	103	8
ATL	14	Wilmington	NC	93	33	74	72	54	63	100	13
ATL	15	Savannah	GA	91	49	77	67	58	71	102	9
ATL	16	Jacksonville	FL	90	59	80	76	59	68	105	12
ATL	17	PtEverglades	FL	92	63	80	83	67	75	96	34

Table H

ENVIRONMENTAL CRITERIA - ATLANTIC (Waves and Wind)

Source: U.S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

TABLE H

ENVIRONMENTAL CRITERIA- ATLANTIC

Geog. Area	Map Ref	Location	State	WAVES (feet) Averages Dist.	%	Ht	%	Ht	Mean Ht	WIND (knots) Fastest Mile	Mean	Average %	Speed
ATL	1	Portland	ME	1	82	3-4	95	5-6	3.0	66	7.6	50	7-16
ATL	2	Penobscot	ME	1	82	3-4	95	5-6	3.0	66	7.6	50	7-16
ATL	3	Albany	NY	3	71	3-4	86	5-6	3.0	62	7.6	50	7-16
ATL	4	Newburg	NY	3	71	3-4	86	5-6	3.0	61	10.7	50	7-16
ATL	5	EastRBklyn	NY	3	71	3-4	86	5-6	3.0	61	10.7	50	7-16
ATL	6	NewLondon	CT	3	71	3-4	86	5-6	3.0	58	10.4	50	7-16
ATL	7	Delaware	PA	3	62	3-4	80	5-6	3.5	52	7.8	51	7-16
ATL	8	Philadelphia	PA	3	62	3-4	80	5-6	4.0	64	8.4	51	7-16
ATL	9	Baltimore	MD	5	69	3-4	83	5-6	3.0	70	8.4	52	7-16
ATL	10	Washington	DC	5	69	3-4	83	5-6	3.0	68	8.0	52	7-16
ATL	11	Richmond	VA	5	69	3-4	83	5-6	3.0	59	6.6	52	7-16
ATL	12	Yorkriver	VA	5	69	3-4	83	5-6	3.0	68	9.2	52	7-16
ATL	13	Norfolk	VA	5	69	3-4	83	5-6	3.0	68	9.2	52	7-16
ATL	14	Wilmington	NC	5	51	3-4	72	5-6	4'	77	8.0	50	7-16
ATL	15	Savannah	GA	7	49	3-4	71	5-6	4'	57	7.2	71	7-16
ATL	16	Jacksonville	FL	7	53	3-4	75	5-6	4'	71	7.7	54	7-16
ATL	17	PtEverglades	FL	7	66	3-4	84	5-6	3'	64	7.8	58	7-16

Table I

ENVIRONMENTAL CRITERIA - GULF AND PACIFIC (Current and Tide)

Sources: U. S. Department of Commerce, Tidal Current Tables (1973)
U. S. Department of Commerce, Tide Tables (1973)
U. S. Department of Commerce, Marine Weather Service Charts (1973)

TABLE I
ENVIRONMENTAL CRITERIA-GULF & PACIFIC

Geog Area	Map Ref	Location	State	Dist.	CURRENT (Knots) HI	LO	Mean Flood	Mean Ebb	TIDE (Feet) HI	LO	Mean	Rng
GLF	18	Tampa	FL	7	3.5	0.2	0.9	0.9	3.5	-0.9	1.3	4.4
GLF	19	New Orleans	LA	8	2.8	0.2	1.1	1.5	1.7	-0.9	0.5	2.6
GLF	20	Morgan City	LA	8	N/A	N/A	N/A	N/A	1.9	-0.8	0.7	2.7
GLF	21	Houston	TX	8	3.5	0.2	1.3	1.4	N/A	N/A	N/A	N/A
GLF	22	Corpus Chris	TX	8	2.1	0.2	0.9	1.2	2.1	-0.8	0.8	2.9

N/A = Data Unreliable Not applicable.

Geog Area	Map Ref	Location	State	Dist.	CURRENT (Knots) HI	LO	Mean Flood	Mean Ebb	TIDE (Feet) HI	LO	Mean	Rng
PAC	23	LA/LB	CA	11	1.2	0.2	0.7	0.7	7.0	-1.8	2.8	8.8
PAC	24	SB Channel	CA	11	1.2	012	0.5	0.5	6.8	1.8	2.8	5.0
PAC	25	Suisan Bay	CA	12	2.5	0.4	1.5	1.4	5.1	-0.8	2.2	6.9
PAC	26	Martinez	CA	12	1.3	0.6	1.9	2.2	7.1	-1.6	3.2	8.7
PAC	27	Carquinez St.	CA	12	3.1	0.5	1.3	1.7	7.3	1.5	3.3	8.8
PAC	28	Richmond	CA	12	2.5	0.5	1.3	1.6	7.0	-1.5	3.1	8.5
PAC	29	SF Bay	CA	12	5.6	0.7	2.5	2.3	6.9	-1.5	3.1	8.4
PAC	30	Portland	OR	13	5.3	0.5	3.0	0.6	N/A	N/A	N/A	N/A
PAC	31	TriCities	WN	13	3.5	0.8	N/A	N/A	N/A	N/A	N/A	N/A
PAC	32	Rosario	WN	13	4.2	0.2	1.1	2.2	9.6	-2.9	4.9	12.5

Table J

ENVIRONMENTAL CRITERIA - GULF and PACIFIC
(Sea and Air Temperature)

Sources: U. S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

U. S. Department of Commerce, Local Climatological Data (1972)

TABLE J
ENVIRONMENTAL CRITERIA–GULF&PACIFIC

Geog Area	Map Ref	Location	State	Dist	TEMP (Sea F°) HI	TEMP (Sea F°) LO	TEMP (Sea F°) Mean	TEMP (Air F°) Record Average Max	Record Average Min	Record Average Mean	Extreme HI	Extreme LO
GLF	18	Tampa	FL	7	92	55	78	81	63	72	97	23
GLF	19	New Orleans	LA	8	87	41	64	78	60	69	100	14
GLF	20	Morgan City	LA	8	87	42	65	78	57	68	102	10
GLF	21	Houston	TX	8	92	49	76	79	57	68	100	19
GLF	22	Corpus Chris	TX	8	90	57	77	78	64	71	101	25

N/A = Data Unreliable Not Applicable

Geog Area	Map Ref	Location	State	Dist	TEMP (Sea F°) HI	TEMP (Sea F°) LO	TEMP (Sea F°) Mean	TEMP (Air F°) Record Average Max	Record Average Min	Record Average Mean	Extreme HI	Extreme LO
PAC	23	LA/LB	CA	11	76	45	59	73	53	63	111	25
PAC	24	SB Channel	CA	11	76	45	57	70	54	62	110	30
PAC	25	Suisan Bay	CA	12	72	43	57	74	48	6k	114	19
PAC	26	Martinez	CA	12	72	43	57	74	48	61	114	19
PAC	27	Carquinez St	CA	12	72	43	57	66	49	57	99	26
PAC	28	Richmond	CA	12	72	43	57	66	49	57	99	26
PAC	29	SF Bay	CA	12	72	43	57	65	48	57	101	30
PAC	30	Portland	OR	13	72	37	55	61	43	52	107	-3
PAC	31	Tri Cities	WN	13	68	40	53	63	44	54	113	-16
PAC	32	Rosario St	WN	13	70	35	52	60	39	50	100	-7

Table K

ENVIRONMENTAL CRITERIA - GULF and PACIFIC
(Waves and Wind)

Source: U.S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

TABLE K

ENVIRONMENTAL CRITERIA - GULF & PACIFIC

Geog Area	Map Ref	Location	State	Dist.	Waves(feet) Averages % & Ht.	% & Ht	Mean	Wind (Knots) Fastest Mile	Mean	Average % & Speed
GLF	18	Tampa	FL	7	72 < 3-4	87 < 5-6	3	58	7.7	56 7-16
GLF	19	New Orleans	LA	8	67 < 3-4	86 < 5-6	3	60	7.3	58 7-16
GLF	20	Morgan City	LA	8	67 < 3-4	86 < 5-6	3	50	6.9	58 7-16
GLF	21	Houston	TX	8	70 < 3-4	88 < 5-6	3	40	6.3	58 7-16
GLF	22	Corpus Chris	TX	8	67 < 3-4	86 < 5-6	3	104	10.3	58 7-16

N/A = Data Unreliable Not Applicable

Geog Area	Map Ref	Location	State	Dist.	Waves(feet) Averages % & Ht.	% & Ht	Mean	Wind (Knots) Fastest Mile	Mean	Average % & Speed
PAC	23	LA/LB	CA	11	50 < 3-4	70 < 5-6	4	38	5.8	44 7-16
PAC	24	SB Channel	CA	11	50 < 3-4	70 < 5-6	4	54	6.4	44 7-16
PAC	25	SuisanBay	CA	12	46 < 3-4	65 < 5-6	2	40	6.3	45 7-16
PAC	26	Marinez	CA	12	46 < 3-4	65 < 5-6	2	40	6.3	45 7-16
PAC	27	Carquinez St	CA	12	46 < 3-4	65 < 5-6	2	40	6.3	45 7-16
PAC	28	Richmond	CA	12	46 < 3-4	65 < 5-6	2	43	7.0	45 7-16
PAC	29	SF Bay	CA	12	46 < 3-4	65 < 5-6	3	41	7.6	45 7-16
PAC	30	Portland	OR	13	N/A	N/A	N/A	77	6.7	N/A N/A
PAC	31	Tri Cities	WN	13	N/A	N/A	N/A	58	4.6	N/A N/A
PAC	32	Rosario St.	WN	13	52 < 3-4	69 < 5-6	4	52	5.8	43 7-16

Table L

ENVIRONMENTAL CRITERIA - INLAND and GREAT LAKES
(Current and Tide)

Sources: U. S. Department of Commerce, _Tidal Current Tables_ (1973)

