III-B. CONTROL OF OIL SPILLS

The cost-effectiveness of controlling (contain and cleanup) an oil spill is dependent on the operational response, capability, resource protection priority, and the implementation of reliable equipment. This section examines, in detail, each of these factors, evaluating the current state-of-the-art and recommending improvements where appropriate. The environmental resource data of Section II-A, the trends in oil handling on Puget Sound as discussed in II-B, II-C, and III-A, along with the economic evaluation, form an integral background of the forthcoming discussions. In addition, the critiques of equipment in Appendices 5 and 6 have influenced the study team's choice of integrated containment cleanup system.

Part 1 of this section discusses the organizational and operational aspects of a response plan. A system of resource protection priorities is presented in Part 2, while configuration for containment and cleanup devices are proposed in Part 3.

1. OPERATIONAL RESPONSE PLAN

a. Introduction

Up to the present time the response to major oil spills and the means directed at containing and cleaning them up have been inadequate indeed. Each succeeding spill revealed new techniques and methods of combatting the spread of oil, but because of the sheer magnitude of a large spill the present overall capability has not advanced significantly.

The Puget Sound region, ecologically one of the cleanest waters in the world, has only now begun to face up to the problems inherent with the transportation of oil. The historical indifference toward solving the problem can be credited primarily to a lack of significant oil shipment on Puget Sound. This coupled with low numbers of oil spill incidents has led many people to believe that a 'real' problem does not exist in the regional waters. With the discovery of the North Slope crude oil and its possible transhipment to markets via Puget Sound waters the problem has been brought close to home. The probable future impact of the discovery will be to double the crude oil movement within the regional waters as well as an increase in refined product shipment due to growth in refinery capacity. Perhaps more important, at least half of this oil will move through narrow channels, marked with navigational hazards, and will be carried by vessels exceeding 100,000 dwt capacity.

The standard answer for what should be done about oil spill control today is to entrust it to technology. Supposedly, this mystical word will permit industry to extract 20,000 barrels of oil from Puget Sound waters when a cargo tank of a large tanker is split open from grounding or collision. In spite of the many advances in oil spill recovery techniques, the resources at command are pitifully ineffective when compared to the requirement dictated by a spill of any significant size. Claims about future capabilities of various cleanup and containment devices do not alter today's cleanup ability. Instead of relying on these promises for the future it is necessary that the most efficient utilization of present scarce resources be undertaken in the event of a crisis. To do so requires the formulation of an organization to control and put to work the ability these scarce resources possess to combat an oil spill. Such plans do exist, but the question that must be asked concerns the ability to respond operationally to a spill of large magnitude and duration. Specifically, are the present contingency plans sufficient, does the skilled manpower in this region to make the plans operational exist, what what would be the costs of such an undertaking? These are only a few of the many questions that must be answered before the effectiveness of a response plan can be evaluated. All along it must be kept in mind that present response systems are the result of a reaction to crises that are tempered with little or no experience.

Furthermore, no two oil spills behave the same because of the multitude of variables involved. A spill on Puget Sound waters will react differently and cause different problems than a spill on some other water. Due to this characteristic, a more specific perspective is taken of the present response capability in the region. The following discussion is not to judge the acceptability, but to evaluate the response system that is the present modus operandi for dealing with oil spills. In so doing the major attributes of an effective response system are presented. The present structure and capability of oil response readiness on Puget Sound is looked at. Finally, some recommendations are made with the major effort directed toward enabling oil spill response on Puget Sound to be an operational reality.

b. Major Prerequisites for an Effective Response System

An organization designed to respond quickly and efficiently to periodic random happenings is not to be considered as any ordinary day-to-day organization. This peculiarity becomes especially evident when one considers that the organization is staffed with non-professional, for the most part, and volunteer people. The various component parts of the organization have different interests and motivating pressures in spite of a single objective; and the organization, by necessity, operates in an environment where speed and accuracy of decisions are of utmost importance. The design of an organization to respond effectively to the crisis of an oil spill obviously is difficult; however, not impossible. The plan discussed in this section is patterned after the industry response plan proposed by the Dillingham Environmental Company in 1970.[1] The ideas and recommendations are to some extent, utilized and made specific for the characteristics in the Puget Sound region. As well they have formed the framework with which the existing response capability is measured and evaluated.

1. Component Parts

Basically a response plan must specify the following categories to be effective:

a. Organization: A formal organization structure with the lines of authority clearly delineated.

b. Operations: The detailed procedural steps need to be developed.

c. Logistics: Must include all the necessary contractural pre-arrangements for the procurement of resources and transportation to the site of the spill in the shortest time possible.

d. Preparedness: The entire response plan must be operational prior to the spill event, with regard to the specific functions that need be performed, and at a level commensurate with the financial capability of the relevant sectors in the Puget Sound region.