U. S. Department of Commerce, _Tide Tables_ (1973)

U. S. Department of Commerce, _Marine Weather Service Charts_ (1973)

TABLE L

ENVIRONMENTAL CRITERIA - INLAND & GREAT LAKES

GEOG. AREA	MAP REF	LOCATION	STATE	DISTRICT	Current (Knots) HI	Current (Knots) LO	Current (Knots) MEAN Flood	Current (Knots) MEAN Ebb	TIDE (Feet) HI	TIDE (Feet) LO	TIDE (Feet) MEAN	RANGE
INL	33	PITTSBURG	PA	2	12.0	0.2	N/A	N/A	N/A	N/A	N/A	N/A
INL	34	HUNTINGTON	W.VA	2	3.4	2.1	2.3	N/A	N/A	N/A	N/A	N/A
INL	35	CINCY	OH	2	8.0	0.5	N/A	N/A	N/A	N/A	N/A	N/A
INL	36	LOUISVILLE	KY	2	8.0	0.7	N/A	N/A	N/A	N/A	N/A	N/A
INL	37	EVANSVILLE	ID	2	7.5	0.7	N/A	N/A	N/A	N/A	N/A	N/A
INL	38	NASHVILLE	TN	2	3.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A
INL	39	MEMPHIS	TN	2	4.3	0.8	N/A	N/A	N/A	N/A	N/A	N/A
INL	40	HELENA	AR	2	4.8	1.1	N/A	N/A	N/A	N/A	N/A	N/A
INL	41	MINN-ST.PAUL	MIN	2	4.0	0.2	0.9		N/A	N/A	N/A	N/A
GL	42	CHICAGO	ILL	9	1.6	0.2	0.6		N/A	N/A	N/A	N/A
GL	43	IND-HARBOR	ID	9	1.2	0.0	0.1		N/A	N/A	N/A	N/A
GL	44	ST CLAIR	MICH	9	3.2	1.4	2.2		N/A	N/A	N/A	N/A

Table M

ENVIRONMENTAL CRITERIA - INLAND and GREAT LAKES
(Sea and Air Temperature)

Sources: U.S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

U.S. Department of Commerce, Local Climatological Data (1972)

TABLE M

ENVIRONMENTAL CRITERIA - INLAND & GREAT LAKES

GEOG	MAP				TEMP (Sea F°)			TEMP (Air F°) RECORD AVERAGE				EXTREME
AREA	REF	LOCATION	STATE	DISTRICT	HI	LO	MEAN	MAX	MIN	MEAN	HI	LO
INL	33	PITTSBURG	PA	2	88	30	52	62	44	53	98	-18
INL	34	HUNTINGTON	W.VA.	2	80	40	55	67	45	56	100	-15
INL	35	CINCY	OH	2	84	40	55	64	45	55	109	-17
INL	36	LOUISVILLE	KY	2	84	40	54	66	47	57	101	-20
INL	37	EVANSVILLE	ID	2	84	40	55	66	47	57	104	-18
INL	38	NASHVILLE	TN	2	86	42	55	69	50	60	103	-6
INL	39	MEMPHIS	TN	2	88	33	54	71	53	62	106	-13
INL	40	HELENA	AK	2	87	34	54	71	53	62	94	20
INL	41	MINN-ST.PAUL	MINN	2	84	32	48	54	36	45	99	-34
GL	42	CHICAGO	ILL	9	80	32	50	57	42	50	101	-16
GL	43	IND-HARBOR	ID	9	70	32	48	57	42	50	101	-16
GL	44	ST.CLAIR	MC	9	69	33	N/A	58	39	48	99	-14

Table N

ENVIRONMENTAL CRITERIA - INLAND and GREAT LAKES
(Waves and Wind)

Source: U. S. Navy, Summary of Synoptic Meteorlogical Observations (1970)

TABLE N

ENVIRONMENTAL CRITERIA- INLAND & GREAT LAKES

					WAVES (Feet)			WIND (Knots)			
Geog Area	Map Ref	Location	State	Dist.	Averages % & Ht.	% & Ht	Mean	Fastest Mile	Mean	Average %	& Speed
INL	33	Pittsburg	PA	2	N/A	N/A	N/A	51	8.2	N/A	N/A
INL	34	Huntington	WVA	2	N/A	N/A	N/A	41	5.5	N/A	N/A
INL	35	Cincy	OH	2	N/A	N/A	N/A	43	6.2	N/A	N/A
INL	36	Louisville	KY	2	N/A	N/A	N/A	53	7.2	N/A	N/A
INL	37	Evansville	ID	2	N/A	N/A	N/A	51	7.2	N/A	N/A
INL	38	Nashville	TN	2	N/A	N/A	N/A	64	6.9	N/A	N/A
INL	39	Memphis	TN	2	N/A	N/A	N/A	50	8.0	N/A	N/A
INL	40	Helena	AR	2	N/A	N/A	N/A	50	8.0	N/A	N/A
INL	41	Minn-StPaul	MN	2	N/A	N/A	N/A	80	9.1	N/A	N/A
GL	42	Chicago	IL	9	N/A	N/A	N/A	52	9.2	N/A	N/A
GL	43	Ind-Harbor	ID	9	N/A	N/A	N/A	52	9.2	N/A	N/A
GL	44	St Clair	MC	9	N/A	N/A	N/A	45	8.7	N/A	N/A

TABLE O

SUPPORT CRITERIA-AIRCRAFT AVAILABILITY

Geog Area	Map Ref	Location	State	Dist.	TYPES AIRCRAFT & NUMBER AVAILABLE HH-3F	HU 16E	HH52A	VC 11A	VC 4A	130E	130B	123B
ATL	1	Otis AFB	MA	1	3	0	4	0	0	0	0	0
ATL	5	Brooklyn	NY	3	3	0	4	0	0	0	0	0
ATL	5	Cape May	NJ	3	0	0	1	0	0	0	0	0
ATL	10	Washington	DC	HQ	0	0	0	1	1	0	0	0
ATL	14	Eliz City	NC	5	0	3	3	0	0	1	5	0
ATL	15	Savannah	GA	7	0	0	2	0	0	0	0	0
ATL	17	Miami	FL	7	0	5	4	0	0	0	0	1
GLF	18	St Pete	FL	7	4	0	0	0	0	0	0	0
GLF	19	Mobile	AL	HQ	3	3	18	0	0	0	0	0
GLF	19	New Orleans	LA	8	3	0	0	0	0	0	0	0
GLF	21	Houston	TX	8	0	0	3	0	0	0	0	0
GLF	22	Corpus C.	TX	8	0	3	2	0	0	0	0	0
PAC	23	S. Diego	CA	11	4	0	0	0	0	0	0	0
PAC	23	LA/LB	CA	11	0	0	2	0	0	0	0	0
PAC	29	SFO	CA	12	0	3	4	0	0	0	2	0
PAC	32	PortAngeles	WA	13	0	3	3	0	0	0	0	0
INL	44	Detroit	MN	9	0	0	3	0	0	0	0	0
INL	42	Chicago	IL	9	0	0	2	0	0	0	0	0

TABLE P

SUPPORT CRITERIA VESSEL AVAILABILITY
ATLANTIC

Geog Area	Map Ref	Location	State	Dist	FLEET VESSELS	OTHER VESSELS
ATL	1	Portland Penobscot	ME ME	1 1	1-WPB 82 1-WLB 1-WYTM 2-WMEC 1-WYTL 3-WHEC	10-25'MSB 27-PEOIN 7-17'UTL 4-18'UTL 1-44'MLB 1-56' LCM 13-SKM 4-25'MCB 1-20'DIN 11-46'BUSL10-SKB 1-31'Barge 1-20'DIN 10-40'UTB 4-44'MSB 1-40'BU 1-SKL
ATL	5	New York	NY	3	1-WPB 82 1-WLB 1-WPB 93 1-WLM 4-WHEC 3-WYTM 1-WAGO 4-WYTL 1-WMEC 1-WLI	3-46'BUSL 1-44'UTB 2-25 MCB 14-25"MSB 3-44'MLB 5-SKB 1-22'MRB 4-30'UTM 6-SKM 7-17'UTL 3-SKL 1-70'Barge
ATL	6	New London	CT	3	1-WHEC 1-WLB 1-WMEC 1-WPB 95 1-WLM 1-WPB 82	4-64'CT 4-64'YL 1-25'MCB 1-30'UTM 1-SKM 2-17'UTL
A ATL	8	Cape May	NJ	3	1-WTR 1-WPB 95 1-WMEC 1-WPB 82 1-WLB 1-WYTL	3-40' UTB 1-46'BUSL 1-23'MON 4-SKB 2-SKL 8-SKM 4-25'MSB 2-25'MCB 1-44'MLB 10-30'UTM
ATL	9	Baltimore	MD	5	3-WYM 1-WLM 2-WAGB 1-WLI	1-110'Barge 2-17'UTL 1-60'AB 2-40'UTB 3-WP 1-40' Barge 1-40'UTM 4-35'LCUP 9-SKM 7-30'UTM 2-39'ASB 6-SKB 3-44MLB 2-25'MSB 1-SKI 6-TICWAN 2-26'MON
ATL	12	Yorktown	VA	5	1-WIX 1-WTR	2-40'UTB 4-31'PSB 1-SKM 2-26'MON 2-25'PSB
ATL	13	Norfolk	VA	5	1-WYTL 3-WHEC 4-WPB 82 1-WAGW 1-WYTM 1-WMEC 2-WLB 1-WLM 1-WLIC	9-18'UTL 1-84'Barge7-SKB 3-46'BU 2-SKL 3-40'UTB 3-25'MCB 1-44'MLB 14-25'MSB 9-SKM 1-35'Larc2-Ticwan 8-30'UTM 2-WP 1-46'Dory

TABLE P (cont)

Geog Area	Map Ref	Location	State	Dist	Fleet Vessels	Other Vessels
ATL	15	Savannah	GA	7	1-WPB 95	1-40'UTB 1-SKB 1-30'UTM
ATL	16	Jacksonville	FL	7	1-WLB 1-WLIC 1-WPB 82	1-17'UTL 1-SKB 2-40'UTB 1-TICWAN 2-SKM
ATL	17	Miami	FL	7	1-WHEC 3-WPB 95 1-WMEC 1-WPB 82 2-WLM 1-WLIC	1-21'JB 1-44'MLB 1-18'ML 6-SKB 1-60'HB 3-25'MCB 4-TICWAN 4-30'UTM 6-27'ML 6-SKM 4-25'MSB 6-40'UTB 1-68'Bargel-SKB

TABLE Q

SUPPORT CRITERIA VESSEL AVAILABILITY
GULF & INLAND

Geog Area	Map Ref	Location	State	Dist.	Fleet Vessels	Other Vessels
GULF	18	Tampa/StPete	FL	7	1-WMEC 1-WLI 1-WLM 2-WPB 82 1-WLIC	2-SKM 1-60'HB 2-25'MCB 4-TICWAN 2-SKB 1-18'UTL 2-30'UTM 2-40'UTB 2-25'MSB 2-68' Barge
GULF	19	Mobile	ALA	8	1-WLI 1-WPB 82 1-WLIC(panama c.)	1-17'UTL 6-45'BU 1- 68'Barge 1-45'Barge6-45'UTB 1-30'UTM 5-WP 1-27'ML 4-TICWAN 1-56'LCM 8-SKM
GULF	19	New Orleans	LA	8	4-WLI 1-WLIC 3-WPB 82	7-25'MSB 2-25'MCB 3-SKB 7-17'UTL2-20'MCBL 3-40'UTB 5-barges 5-30'UTM1-53'CB 5-WP 5-SKM 3-SKB 1-45'BU
GULF	21	Houston	TX	8	1-WMER 1-WPB 82 2-WLB 2-WLIC	7-30'UTM 4-25'MSB 3-WP 2-TICWAN 2-SKM 4-SKB 2-barges2-40'UTB
GULF	22	Corpus C.	TX	8	1-WPB 82 1-WMEC 1-WLI 1-WLIC	2-40'UTB 3-30'UTM 2-TICWAN 1-SKM 1-36'MLB 4-WP 2-45'MSB 2-barges 3-SKB
INLAND INLAND INLAND INLAND INLAND	34 35 36 39 40	Huntington Cincinnatti Louisville Memphis Helena	WVA OH KY TN ARK	2 2 2 2 2	4-WLR 3-WLR 4-WLR(area)	1-17'UTL 1-76'barge 1-100'barge 1-90'HB 1-125'barge 4-WP 2-TICWAN 2-90'barge 4-100'barge 2-100'barge 1-90'barge

TABLE R

SUPPORT CRITERIA-VESSEL AVAILABILITY
PACIFIC & GREAT LAKES

Geog Area	Map Ref	Location	State	Dist.	Fleet Vessels	Other Vessels
PAC	23	LA/LB	CA	11	2-WAG 1-WMEC	6-40'UTB 8-17'UTL 4-36'LCUP 1-45'BU
					5-WPB 822-WHEC	2-39'ASB 7-25'MSB 8-SKM 1-30'UTM
					3-WAG 1-WLM	1-40'UTB 3-SKB 1-25'MCB
PAC	24	SantaBarbara	CA	11	1-WPB 95	2-SKM 1-40'UTB
PAC	29	SanFrancisco	CA	12	6-WPB 82 3-WHEC	4-44'MLB 1-36'MLB 9-40'UTB 11-SKM
					-WLM 1-WLB	9-25'MSB 10-17'UTL 1-20'DIN 4-30'UTM
						1-TICWAN 2-25'MCB 7-31'PSB 3-SKB
PAC	29	Alameda	CA	12	1-WTR	4-30'UTM 2-25'MSB 1-SKM 2-26'MON
PAC	30	Portland	OR	13	1-WLI	1-40'UTB 7-FR 1-TICWAN 1-30'UTM
						1-45'BU 3-SKM 1-SKB
PAC	31	Tri-Cities	WN	13	1-WLI	1-60'barge 3-SKM 2-TICWAN
PAC	32	Rosario	WN	13	1-WPB 82(Ancortes)	(Seattle see OPFAC CG 244)
					1-WYTL(Bellingham)	
G.Lakes	44	StClair	MC	9		2-30'UTM 2-SKI 2-17'UTL

Figure 1

AVERAGES OF SPILL HISTORY 1971 and 1972 (Geographic Areas)

Source: U.S. Coast Guard, _Polluting Incidents In and Around U.S. Waters_ (1971-72)

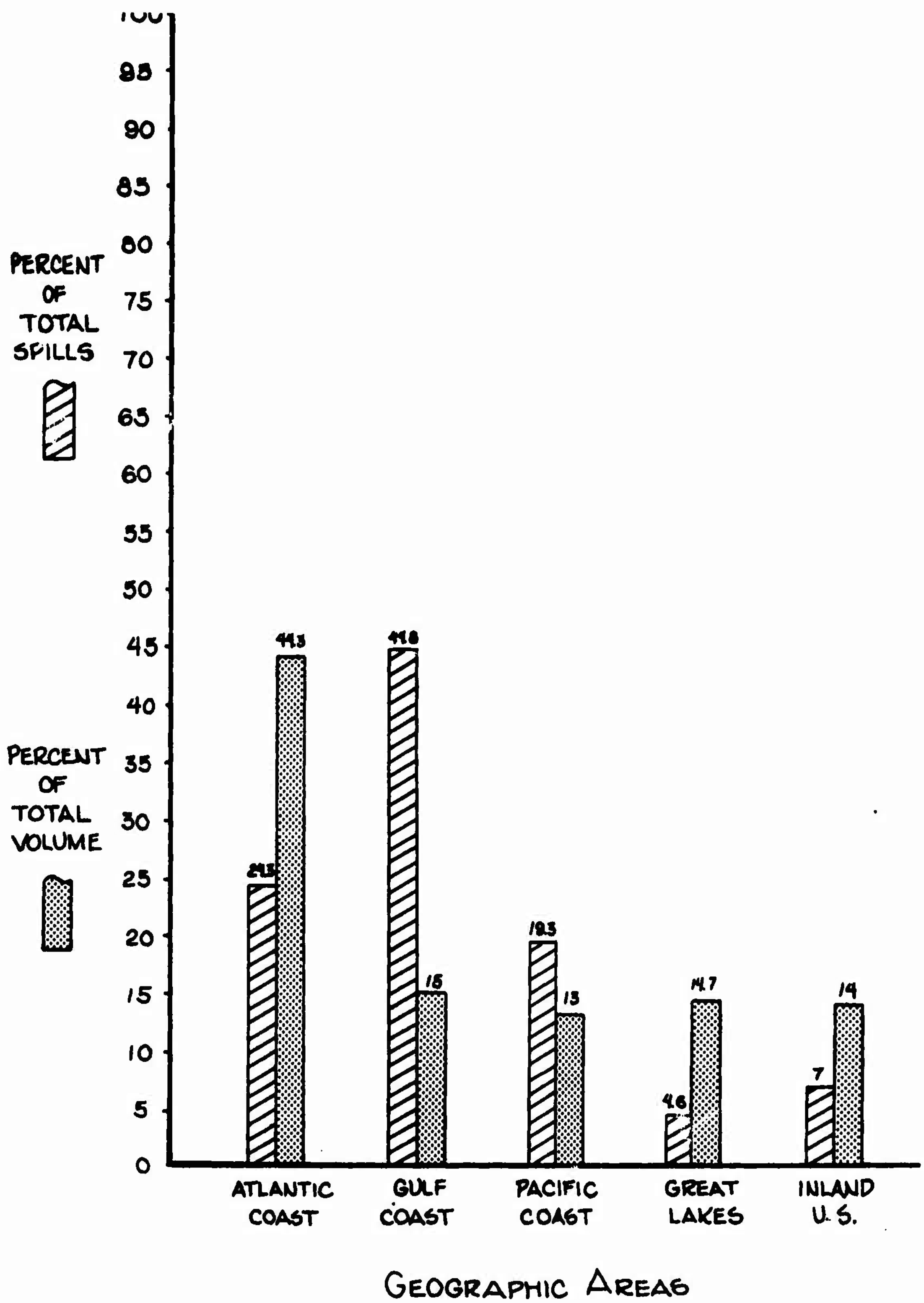


FIG. 1 AVERAGES OF SPILL HISTORY 1971 & 1972 – % OF SPILLS & % OF VOLUME

AVERAGE # SPILLS = 9335/yr.; AVERAGE VOL. (gals x 10^{-3}) = 13,828/yr.

Figure 2

AVERAGES OF SPILL HISTORY 1971 and 1972 (Waters within Areas)

Source: U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1971-72)

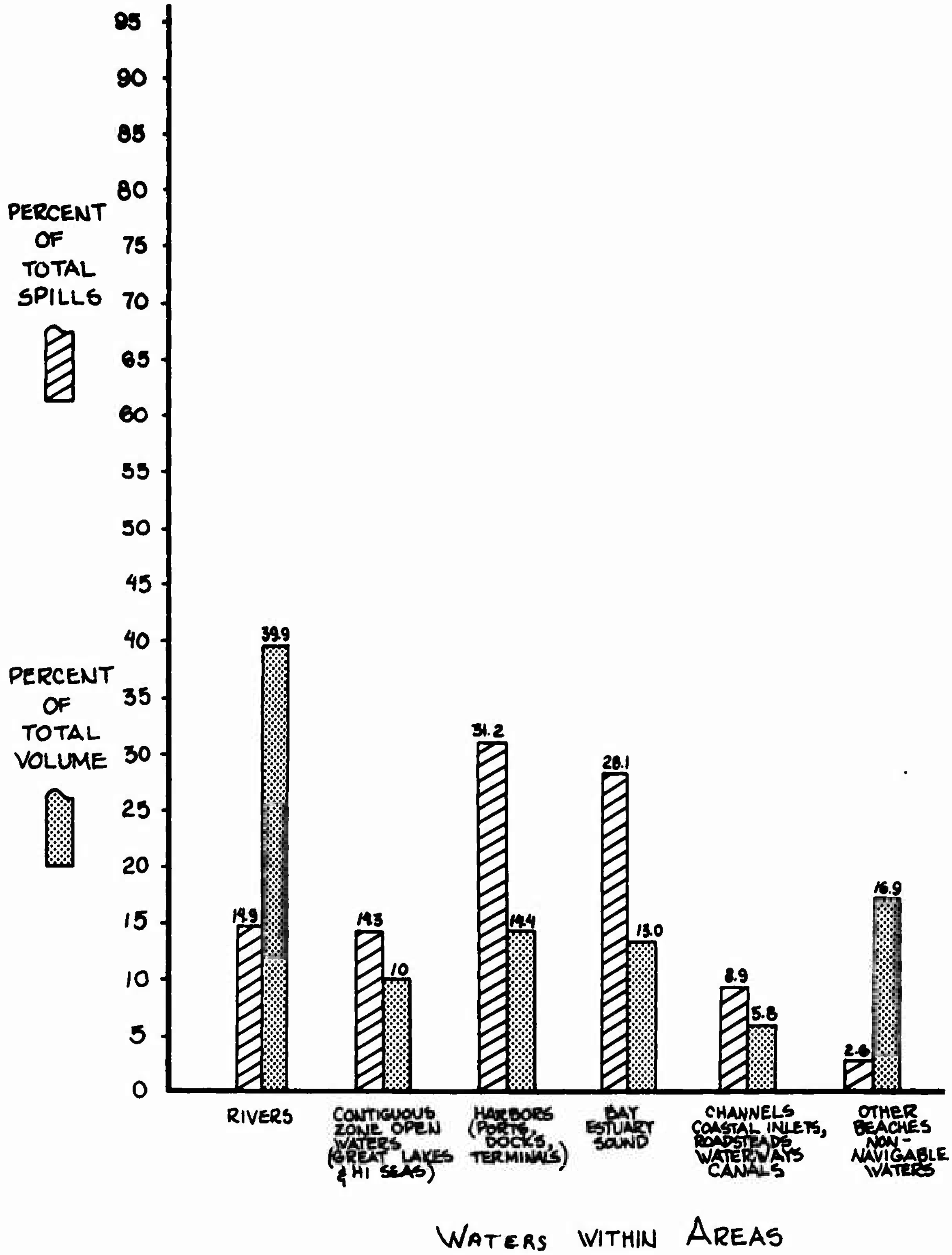


FIG. 2 AVERAGES OF SPILL HISTORY 1971 & 1972 -
% OF SPILLS & % OF VOLUME
AVERAGE # SPILLS = 9335/yr. ; AVERAGE VOL. (gals x 10^{-3}) = 13,828/yr.