2. Objective and Attributes Required

The primary objective of the organization is to contain and clean up oil on water at the least economic cost and in time to minimize the damage inflicted upon the environment. In achieving this primary goal there are any number of attributes the organizational response plan needs to possess. The primary characteristics are discussed below:

a. The plan, because of legal constraints (i.e., liability of the offender), must be voluntary on the part of industry. That is, if industry does not agree to accept the provisions therein it cannot be forced to do so. If agreement is not reached, effectiveness is decreased. A company deciding to act alone in relieving its liability for an oil spill it created can do so - response plan or not, so long as this duty is discharged without jeopardizing to interests of the public at large.

b. The myriad of problems created by all but the smallest oil spills today dictate a relatively large, though not necessarily rigid, organization to solve these problems.

c. Because of financial cost considerations, many key positions need to be filled with the assignment of temporary people in the local response area. These would most likely be selected from interested government agencies and participating private industry. It is felt that the incremental cost attached to a decreased organizational efficiency is much less than the loss of incremental benefits of staffing the organization with full-time personnel. It would be expected, however, that the response organization be professionally staffed to the point where the incremental cost of the partially staffed organization is equal to the loss of incremental benefit as a result of that action. A benefit to the industry point-of-view in this idea of temporary staffing is that ultimately industry maintains more control over the operation, and hence its financial liability.

d. For total response planning, an independent communications network complete with the appropriate central command and field communications centers is of utmost importance. The need for effective communications cannot be overstressed in light of the problems encountered as a result of poor communications in past spill incidents.[2] It does not appear unrealistic to procure, through a one time expenditure, the necessary communications equipment and design into this primary system an interface of periphery secondary systems, comprised of all interested parties in the region, rather than relying on a patchwork of temporary and unreliable crisis-constructed systems.

e. The requirement of rapid response to a spill incident dictates the need for a continuously operational alert system that not only will bring the response effort into full operation quickly, but that will also confirm the degree of response required. The recent Anacortes spill showed the great need for an accurate appraisal of the spill situation so as to intelligently activate the degree of response required.[3]

f. The authority and responsibility relationships between cooperative parties for the initiation of containment and removal operations needs to be clearly delineated before the fact as extensive cash flow expenditures become ongoing with each decision. In a parallel vein, the specific conditions under which the public interest is no longer being represented by the offending polluter in his cleanup operation needs to be spelled out so as to relieve the on-scene commander (OSC) and the respective government agency (USCG) from possible future litigation and the assumption of the costs of the cleanup. These authorities, responsibilities, and takeover conditions must be well defined, clearly stated, and thoroughly understood by all the interested parties in this response region.

g. Because of basic financial constraints, the capability existing today must be utilized to its full extent. This requires pre-planning, which in effect this proposed response plan is intended to do. Nowhere should a present effective response plan be downgraded in view of "future developments" of the technical capability to remove oil spills from water.

h. Arrangements must be made to stockpile all the necessary supplies, and materials required to combat a spill. The deployment of such apparatus to the site of the spill also needs to be pre-arranged. The distribution of the supplies and materials within the region is subject to many factors, primarily being the relative assessed hazard of a spill in each and every subzone within the region. In any regard, at least a minimum level is required to provide for an initial response. (More details on this are in Part 2 of this section.)

i. To maintain the operational preparedness required, there is a need for some type of ongoing formal training of regional personnel who will fill the various organization billets in the event of a response. This is necessary because of the many parties that are integrated into the response organization. It is necessary that all concerned receive the same interpretations and gain a common understanding of the organization in which they are participating.

c. Present Status of Puget Sound Response Capability

For a response plan to be truly operational the organizational attributes discussed above are of vital importance. Of overriding consideration in the development of this plan is the fact that it must be operational much the same as the municipal fire department; and secondly, along these same lines, that it evoke an immediate response action. Thus, the organization must be flexible yet authoritative, large but not cumbersome. This is especially a requirement for the Puget Sound region, as all its waters are closely bounded by land rich in man-made and natural resources. Along with the waterway itself, all are of vital necessity to the future economic development of the region. The need for more than a paper plan is thus magnified because of these special considerations.

The organizational response capability now present in this region lies with two basic plans. The first, and perhaps the most general, is the contingency plan of the U. S. Coast Guard.[4] This plan addresses itself primarily to the response capability of the various government agencies. The procedures outlined adequately to interlock a local regional plan into a national response capability and dictate under what circumstances the local capability can be expanded to receive aid outside the immediate response area. It constitutes a viable framework for those individuals operating at the upper level of responsibility. The guidelines of what action to take are fairly definite down to the level of the sub-regional response center (SRC). Beyond that level, however, the plan loses its effectiveness, the very level in the total organizational response structure where the actual work of removing the oil from the water takes place.

The second formal plan is the joint venture of Puget Sound Tug & Barge Company and Pac-Mar Services, Inc., known as Marine Oil Pick Up Service (MOPS).[5] This plan in essence is not a response plan at all, but a prospectus offering of the service capability of MOPS. MOPS is available as a third party contractor to individuals or firms that bear the responsibility of oil cleanup but do not have the expertise nor the resources with which to accomplish such a task (which virtually includes all oil handling facilities on the Sound). The MOPS plan is perhaps the closest thing this region has to an operationally ready response capability. Although not spelled out on paper per se, the firm appears to have the capability of operating effectively once called into action. This is due to their experience and expertise in this field.[6]

Supplementing the MOPS operational capability are the response plans of the various individual companies involved in the business of oil transportation, receiving, refining, etc. This study group is aware of the plans of 11 such facilities, however, it is noted in another section of this report of the general inadequacy of the response capability of these firms.[7] For the most part these eleven oil handling facilities conformed to the minimum requirements of the Coast Guard Standard for oil handling facilities.[8] However, their ability to respond to a spill situation, should one occur, is questionable, as shown by the results of the survey and discussion with the operating personnel of these facilities.[9] Regardless of the fact that the sum total of these fragmented response capabilities may be considered significant, their total contribution is minimal unless they become integrated through some collective agreements into an overall organization response plan.