Figure 3

AVERAGE OF SOURCES OF POLLUTING SPILLS 1971-72

Source: U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1971-72)

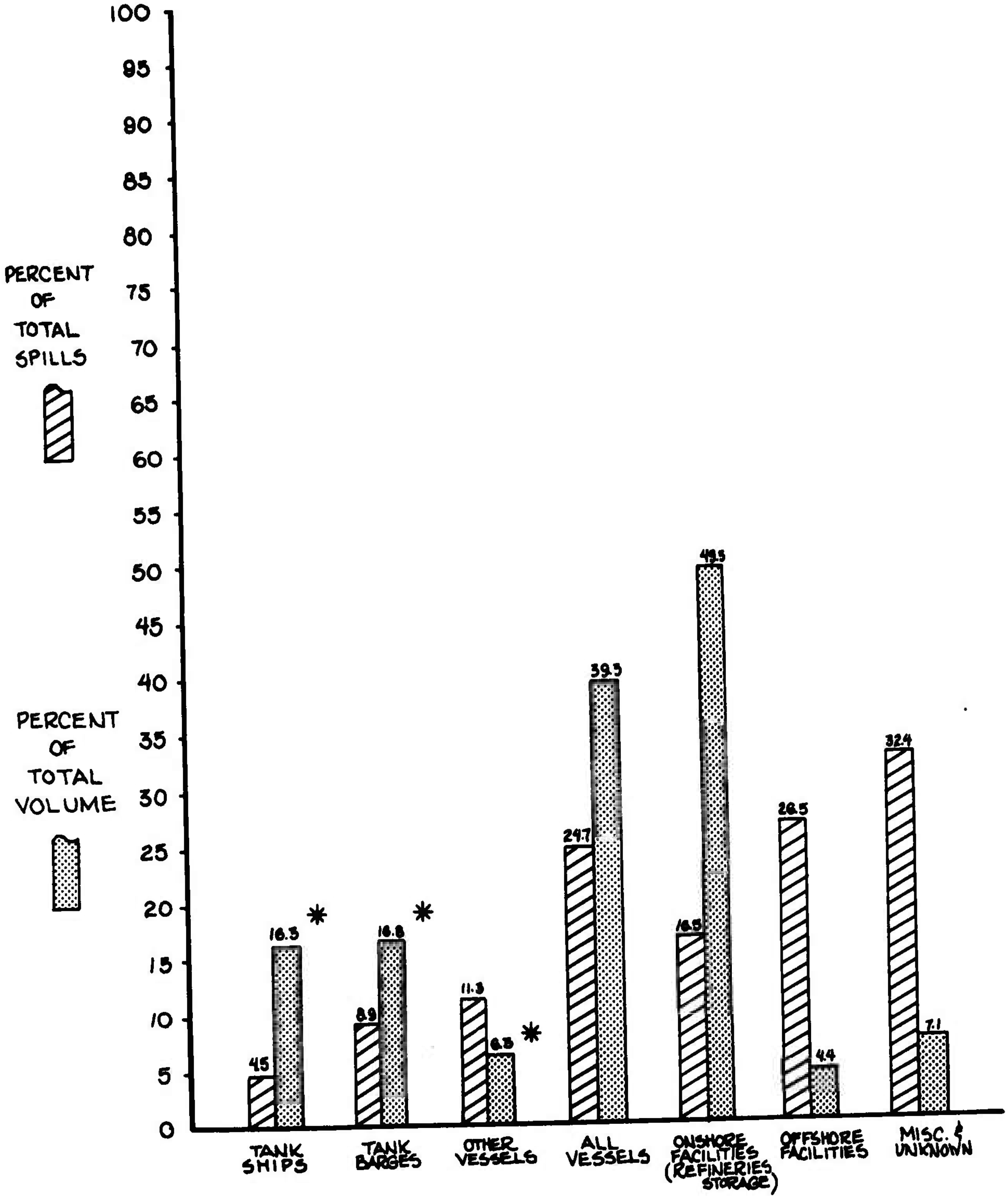


FIG. 3 AVERAGE OF SOURCES OF POLLUTING SPILLS 1971-72
% OF INCIDENTS & % OF VOLUME (GALS. x 10^{-3}) =
VOL. = 18,808 MILLION GALS.
* BREAKDOWN OF ALL VESSELS, COLUMN #4

Figure 4

AVERAGE PERCENTAGE OF SPILLS BY DISTRICT 1971-1972 and PERCENTAGE OF TOTAL OIL VOLUME OF SPILLS 1972

Source: U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1971-72)

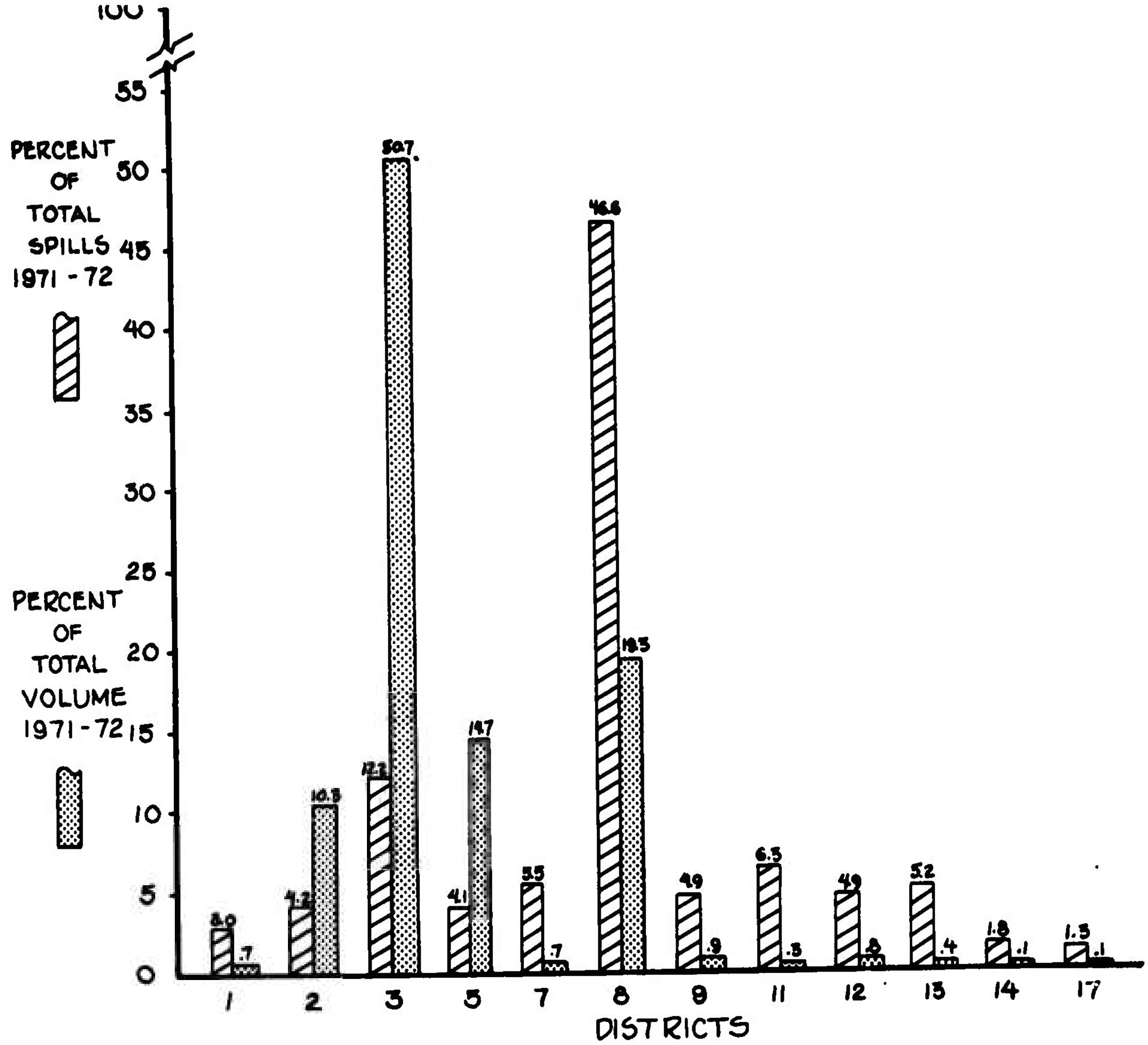


FIG. 4 AVERAGE PERCENTAGE OF SPILLS BY DISTRICT 1971-1972 & PERCENTAGE OF TOTAL OIL VOLUME OF SPILLS 1972.

RANK ORDER

	%-SPILLS		%-VOLUME
1	8TH	—	3RD
2	3RD	—	8TH
3	11TH	—	5TH
4	7TH	—	2ND
5	13TH	—	1ST
6	12TH	—	9TH
7	9TH	—	12TH
8	2ND	—	7TH
9	5TH	—	13TH
10	1ST	—	11TH
11	14TH	—	14TH
12	17TH	—	17TH

Figure 5

PRINCIPAL U.S. OIL SPILL CONTROL AREAS

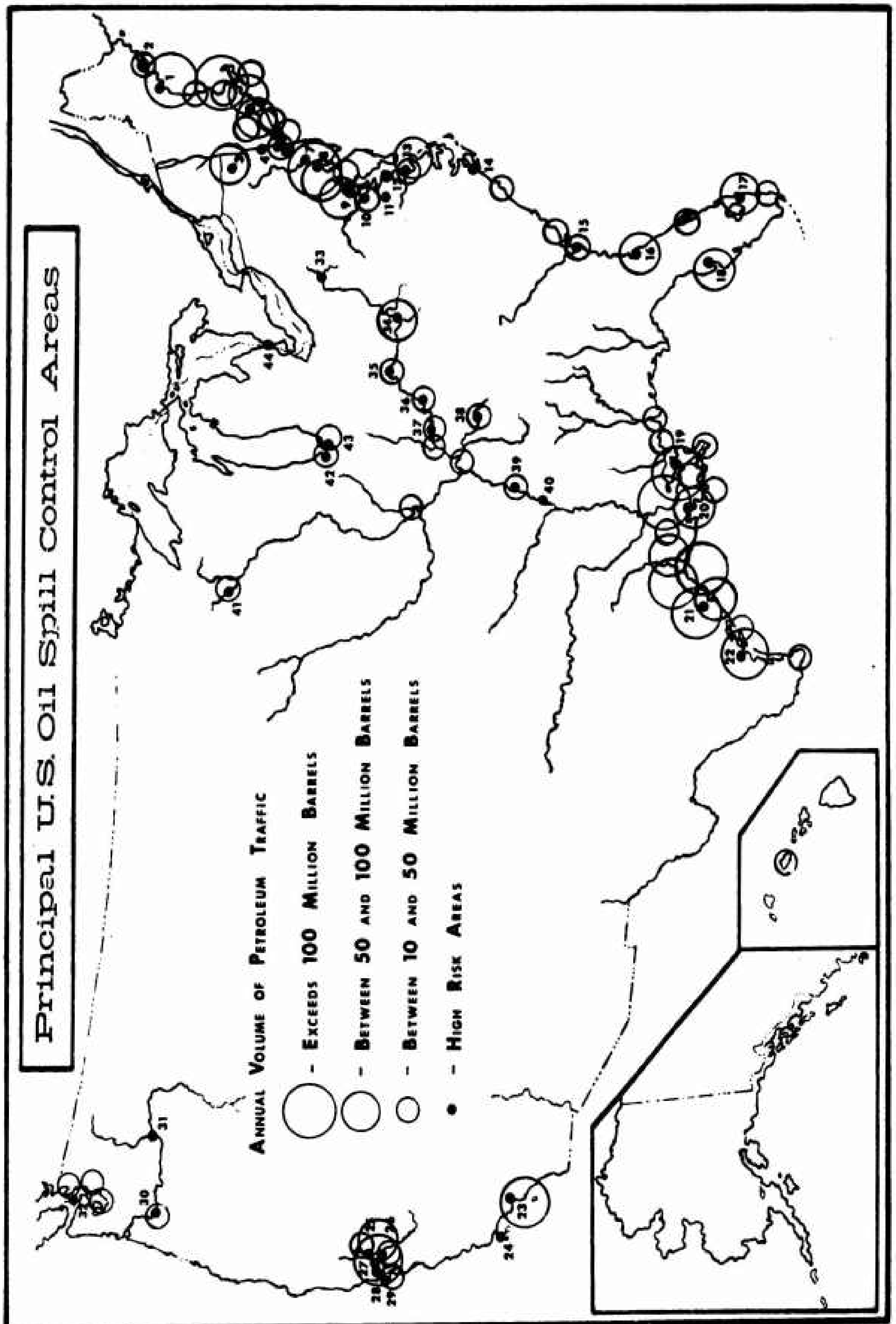
Sources: U.S. Army Corps of Engineers, Waterborne Commerce of the United States (1970-71)

U.S. Army Corps of Engineers, Port Series

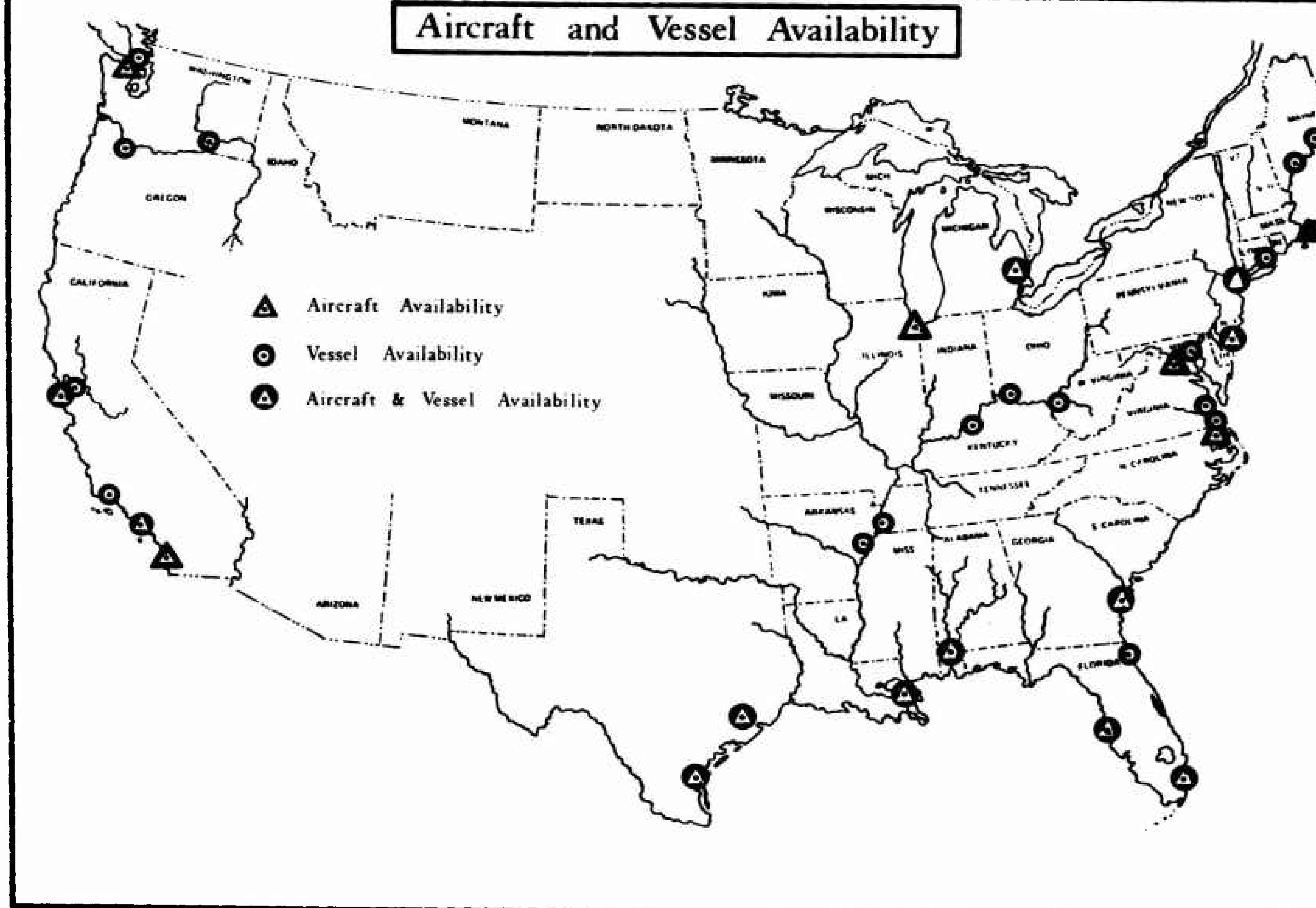
American Petroleum Institute, Information on Offshore and Inland Facilities and Pipeline Crossings (1972)

U.S. Coast Guard, Polluting Incidents In and Around U.S. Waters (1970-71-72)

FIGURE 5



Principal U.S. Oil Spill Control Areas
Annual Volume of Petroleum Traffic
- Exceeds 100 Million Barrels
- Between 50 and 100 Million Barrels
- Between 10 and 50 Million Barrels
- High Risk Areas



Aircraft and Vessel Availability
Aircraft Availability
Vessel Availability
Aircraft & Vessel Availability
OREGON
CALIFORNIA
IDAHO
MONTANA
NORTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
MISSOURI
KENTUCKY
TENNESSEE
ARKANSAS
MISS
ALABAMA
GEORGIA
LA
FLORIDA
TEXAS
NEW MEXICO
ARIZONA
PENNSYLVANIA
NEW YORK
W. VIRGINIA
VIRGINIA
N. CAROLINA
S. CAROLINA
VT