Major oil refiners and handlers, in and around Puget Sound, have formulated an organization to provide response capability for oil spill cleanup. This group, the Washington Oil Spill Cooperative, is made up of ten private firms, and was created in April, 1971. After several months of negotiating financial and political questions with their respective parent companies, each firm has begun to provide the required resources to fulfill the cooperative's objectives. These goals include the assessment of the required response to an oil spill, evaluation of current capability, stockpiling of equipment and materials, and training of personnel. At publication time of this report, no progress report of the cooperative's efforts was available.*

*See Endnote 41 this section.

To summarize the preceding discussion, two response plans are of any significance in terms of their ability to cope with larger spills. They are the previously mentioned Coast Guard contingency plan and the MOPS Plan. The Coast Guard plan is well organized insofar as its ability to develop an effective governmental response and provide direction from the higher level of responsibility. It also provides technical and factual information as to the various oil spill combatant methods and the availability of equipment and materials for the man in the field, but does not provide the necessary direction to ensure the necessary attainment of optimal operational results. The MOPS plan contains a degree of this capability but is of value only when, as a third party, they are contracted to remove the spill. Clearly what is needed are some guidelines for the personnel directing the cleanup operation as to what is necessary for a complete and thorough job. A discussion of these requirements follows in the development of an integrated operational plan below.

d. Proposed Integrated Overall Operational Response Plan for Puget Sound

Portions of existing response plans are included in an overall response framework to show what areas presently appear adequate, as well as to point out areas where potential deficiencies exist. From an elaboration of these points, recommendations are made that, if adopted, would give Puget Sound a much improved capability to respond to an oil spill over what presently exists.

The total response model is represented by Figure III-B1, a block diagram of the major functions necessary for effective spill response and their inter-relationships.

1. Participants

Present support capability is both operational in nature as well as technical in terms of advisory staff. A scientific advisory group has been formulated in the Coast Guard plan.[10] Their function is to offer information and supporting data as to the appropriate plan of action that should be taken by the sub-regional response team (SRT). This support includes, but is not limited to, technical expertise in plans of containment,