Figure 6

USCG Support Personnel Location

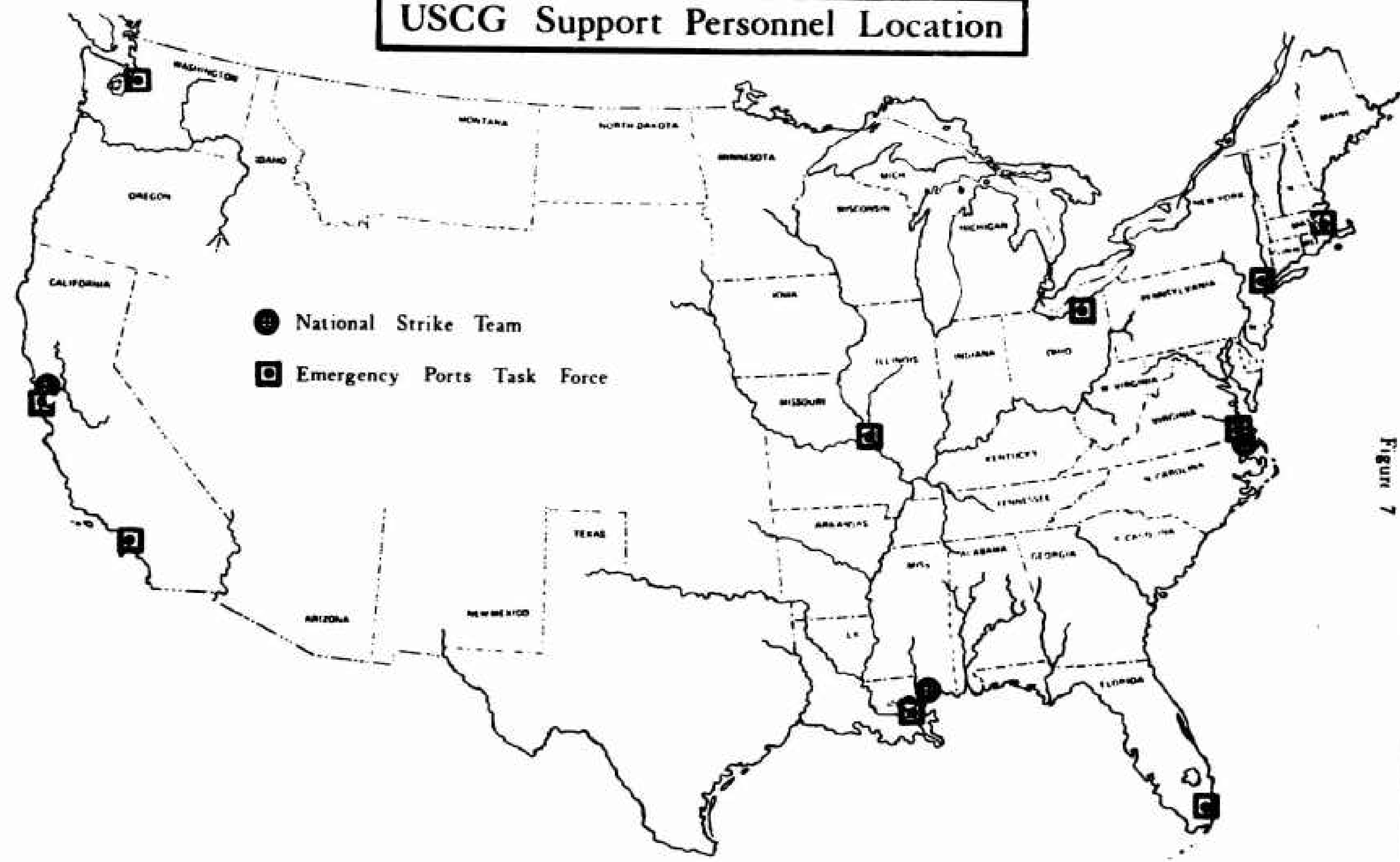


Figure 7

REFERENCES

REFERENCES

LITERATURE

1. API; Publications & Materials; American Petroleum Institute, 1801 K Street, Washington, D. C. 20006 1973

2. Annual Report; Environmental Research; American Petroleum Institute 1801 K Street, Washington, D. C. 20006 January 1973

3. A Staff Paper; Oil Spills Cleanup Cooperatives; American Petroleum Institute, 1801 K Street Washington, D. C. 20006 February 1973

4. Analysis of the Coastal Tank Vessel & Barge Traffic; Report DOT-CG-23,560-A-USCG-(GWEP) Washington, D. C. 20590 April 1973

5. Support Systems to Deliver & Maintain Oil Recovery Systems and Dispose of Recovered Oil (Draft) Report DOT-CG-23,223-A Task No. 5 USCG (GDET) Washington, D. C. 20590 June 1973

6. Proceedings; Conference on Prevention & Control of Oil Spills; API, EPA, USCG, Washington, D. C. 20590 March 13-15, 1973

7. Pollution Detection & Prevention System; Appendix F: Internal Movements, Imports and Exports of Petroleum Products (draft) Purdue Research Foundation USCG (GWEP), Washington, D. C. 20590 May 1973

8. Pollution Detection & Prevention System: Purdue Research Foundation (Draft) USCG (GWEP) Washington, D. C. 20590 May 1973

9. Polluting Spills in U.S. Waters - 1970; USCG (GWEP) Washington, D. C. September 1971

10. Polluting Incidents in & around U.S. Waters, calendar year, 1971; USCG (GWEP) Washington, D. C. 20590

11. Polluting Incidents in & around U.S. Waters, calendar year, 1972; USCG (GWEP) Washington, D. C. 20590

12. U.S. Requirements for Oil Spill Cleanup Cooperatives (draft) Marine Management Services for the American Petroleum Industries, Washington D. C. February 1973.

13. Oil Spill Control on the Lower Mississippi (Partial Draft), Marine Management Services for the American Petroleum Institute, Washington D. C. June 1973

14. Analysis of Oil Spills; Applied Oceanography Division of Dillingham Corp; LaJolla, California 1970

LITERATURE. (CON'T)

15. Bates, Chas. C. & Yost, Paul: Where Trends the Flow of Merchant Ships; a paper for inclusion in the Proceedings of the Eighth Annual Conference, Law of the Sea Institute, 18-21 June 1973, University of Rhode Island, Kingston, Rhode Island 02881

16. Tide Tables East Coast of N & S America. U.S. Department of Commerce Washington, D. C. 1973

17. Tide Tables Pacific Coast of N. America & Asia; U.S. Department of Commerce, Washington, D. C. 1973

18. Tidal Current Tables, Atlantic Coast of N. America; U.S. Department of Commerce, Washington, D. C. 1973

19. Tidal Current Tables, Pacific Coast of N. America & Asia, U.S. Department of Commerce, Washington, D. C. 1973

20. Heiner, W. R.: A Partial Bibliography Inshore Survey Problem Along Atlantic & Gulf Coast, National Oceanographic Office, Washington, D. C. 20390 September 1967

21. Oceanographic Report N. 53 (CG-373-53); U.S. Coast Guard Oceanographic Office, Navy Yard, Washington, D. C. 1970

22. Johnson, J. W. et. el.: Graphical Construction of Wave Refraction Diagrams; H. O. Pub. #605, USN Oceanographic Office, Washington, D. C. 1966 Reprint

23. Oceanographic Atlas of the North Atlantic Ocean: Section 1-Tides & Currents; USN Oceanographic Office, Washington, D. C.

24. Summary of Synoptic Meteorlogical Observations; U. S. Navy Weather Command, Washington, D. C. 1970 - Volumes 1-12

25. Serial Atlas of the Marine Environment; American Geographic Society, Broadway at 156th Street, New York, New York 10032 1968 - Vols. 7, 15

26. Tidal Current Charts - 2nd Edition: Upper Chesapeake Bay - Department of Commerce 1973

27. Port of Corpus Christi, Nueces County Navigation District # 1; File # p-1-54(EE) Application Letter to Work in Navigable Waters of Texas. Corpus Christi, June 20, 1973 - (Concerning Inshore Superport - 72 foot by 600 ft channel to accomodate 275,000 OWT Vessels - OBO, VLCC; to be ready December 1976.)

28. SMITH, F. Ames. Water Transportation of Petroleum and Petroleum Products in the Future, A paper presented to Committee on Hazardous Materials, July 9, 1973. (Conference July 18-19, College Park, Md.)

LITERATURE (CON'T)

29. Nathan, Robert R. Associates, Inc; U. S. Deepwater Port Study; Institute for Water Resources, Alexandria, Virginia August 1972

30. Battelle Columbus Labs; Oil Transport Traffic Study; DOT-CG-23,223-A October 1973

31. Climatological Study of the Southern California Operating Area. Naval Weather Service Command, Ashville, North Carolina 1971

32. Local Climatological Data, Annual Summary of Comparative Data. U.S. Department of Commerce, National Climatic Center, Asheville, North Carolina 28801 1972

33. Water Discharge Determinations for the Tidal Reach of the Willamette River. Geologic Survey Water Supply Paper 1586-H - U.S. Department of Interior - Government Printing Office Washington, D. C. 1968

34. Report on U. S. Energy Outlook. National Petroleum Council, 1625 K Street, N. W., Washington, D. C. 20006 1972

35. U.S. Energy Outlook. 1971-1985, An Initial Appraisal. (An Interim Report): National Petroleum Council, 1625 K Street, N. W., Washington, D. C. 20006 1972

36. Crookshank, N. L. Containment Oil Slicks on The St. Clair & Detroit Rivers, Division of Mechanical Engineering, Department of Environment, Ottowa, Canada 1973

37. Public Hearing on Gulf Coast Deepwater Port Facilities, by the Corps of Engineers, Held in Mobile, Alabama, May 24, 1973

38. Battelle Columbus Labs; Analysis of Inland Waterways Oil Transport Traffic Density Patterns; DOT-CG-23,223-A, December 1973

PERSONAL INTERVIEWS

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3. LTJG P. GOLDEN (GWEP-4)

4. LT C. WILLIS (GWEP-4)

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6. Mr. George GILMORE, Marine Management Services, 1050 Potomac Street, Washington, D. C.

7. Mr. Art RESCOALA, American Petroleum Institute, 1804 K Street, Washington, D. C.

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10. Mr. BOISVERT, Current Section, Navy Oceanographic Office, Suitland, Md. Phone 763-1139

11. Mr. BOYD, Tide Section, Navy Oceanographic Office Suitland, Md. Phone 763-1091

12. Mr. TOBIAS, Army Corps of Engineers, Forrestal Building, Washington, D. C. Phone 693-6995 (Info - DOD - LI56700) (also Mr. Millard for info on C of E)

13. CDR DRIGGER, USCG, Oceanographic Unit, Navy Yard, Washington, D. C. Building 159 E Phone 426-4631

CHIEFS, MEPS, BY DISTRICT

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1st	LT Dick JONES USCG	617-223-6917
2nd	CDR James WEBB USCG	314-622-5053
3rd	CDR Earnest BIZZOZERO USCG	212-264-4916
5th	CDR DIERSEN USCG	804-393-9315
7th	ENS LAPORTE USCG	305-350-5651 5276 5640
8th(oil)	CAPT H.S. MUNDY USCG	504-527-6296
9th(oil)	CDR MASON USCG	216-522-3918
11th	CDR JANACEK USCG	213-590-2216 2301
12th	CDR DICKMAN USCG	415-556-0715
13th	LCDR GORDON USCG	206-624-2902 X343
14th(oil)	LCDR Marshall SHYTLE USCG	415-556-0220 Ask 808-546-7121 ID 7DC 6903 831-3460 or 831-3710
17th(oil)	LT Roger BEVING USCG	206-442-0150 ID 7DC 6903 317-388-1121 X363

NATIONAL STRIKE FORCE

ATLANTIC STRIKE TEAM -LCDR S. WILLIAMS ---MR. WIRT(WO)---804-620-3268

GULF STRIKE TEAM --- LCDR WM. C. PARK III --- 601-688-2380

PACIFIC STRIKE TEAM --- LCDR JOHN H. WIECHERT --- 415-556-0729

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   LCDR Moe - Asst. COTP -New Haven

   CDR. Wood - COTP Albany

4. CDR Dierson, MEP, 5t- District - Norfolk - Phone 804-393-9315

5. Ens La Porte, MEP, 7th District - Miami - Phone 305-350-5651

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12. LCDR Park, Gulf Strike Team - NASA Bay St. Louis - Miss. - Phone 601-688-2380

13. LCDR Weichert, Pacific Strike Team - Yerba Buona Island San Francisco - Phone 415-556-0729

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19. Mr. Pendergrass, " " " " Memphis Dist Ph. 901-534-3221