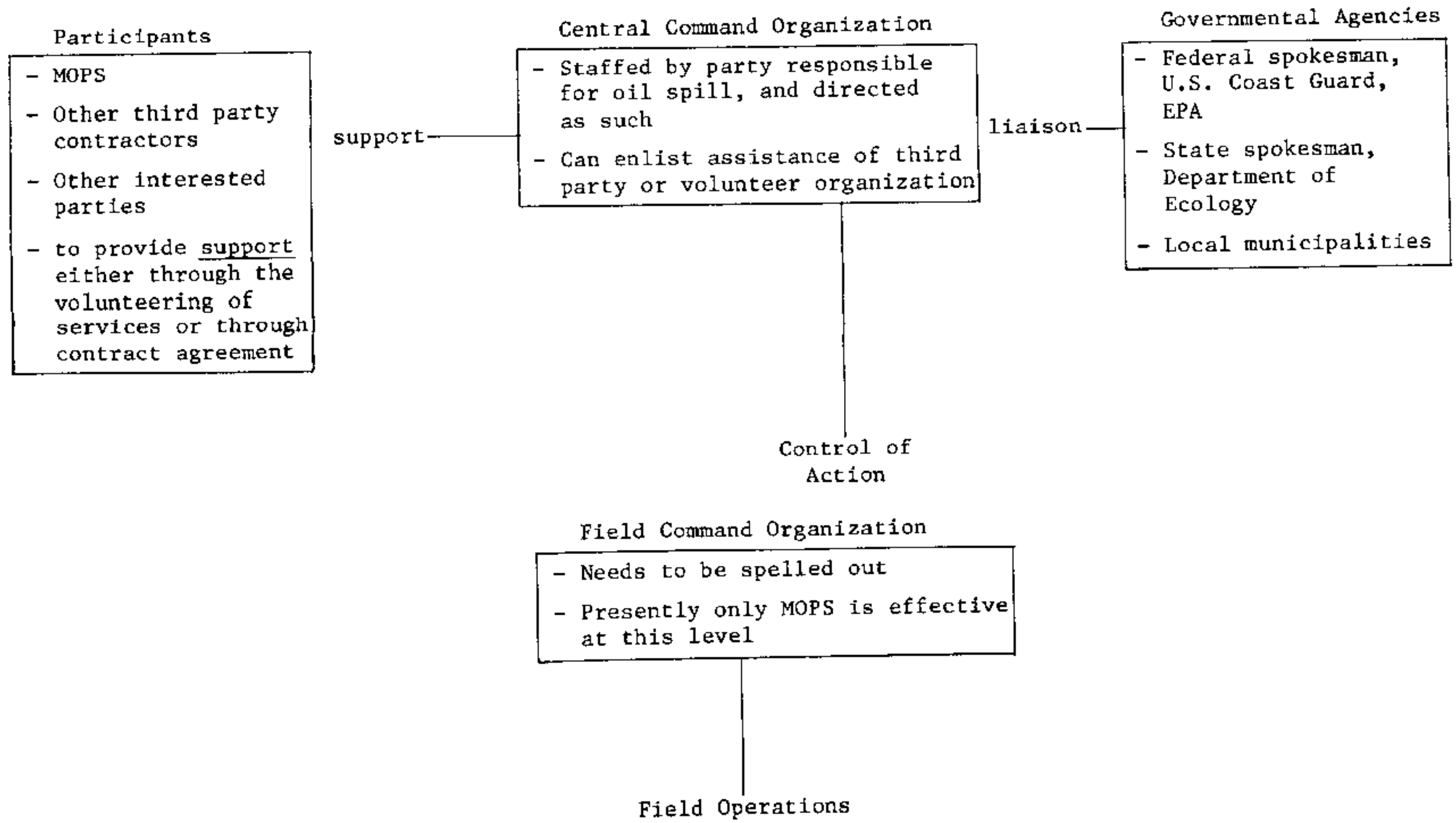


FIGURE III-B1: PROPOSED RESPONSE ORGANIZATION cleanup and environmental restoration. A second support advisory group consists of members of the industrial community that can offer expertise on operations and physical peculiarities of onshore and offshore structures, water-front facilities, ships, barges and other sources. Both groups are to meet and support the SRT in the event of a moderate or major spill (a spill greater than 100 gallons in internal waters).

Operational support can be provided by the MOPS organization on a contract basis, or by any number of interested third parties who may volunteer or contract their services to the party responsible for the spill. The main strength in this operational support capability appears to be MOPS. Other companies do not have an adequate or immediate response capability other than perhaps management expertise and labor resources to effectively cope with a spill. At present even this limited capability is questioned because of their apparent lack of a totally integrated readiness plan.

It appears then that the Central Command responsibilities will be supported primarily by MOPS should a spill occur in the near future. It is doubtful, though, under the circumstances, that the responsible party would turn control of the cleanup operation over to MOPS unless the necessary agreements had been made previously before the fact.

2. Central Command

The proposed Central Command will be staffed by personnel of the responsible party supported in key areas by MOPS personnel. Presently at issue in this type of arrangement is the ability of the responsible party personnel to provide a level of expertise and management knowledge so as to best cope with the spill. The public interest is legally represented by the Coast Guard On-Scene Commander (OSC) who has discretionary power to assume command when he deems the efforts of the responsible party are not sufficient. However, there are no established guidelines through which this authority may be exercised. Herein lies the problem that needs to be resolved through the establishment of these guidelines.

It is anticipated that MOPS can make a significant contribution to the overall Central Command function primarily due to their past experience in dealing with oil spills. In the event of a spill all possible efforts should be expended to place some of this expertise in the position where it can do the most benefit regardless of the contractual arrangements implicit in the relationship.

The Central Command Center is the hub of control and, as such, it must contain the necessary equipment and supplies. It does not appear of benefit, in Puget Sound, to duplicate this center to assure more readiness. One center centrally located, preferably adjacent to the primary staging area, is sufficient. At present there are two Central Command Centers. The MOPS organization has such a resource located at their present base of operations.[11] The Coast Guard has provided a center for the federal response effort at the 13th CGD Regional Response Center (RRC) and for the OSC at the Coast Guard Stations which is designated as the Sub Regional Response Center (SRC).[12]

Both centers have shortcomings. The MOPS center is privately owned and not available for use unless under contract. The RRC provided by the Coast Guard is available only to federal officials. What is needed is a center completely furnished with the necessary materials that could be made available to the party responsible for cleanup with no questions asked.[13] Funding for such a center could come through the appropriate state agency. The amount will be miniscule compared to the total amount involved in a cleanup operation and would be in the best interests of all segments of society.

3. Governmental Agencies

The primary liaison exists between the various federal and state agencies and the Central Command organization. This liaison exists and is necessary because of the Federal and State statutory responsibilities for response to pollution incidents.[14] The primary federal responsibility is to ensure that the party responsible for the oil discharge is taking adequate action to remove the pollutant or adequately mitigate its environmental effects. As pointed out previously some policy guidelines need to be developed in order to carry this out. So long as effective action is being taken, the federal activity is primarily to observe and monitor the progress, providing advice and counsel as required. Where proper action is not taken by the responsible party, further federal response needs to be initiated. Those federal agencies possessing the necessary facilities and resources useful in combatting a spill can be called into action consistent with their operational requirements and within the limits of existing statutory authority. The exact nature of these federal response capabilities in this region are spelled out explicitly.[15]