20. Mr. Pera, " " " " " St. Paul Dist Ph. 612-725-2501

21. Mr. Tomando, " " " " " Detroit Dist Ph. 313-226-6440

22. Mr. Lanham, " " " " " Walla Walla Dist Ph 590-525-5500 x 339

23. Mr. Connor, " " " " " Nashville Dist Ph. 615-749-5632

24. Mr. Lipski, " " " " " Phila. Dist Ph. 215-597-4810

25. Mr. Kolessar, Corps of Engineers,Hydrology Office,Chesepeake Dist-Ph.301-962-4600

26. Mr. Orzehoski, " " " " " Chicago Dist. Ph.312-353-6470

27. Mr. Buchwald, Nat'l Climactic Weather Center, Ashville, N. C. - Ph.-704-254-0683 or 427-7919

28. Mr. Robinson, Planning Study Group-Chesepeake Dist. Ph- 301-962-2512

29. Mr. Johnson, San Francisco Bay Model, Sauselito Co. Ph.-415-332-3870 must dial 8-415-556-9000

30. Mr. Hosee, Oregon Dept. of Environmental Quality Phone - 503-229-5983

31. Dr. Saylor, Great Lakes Survey Research Center - Phone - 313-226-6408 or 6400

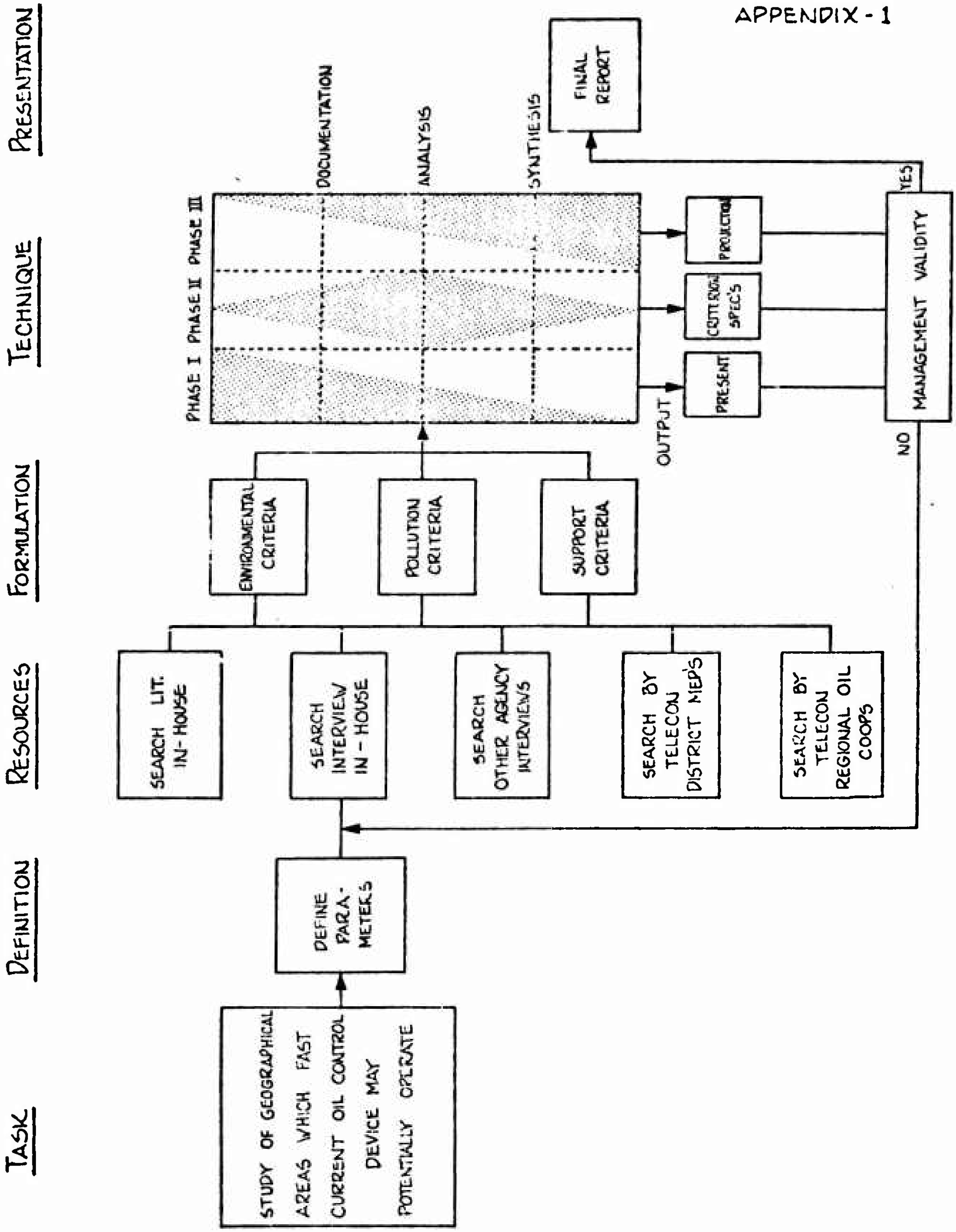
32. Mr. Susag, Metro Water Board - St. Paul - Minn. Phone - 612-222-8423

33. Mr. Bouslag, National Weather - St. Paul - Minn. Phone - 612-725-3401

APPENDIX I

STUDY SYSTEM PHASES

APPENDIX - 1



TASK
DEFINITION
RESOURCES
FORMULATION
TECHNIQUE
PRESENTATION
STUDY OF GEOGRAPHICAL AREAS WHICH FAST CURRENT OIL CONTROL DEVICE MAY POTENTIALLY OPERATE
DEFINE PARA-METERS
SEARCH LIT. IN-HOUSE
SEARCH INTERVIEW IN - HOUSE
SEARCH OTHER AGENCY INTERVIEWS
SEARCH BY TELECON DISTRICT MEP'S
SEARCH BY TELECON REGIONAL OIL COOPS
ENVIRONMENTAL CRITERIA
POLLUTION CRITERIA
SUPPORT CRITERIA
PHASE I PHASE II PHASE III
DOCUMENTATION
ANALYSIS
SYNTHESIS
OUTPUT
PRESENT
CRITERION SPEC'S
PROJECTION
MANAGEMENT VALIDITY
YES
NO
FINAL REPORT

APPENDIX II

ENVIRONMENTAL CRITERIA WORKSHEET

APPENDIX-II

ENVIRONMENTAL CRITERIA WORKSHEET

AREA ______________________ STUDY MAP REFERENCE # ______________________

REGION ______________________

DATA REFERENCES: ______________________ ______________________

______________________ ______________________

______________________ ______________________

Criteria Item	HI	LO	MEAN	RANGE	FORCE	PRE-VAIL	HEIGHT	OTHER
Current								
Tide								
Temp.								
Wind								
Wave.								

SUMMARY COMMENT

Seasonal Extreme.
Temp. Extreme.
Tidal/Current.
Turbulence/Vortex.
Oscillation.
Frequency.

APPENDIX III

INCIDENTS BY SIZE

SIZE IN GALLONS	Number of incidents	% of total	Volume in gallons	% of total
Unknown	2,791	28.2	----	----
1-99	5,412	54.7	107,729	0.6
100-999	1,309	13.2	356,474	1.9
1,000-9,999	299	3.0	866,645	4.6
10,000-99,999	63	0.7	2,086,684	11.1
100,000+	19	0.2	15,388,200	81.8
TOTAL	9,893*	100.0	18,805,732	100.0

* Number of incidents does not include 38 reported discharges which indicated quantity of material discharged in pounds.

APPENDIX IV

SOURCE AND CAUSE

Number of incidents / Volume in Gallons

SOURCE \ CAUSE	Collision	Grounding	Capsizing/ Overturning	Fire/Explosion	Other Casualty	Tank Rupture	Hull Structural Failure	Storage Tank Rupture or Leak	Hose Rupture	Line Leak
Vessels										
Dry Cargo	2 / 125	5 / 705	1 / 500	10 / 821	3 / 5	1 / 0	2 / 102	3 / 1,262	6 / 44	7 / 253
Tankships	7 / 105,315	9 / 319,100	X	1 / 0	3 / 212	13 / 2,877	18 / 23,376	17 / 1,801	9 / 2,206	5 / 130
Tank Barges	45 / 1,294,732	23 / 422,207	1 / 0	2 / 92	15 / 1,690,249	81 / 46,825	70 / 121,461	35 / 11,259	31 / 8,361	19 / 8,861
Combatant	1 / 20	X	X	X	3 / 53	2 / 2,045	2 / 22	4 / 415	7 / 406	8 / 55
Other	10 / 1,118	8 / 1,670	1 / 37	4 / 1,000	68 / 7,930	2 / 2,030	6 / 299	5 / 92	4 / 375	7 / 132
Land Vehicles	22 / 17,943	X	37 / 91,613	1 / 250	5 / 15,030	7 / 31,110	5 / 3,250	1 / 50	X	2 / 20
SHORE FACILITIES										
Refineries	X	X	X	X	1 / 50	1 / 300	X	X	6 / 952	12 / 502
Bulk Storage	1 / 100	1 / 20,000	1 / 3,000	1 / 0	1 / 5	7 / 42,505	X	17 / 58,429	3 / 193	20 / 5,941
Waterfront Transportation Facilities	6 / 1,263	X	X	1 / 0	2 / 50	7 / 446,615	2 / 280	10 / 267	45 / 16,464	35 / 29,575
Non-Transport. Facilities	1 / 20	X	1 / 800	5 / 7,275	3 / 4,005	7 / 25,350	1 / 0	13 / 2,781	13 / 742	50 / 8,192
Other Land Transportation Facilities	X	X	X	X	3 / 167	X	X	1 / 0	2 / 55	2 / 400
Pipelines	6 / 33,910	X	X	1 / 0	2 / 24	X	X	X	1 / 1	41 / 6,035
OFFSHORE FACILITIES	9 / 901	X	X	5 / 21,300	17 / 18,077	5 / 477	2 / 47	18 / 3,805	19 / 575	791 / 42,157
MISCELLANEOUS	1 / 20	X	X	2 / 0	2 / 400	2 / 400	X	5 / 43,820	2 / 30	7 / 1,784
UNKNOWN	X	X	X	X	X	X	X	X	X	X
TOTAL	111 / 1,455,467	46 / 763,682	42 / 95,950	33 / 30,738	128 / 1,736,257	135 / 600,534	108 / 148,787	129 / 123,981	148 / 30,404	1,007 / 104,037

Appendix IV Con't.

	Pipe Rupture or Leak	Other Rupture Or Leak	Valve Failure	Pump Failure	Other Equipment Failure	Tank Overflow	Improper Valve Handling	Improper Hose Connection	Other Personnel Error	Intentional Discharge	Natural Phenomenon	Unknown	Total
1	4/52	8/78	9/329	1/30	10/1,065	68/9,433	14/2,828	9/123	39/2,250	100/20,011	5/6	95/2,749	402/42,771
2	10/1,281	39/2,002,007	30/1,577	8/1,333	9/1,302	77/75,530	33/8,204	11/1,619	35/11,784	34/1,605	5/869	80/21,874	453/2,583,952
3	12/542	56/8,448	24/4,507	16/734	22/1,072	202/53,339	34/3,953	13/17,062	[illegible]/5,[illegible]98	5/50	7/70	70/40,232	830/3,739,144
4	2/230	8/301	11/563	x	8/425	64/9,858	14/2,908	8/475	32/8,298	20/949	6/1,903	94/11,997	294/40,923
5	1/15	12/602	8/513	3/70	8/366	53/164,213	14/389	5/120	31/863	137/8,711	6/69	101/5,894	494/96,508
6	1/10	3/12	4/1,000	x	1/0	9/3,370	3/3,040	3/96	9/1,613	12/2,105	6/205	14/1,802	145/172,519
7	13/2,546	6/969	12/1,103	5/314	28/1,366	11/16,440	9/796	3/106	5/335	4/428	24/1,235	45/14,585	185/42,027
8	21/256,946	8/4,023	24/8,146	6/421	24/3,056	22/8,238	11/221,786	3/30,008	18/4,257	12/1,806	18/3,343	75/20,467	294/692,670
9	47/268,828	28/3,715	18/1,434	9/959	33/3,840	29/153,654	19/1,393	20/646	64/3,332	23/1,519	26/312	53/9,218	478/943,264
10	46/199,169	23/96,114	31/10,494	18/1,905	50/9,278	30/18,472	14/161,213	2/60	38/1,533	66/23,465	44/8,001,683	259/37,699	715/8,610,250
11	3/650	2/55	2/50	x	7/261	5/6,675	x	x	1/5	12/567	9/1,840	19/2,606	68/13,331
12	83/854,797	40/62,893	6/163	1/84	4/159,714	1/80	2/410	3/40	10/8,971	2/1,010	7/25,445	6/83,650	216/1,237,227
13	115/46,048	72/3,923	403/19,743	233/3,775	433/45,542	62/3,123	23/9,496	3/26	27/1,449	6/211	38/3,064	36/7,324	2,317/237,063
14	10/1,305	1/20	2/950	2/70	19/301	7/625	3/114	x	15/577	24/6,078	56/5,928	69/13,246	229/75,668
15	x	x	x	x	x	x	x	x	x	x	x	2,811/278,415	2,811/278,415
16	368/1,632,419	306/2,183,160	584/50,572	302/15,595	656/227,588	640/423,050	193/271,530	83/50,381	371/50,355	457/68,515	257/8,045,972	3,827/551,758	9,931/18,805,732

APPENDIX V

INCIDENTS BY SIZE

SIZE IN GALLONS	NUMBER OF INCIDENTS	% OF TOTAL	VOLUME IN GALLONS	% OF TOTAL
UNKNOWN	2,867	32.9	---	---
1-99	4,272	49.1	94,322	1.1
100-999	1,203	13.8	336,640	3.8
1,000-9,999	285	3.3	830,595	9.4
10,000-99,999	65	0.7	1,604,580	18.1
100,000+	17	0.2	5,973,386	67.6
TOTAL	8,709*	100.0	8,839,523	100.0

* Number of incidents does not include 27 reported discharges which indicated quantity of material discharged in pounds.

APPENDIX VI

SOURCE AND CAUSE

Number of incidents / Volume in Gallons

SOURCE \ CAUSE	Collision	Grounding	Capsizing/ Overturning	Fire/Explosion	Other Casualty	Tank Rupture	Hull Structural Failure	Storage Tank Rupture or Leak	Hose Rupture	Line Leak
Vessels										
Dry Cargo	2 / [illegible]	1 / 126	X	1 / 393,[illegible]	6 / 3,000	X	3 / 51[illegible]	1 / 42	4 / 57[illegible]	6 / 172
Tankships	6 / 1,095,4[illegible]	1[illegible] / 430,[illegible]	X	X	2 / 240	8 / 1,557	5 / 1,11[illegible]	19 / 3,519	16 / 19,269	8 / 8,51[illegible]
Tank Barges	3[illegible] / [illegible]	18 / [illegible]	2 / 75	X	4 / 104	48 / 60,015	14 / 1,221	38 / 2,499	24 / 2,719	12[illegible] / 45,[illegible]
Combatant	2 / 16,500	2 / 100	X	X	1 / 130,000	X	1 / 10	7 / 2,400	3 / 55	5 / 210
Other	7 / 2,0[illegible]	20 / 27,755	4 / 0	7 / 400	42 / 123,458	1 / 10	X	1 / 5	2 / 213	17 / 1447
LAND VEHICLES	9 / 22,9[illegible]	X	15 / 32,500	X	3 / 3,700	X	X	X	X	1 / 50
ONSHORE FACILITIES										
Refineries	2 / 225	X	X	Y	X	1 / 2,[illegible]	X	6 / 115	2 / 2,36[illegible]	[illegible] / 115,[illegible]
Bulk Storage Facilities	1 / 1[illegible]	X	X	1 / 0	X	4 / 15,666	X	12 / 27,490	4 / 1,480	6 / 1,355
Waterfront Transportation Facilities	2 / 5[illegible]	X	X	X	2 / 135	1 / 0	1 / 0	9 / 99,529	19 / 19,391	25 / 5,366
Non-Transport. Facilities	X	X	X	X	X	5 / 4,120	X	10 / 8,724	9 / 2,212	24 / 1,497
Other Land Transportation Facilities	X	X	X	X	X	X	1 / 4,600	X	X	X
OFFSHORE FACILITIES	1 / 7,0[illegible]	X	X	X	5 / 143	2 / 75	1 / 109	10 / 457	21 / 2,078	1,267 / 350,602
MISCELLANEOUS	X	X	X	X	3 / 30	X	X	10 / 2,035	X	2 / 2
UNKNOWN	X	X	X	X	X	X	X	X	X	X
TOTAL	6[illegible] / 1,455,9[illegible]	54 / 398,[illegible]49	21 / [illegible]	9 / 39[illegible],4[illegible]	68 / [illegible]	[illegible] / 2,[illegible]21,443	26 / [illegible]	12[illegible] / 146,[illegible]19	11[illegible] / 50,347	1,5[illegible]9 / 562,696

SOURCE AND CAUSE

Number of Incidents / Volume in Gallons

Pipe Rupture or Leak	Other Rupture or Leak	Valve Failure	Pump Failure	Other Equipment Failure	Tank Overflow	Improper Hose Connection	Other Personnel Failure	Intentional Discharge	Natural Phenomenon	Unknown	Total
2 / 16	6 / 226	9 / 3,194	1 / 5	13 / 483	37 / 4,072	6 / 117	50 / 1,942	75 / 2,504	2 / 1	46 / 2,826	271 / [illegible]
16 / 3,085	34 / 27,8[illegible]	17 / 12,84[illegible]	8 / 978	3[illegible] / 27,959	18 / 5,324	5 / 637	58 / 11,[illegible]	22 / 1,9[illegible]	3 / 104	97 / 10,60[illegible]	296 / 1,665,[illegible]
54 / 29,407	88 / 11,985	56 / 24,394	1[illegible] / 328	28 / 8,[illegible]	68 / 1[illegible],266	18 / 4,[illegible]	6[illegible] / 231,[illegible]	14 / [illegible]	2 / 2	125 / 14,96[illegible]	[illegible] / 1,19[illegible]
2 / 7[illegible]	1[illegible] / 983	5 / 1,735	X	X	18 / 41,057	3 / 1[illegible]1	52 / 24[illegible],291	47 / 1,764	X	107 / 5,573	261 / [illegible]
4 / 181	8 / 503	3 / 75	[illegible]	14 / 12,2[illegible]	21 / 1,101	1 / 1	41 / 2,[illegible]	71 / 2,[illegible]49	[illegible] / 26	121 / 6,521	[illegible]
1 / 84	X	X	X	4 / 7,1[illegible]	1[illegible] / 4,62[illegible]	1 / 3[illegible]	7 / 1,[illegible]	1[illegible] / 2[illegible],155	1 / 5	[illegible]5 / 5,99[illegible]	[illegible]
[illegible] / 6[illegible],9[illegible]	16 / 2,44[illegible]	15 / 11,279	[illegible] / 226	5 / 611	15 / 5,[illegible]	[illegible]	12 / 644	2 / 84	8 / 1,074	16 / 2,[illegible]	1[illegible] / 2,[illegible]81
11 / 56,[illegible]	4 / [illegible]	3 / 45,[illegible]50	1 / 2[illegible]	57 / 14,479	5 / [illegible]	X	37 / 1[illegible]5,4[illegible]	3 / [illegible]	25 / 1,757	12[illegible] / [illegible]	[illegible]
[illegible]	74 / 1[illegible]6,[illegible]	16 / 1[illegible],1[illegible]	4 / 559	13 / [illegible],795	1 / 577	1 / [illegible]	56 / 9,191	14 / 44	2 / 1,50[illegible]	[illegible] / 73,84[illegible]	[illegible]
[illegible]	1[illegible] / 5,[illegible]	11 / 1,[illegible]	5 / [illegible]	33 / 2,259	17 / [illegible]	[illegible] / 1,[illegible]	34 / [illegible]	[illegible]	15 / [illegible]	1[illegible]9 / 43,516	[illegible]
2 / [illegible]	1 / [illegible]	X	X	X	2 / 28	X	4 / 2,10[illegible]	6 / 3,[illegible]	1 / 0	5 / 1[illegible]	[illegible]
[illegible]6 / [illegible]	9[illegible] / 1[illegible]	[illegible] / 3[illegible],828	17[illegible] / 11,6[illegible]	57 / [illegible],241	39 / 2,[illegible]	15 / [illegible]	6[illegible] / 1,691	[illegible]	14 / [illegible]	[illegible]	[illegible]
6 / 3,4[illegible]	1 / [illegible]	1 / 1	X	18 / 36,062	[illegible]	X	25 / 3,389	[illegible]	17 / 115	14[illegible] / 1[illegible],1[illegible]	[illegible]9 / [illegible]
X	X	X	X	X	X	X	X	X	X	[illegible] / 249,[illegible]35	[illegible]
[illegible]	71[illegible] / 1[illegible]	461 / 141,[illegible]	2[illegible] / [illegible]	279 / 11[illegible]	25[illegible] / [illegible]	71 / [illegible]	5[illegible] / [illegible]	[illegible]59 / [illegible]	9[illegible] / [illegible]	[illegible]	[illegible]