State response takes place through the Department of Ecology, Water Pollution Control Commission, whose present director is Mr. John A. Biggs. State law requires the party owning or having control over oil that is spilled into state waters to be responsible for the immediate removal of the oil. The state has further statutory authority to assume the responsibility of cleanup where the party at fault fails in his obligation to do so as required by law, and where the public interest is at stake. All expenses incurred are subject to reimbursement by the responsible party.[16]

The capability of the various governmental agencies to fulfill their responsibilities appears adequate for the present. This is not to say they should not continually evaluate these capabilities. At the writing of this report, the study group had no direct knowledge of a state response contingency plan. A plan apparently was being formulated however, as reported by Mr. Harry Tracy of the Department of Ecology.[17] It is recommended that the state make public any plan they may now have under consideration at the earliest possible date. The Federal response plan has been critiqued and is included in another section of this report.[18] The substance of the criticism revolved around the following points:

a. definition of spill classification
b. response communications capability
c. establishment of a baseline data bank
d. priority of critical water area classifications
e. utilization of the Scientific Advisory Group
f. training of response personnel
g. adequate listing of equipment and services resources

No further comment is made on these points in this section.

4. Field Command

Up to this point all the various sections of the overall response plan discussed have dealt with the necessary support and liaison functions as well as the upper level of responsibility in directing a cleanup operation. This last section is categorized as perhaps the most important, for it is under this organization that the actual cleanup will be accomplished. (A subsection of the Field Command is Field Operations, which is discussed under a separate heading.) Unfortunately, of all the response capability in Puget Sound to date, this function is perhaps the most overlooked and the weakest. The Coast Guard contingency plan provides very little information to those directing a cleanup operation in the field. Critical water areas are briefly enumerated, some obvious cleanup and disposal techniques are discussed, and a questionable listing of resources is provided.

Therefore, the effort here is to outline a general plan of attack to provide operational direction in combatting an oil spill to those less than completely familiar with technicalities required. It is highly recommended that a plan of this nature, or some derivative thereof, be disseminated among all interested parties to be used by their personnel as needed. The main advantage of such an arrangement is the ease of coordination of field activity with the other aspects of the response plan already fairly well established and understood.

At present, the best answer to a field command organization is perhaps the MOPS organization. They possess the necessary resources, personnel and expertise to sustain large scale field operations. There are other private parties available but not of the necessary size. However, as stated before, these organizations are of value only if their services are contracted for. There needs to be an operational plan that provides the specifics as to the ordering of equipment, mobilizing labor forces and other resources, and the coordination of field efforts with the other sections of the overall response plan.

Such a model plan has been developed by the Dillingham Corporation. The substance of this plan is adopted for utilization in this report with the recommendation that it be expanded upon and a major effort be directed toward the establishment as the standard for Puget Sound. The following discussion presents the basics of the plan.

Once a spill situation occurs certain factors become of utmost importance. These include:

- operations, which can be broken into four phases:
  a. activation of response plan
  b. initiation of offshore control activities
  c. initiation of shoreside protection and cleanup activities
  d. termination of operations and demobilization of equipment and labor resources
- logistics
- preparedness

A brief comment is made about each in turn.

The key to conducting efficient <u>operations</u> is how the response plan is activated. This in turn depends primarily on the initial assessment of the size and nature of the oil spill. Because of the importance of this aspect of the response it needs to be made by an individual in the upper levels of responsibility in the response organization - most likely the general manager. It would also be advisable that he be accompanied by representatives of the State and Federal interests. To ease the uncertainty in the making of this decision several questions need to be asked. Below are a series that, if correctly answered, can provide a reliable reference point for commencing effective cleanup operations.

1. What is the nature of the material spilled? (Chemical qualities.)
2. What is the exact location of the origin of the spill?
3. What has been the quantity of material spilled and is the spill continuing?
4. How much time has elapsed from the initial spill and to what degree has the material spread?
5. What is the source of the spill and the quantity of material remaining in the source?

6. What is the local situation (weather, degree to what action has been taken, etc.)?
7. Is the capability of the responsible party for controlling the situation adequate?

All logistical support needs to be pre-arranged for the entire region in order to ensure that the necessary resources are available at the least economic cost. The responsibility for maintaining a logistical arrangement is primarily a preparedness function discussed in the next paragraph. The responsibility for maintaining logistical readiness should include:

1. All oil spill control equipment and material purchased.
2. The inventory, storage, and maintenance of this equipment and material.
3. All contractual arrangements for other equipment, personnel and facilities.
4. All transportation arrangements.
5. Maintenance of up-to-date equipment and material specifications.

Complete records of all logistical resources need to be maintained including periodic (3-6 month interval) inventory updating of all available resources.

For any response plan to be wholly effective the preparedness function becomes important. Full preparedness by necessity should include the following specifications:

1. Organizational and maintenance of an oil spill alert system.
2. Maintenance of an up-to-date roster of response plan personnel.
3. Maintenance and periodic operation of the region's Central Command Center.
4. Maintenance of an up-to-date inventory of all available oil spill control equipment as well as periodic inspections as to their serviceability.
5. Training in control techniques to all parties who may be expected to participate in an oil spill incident.
6. The planning and initiation of mobilization exercises designed to simulate an actual oil spill incident, with a resultant evaluation of the experience.
7. Provision of up-to-date information to the various governmental authorities concerning the readiness of the response organization.

Such specific preparedness factors could be managed through a cooperative effort on the part of interested parties in this region. This effort could either be in the form of lending management personnel for short intervals of time on some rotation basis, or the pooling of funds contracting a third party to perform the task. Regardless of the method employed, the establishment of the preparedness responsibility is of utmost importance. However, it should be kept in mind that one-time expenditures for adequate equipment and materials should not be sacrificed at the expense of a rather large and elaborate preparedness staff incurring annual costs.

5. Field Operations

Once the response plan has been actuated, the Central Command Center has been established, liaison with the governmental agencies has commenced, and the initial survey of the spill has been taken, the business of cleaning up the spill begins. Generally, for a spill of any size, operations should be conducted round-the clock until the operations are terminated. The conductance of field operations is described primarily by a listing of the task requirements for any one phase of the operation. A complete discussion of the task requirements is presented in the Dillingham Report.[19] Lack of time and space prevent a complete adaptation of these task descriptions to Puget Sound in this report.

It is advisable, though, that these ideas be adapted to this region and incorporated into a type of field operation handbook that could as well become a part of the Coast Guard regional contingency plan. The task descriptions in the Dillingham report incorporate much of what has been learned on previous spills. The four stages of the operational activities as previously listed are now expanded into a sequence of required tasks. Specific reference to each task is made to the Dillingham report, and noted after each item:

Task Descriptions

1. <u>Mobilize for Control Action</u>

a. Establish and man the field command center (1e).

b. Establish communications between the field and central command centers (1f).

c. Commence documentation of the oil spill incident (1g).

d. Commence an environmental analysis ex post for the spill. (It is assumed an ex ante analysis has already established some type of baseline.) (1h)

e. Commence the plotting and prediction of oil slick movements (1i).

f. Formulate the initial plan for control action (1j).

g. Alert the logistical network for the possible movement of control resources (1k).

h. Make final considerations as to the initiation of a control action (1*l*).

2. Initiation of Offshore Control Activity

a. Implement the selected offshore control plan (2a).

b. Implement the logistical system of pre-arranged resources (2b).

c. Submit periodic control status reports to all interested parties (2c).

d. Begin public information disclosures (2d).

e. Monitor and cooperate if necessary in the salvage of the source of the oil spill (2e).

3. Initiation of Shore Side Protection and Cleanup Activities

a. Implement the selected Shore Side Control plan (3a).

b. Maintain liaison and appropriate communications as above in 2b, 2c, 2d;(3b).

c. Begin to dispose of the oil residue and rubbish (3c).

d. Rehabilitate waterfowl and other threatened wildlife (3d).

e. Provide the necessary assistance in settlement of claims resulting from the oil spill (3e).

4. Termination of Operations

a. Evaluate the requirements for continued control action (4a).

b. Begin to recover the control equipment (4b).

c. Make a professional assessment of the effects of the oil spill (4c).

d. Prepare a final report on the spill incident with recommendations for future incidents (4d).

e. Summary and Recommendations for an Integrated Operational Response System

The Puget Sound region at present has a response organization sufficient at the upper levels of response management, primarily in the liaison function of the federal agencies. No plan has been developed by the State of Washington to date, so the exact position they would occupy in the overall response is not completely certain. The major problem in the response capability appears to be with the actual control operations. What is required in this area is to advance a standard operational plan that can be maintained through the cooperative efforts of all the interested parties. The major points of such a plan have been discussed in this section of the report.

The following list of recommendations should carefully be considered in a true assessment of this area response capability. At the risk of some repetition, it is the consensus of the study group that the following factors need be considered in order to improve the Puget Sound oil spill response capability:

1. A baseline of relevant data needs to be collected and stored in such a form that rapid retrieval will permit maximum use. It is recommended that further work be done on the storage of information by digital computer.

2. That training of individuals most likely to become involved in the cleanup of a spill be instituted to provide knowledgeable people experienced in the techniques of oil spill control.

3. That an integrated independent communications network be established that can be placed in the field and made operational within a matter of hours.

4. A detailed up-to-date listing of all available equipment, material, and labor resources be maintained through the cooperative efforts of interested parties. An effort needs to be directed at the establishment of minimum standards for equipment and materials. For example, straw mulchers that break straw too finely are of little value, as there is a optimal size straw for soaking oil.[25]

5. Previous arrangements need to be made for all resources including firm cost estimates and prior contract agreements as well as the means to transport the resources to the spill site.

6. A comprehensive analysis and identification of high priority areas within the region is required. Before this can be accomplished, it is necessary that some agreement be reached as to the definition of what constitutes high priority (see part 2 of this Section).

7. Both during and after the spill incident an evaluation of the environmental impact of the spill needs to be conducted. This should be a part of the pre-arranged part of the response plan and conducted by local disinterested third parties so as to introduce minimum bias into the results. The results of such an evaluation need to be made automatically available to the appropriate agencies.[20]

8. A capability needs to be developed for all-weather surveillance of the movement of the oil slick.

9. Mobilization exercises need to be conducted to test the readiness of the response organization as well as to simulate and evaluate the response system.

10. A minimum level of effectiveness of a response organization needs to be defined so as to set some standard by which a response effort can be gauged.

11. The field command response effort needs to be further defined. One such method is suggested in this report.

12. Specific policy guidelines need to be established to delineate the extent of the authority of the on-scene commander over the responsible party. For instance, under what circumstances does the OSC have the authority to make the decision that an inadequate effort is being made to cleanup the spill.

2. RESOURCE PROTECTION

a. Introduction

The purpose of this section is to integrate the data on the environment and resources of Puget Sound[1] with the evaluation of containment and cleanup devices[2] into the oil spill response plan. Several important qualifications are mentioned here prior to the discussion. These include:

1. Complete and detailed information on the environment, physical resources, and effects of cleanup material on these resources has not been accumulated.
2. Capability of containment and cleanup devices under adverse meteorological and hydrographical conditions is still under investigation.[3]
3. Statistics on oil spills in Puget Sound are not comprehensive enough to allow accurate predictions on frequency and locations of future spills.[4]
4. Valuation of the physical environment and its inherent resources are presently conducted under various criteria, which frequently are in conflict with each other.[5]

Even with these constraints, the consensus of opinion dictates that some assignment of priority rankings is necessary to protect societies resources with a limited arsenal of equipment and manpower. The alternatives to this approach are:

1. Expend sufficient manpower and equipment to completely protect all resources in the Puget Sound area.
2. Expend no effort and "let nature take its course."

Neither one of these choices would minimize the cost to society. The former would impose extremely burdensome capital outlays without commensurate benefits, while the latter would impose potentially severe losses to society today, and even harsher penalties on successive generations. Thus, some basis must be established for selective protection of resources. Three such bases are proposed in this report.

b. Valuation of Resources

The methods of determining the value of resources in Puget Sound include:

1. renewability,
2. economics, and
3. arbitration.

Each method will be discussed separately.

Renewability: The first method compares resources which are renewable (man-made) against those non-renewable (natural). It would evaluate certain natural resources such as a biological community of particles types of organisms as being more important than any other man-made facilities such as a marina, regardless of financial value. Simply stated, this method assigns priority to those resources that would require the longest period of time to be replaced (if ever) regardless of cost. It is assumed that man-made resources (real property) can be readily replaced or repaired.

Economics: The second method, economics, is perhaps the most accepted and widely used method of resource comparison. However, the parameters of this system are often very difficult to evaluate and only a partial comparison may result. Factors abetting this difficulty include the evaluator's viewpoint, and the intrinsic worth versus cash outlay question for a given commodity. For example, the financial value of a man-made facility such as a yacht basin can be accurately determined by an estimate of current replacement value, but what value does man assign to the convenience of easy access to waterborne recreation? It is assumed here that questions of partial replacement and/or primitive assessments due to litigation are de-emphasized. On the other hand, the economic value of commercial species of salmon or oysters is difficult to determine because of the ambiguity of determining the causes of catch variables (no absolute measure of standing stock and the uncertainty about the period of time necessary for stocks to return to pre-spill levels). Furthermore, the assessment of the relative economic value of sport fishing and purely aesthetic resources are only crudely suggested by estimates of tourist and recreational expenditures. Therefore, local man-made resources of readily assignable value tend to become the most highly valued by this system of comparison and because of the difficulties inherent in assigning a financial value upon natural resources.

Arbitration: The third method, arbitration, acknowledges that the relative value of certain resources are presently indeterminate or hardly known. For example, the paucity of conclusive data concerning the importance of non-economic plant and animal species to the sustenance of economic species, via the complex food web, precludes the dismissal of the importance of the non-economic species a priori. Furthermore, the problem of evaluating the recreational and aesthetic values of non-commercial biota and other natural resources (such as beaches) makes a strictly economic mode of comparison seem inadequate. Unfortunately, the arbitrary criteria for evaluation are most susceptible to dispute by parties of differing interests and are not as practical as the first two methods of comparison.

For the purposes of this section, the relative value of subzone resources subject to oil contamination will be determined by both economic and non-economic criteria. Since it is the intent of this section to provide potentially useful information for rational emergency decisions for resource protection, both options for strictly economic and non-renewable resource protection will be presented, and the decision regarding the relative value of each criterion will have to be determined by the emergency response decision maker. Within the limits of the response capability that may be allocated, it is hoped that both economic and non-economic criteria will be given priority.

It should be emphasized that the philosophy of this section is to present an interpretive synthesis of available data for an interim contingency plan for emergency action on Puget Sound and adjacent waters. The recommendations contained herein are not to be construed as final nor absolute; the recommendations are offered in good faith to (1) improve the data base from which emergency decisions can be made, (2) emphasize topics for further analysis, and (3) stimulate discussion and pre-emergency planning.

On the other hand, the priorities documented in this report are the best available today. In case of an oil spill tomorrow, they should be integrated into the response plan. Continual refinement of the values of resources by accumulation and evaluation of information is essential to its effectiveness.

c. Resource Protection Priorities

As indicated in the introduction, the relative uncertainty involving the frequency and distribution of future oil spills on Puget Sound and adjacent waters seriously hinders the possibility of making very specific recommendations for the location of a minimum emergency response facility (-ies). In addition to the great variability in environmental conditions (currents, winds etc.), the character of the particular type of petroleum product that is spilled determines to a large degree the kind of containment and cleanup response that is most appropriate. For example, the more viscous crude or bunker C materials spread less rapidly and interact with water very differently than the lighter refined fractions such as gasoline.

In view of the uncertainties involved, and the number of special cases that may be considered (i.e. crude oil spilled in the turbulent currents of Admiralty Inlet versus the spillage of refined products in the relatively calm waters of Elliott Bay), it is impossible to prepare for all possible cases of emergencies due to spillage in all areas.

However, it is believed that a conservative minimum response capability might be developed to optimize the procurement and placement of emergency resources within practical financial constraints. The recommendations for each subzone which follow will be concerned with a suggested minimum response capability as well as the possible placement of additional emergency equipment and manpower if it becomes available.

Generally, response time in an accidental spillage is critical because the successful containment and cleanup of spilled oil depends upon keeping the oil film as concentrated as possible; as the spilled oil spreads and the film becomes thinner with time, possible resource contamination increases and cleanup potential decreases. Containment barrier systems may be satisfactorily effective in certain cases both to contain an oil slick and to protect special resources as a defensive measure. A distinction should be made between a capability to contain versus a capability to protect. The quantity and character of an "offensive" containment barrier required to retard and redirect oil spreading are dependent upon the environmental conditions and the necessary amount of equipment is difficult to predict for any spill size, even if the spill size can be anticipated. On the other hand, the "defensive" deployment of containment barriers to isolate especially valuable resources may be ascertained by an analysis of regional geography, and minimum quantities can be specified within certain limits.

Because of the cost and variable effectiveness of containment devices, it is not practical to make a recommendation for a minimum quantity of containment barrier that should be maintained in each area on the basis of resource occurrence alone. However, the effectiveness of sorbents both in the removal of oil from water and in the mitigation of damage to shorelines indicates that it would be prudent to maintain at least the availability of a certain minimum quantity of sorbent material accessible to every area that might be jeopardized on Puget Sound. A subjective examination of past spills, oil spreading characteristics, and costs suggests that an arbitrary minimum response capability for all of Puget Sound and adjacent waters should be the availability of enough sorbent material for 5000 gallons of oil that may be deployed anywhere in the region within a maximum of 4 hours after notification.

This minimum response capability will probably require the local storage of some sorbent material in several subzones. With this minimum response, cleanup, and protective measures can begin within the critical first 4 hours which may be supplemented later by additional emergency resources from central points in the region.

Specialized optional recommendations for the availability and deployment of emergency resources will be summarized in the following pages for each subzone.

Subzone 1: Strait of Juan de Fuca

Environmental Conditions:[6] Open water conditions, locally swift tidal currents, wind waves and swells from Pacific Ocean as well as wind waves from prevailing winds in Strait.

Prevailing waves and winds probably exceed the operating limits of commercially procurable barriers most of the time.

Shore Type: Predominantly coarse; rocks and boulders form narrow beaches bordered by banks and cliffs of variable relief. Access to eastern portion of shoreline is fair from public highways. West of Port Angeles, shoreline access from land is only intermittent. Logs and beach drift are common and may hinder shoreline operations.

Possible Sources of Spills: Fuel or cargo of vessels operating in the Strait of Juan de Fuca. Oil spilled in neighboring subzones and Canadian waters.

Special Resources:[7] Port Angeles - Inside Ediz Hook recreational and industrial property such as boats, piers, marinas, may be protectively boomed.

Dungeness Bay - Commercial and sport shellfish are prevalent in intertidal and sublittoral zones. Protective booms may be of marginal effectiveness, but deflecting booms may be most effective due to the tidal currents to divert oil slicks from bay entrance. Generous application of sorbent material on tideland shoreline and on nearshore water surface may mitigate shoreline damage.

Sequim and Discovery Bays - Commercial and sport shellfish. Dynamic or deflection booms may be marginally effective to reduce encroachment of oil slicks. Tidal currents at constricted entrances may significantly reduce the effectiveness of fixed containment booms. Sorbents applied to shoreline would probably reduce damage.

Port Townsend - Piers and moorage facilities; booms probably ineffective except very locally due to waves and currents.

Subzone 2: San Juan Islands/Bellingham

Environmental Conditions:[8] Open water conditions in S.W. quadrant and Rosario Strait. Milder conditions (currents and waves) prevail in San Juan Islands and in the vicinity of Anacortes and Bellingham, but tidal currents may be locally swift at constricted passages. Containment booms would probably be marginally effective except at passages where tidal currents would reduce effectiveness. Dynamic or deflection booms may reduce damage to large areas if placed near eastern passages of San Juan Islands.

Shore Types: Predominantly rocky with some sand and gravel intermittent in San Juan Islands and North of Anacortes. Eastern Padilla, Samish, and Bellingham Bays are mainly estuarine tidelands with broad tidal flats. Access to Bellingham and Anacortes areas is adequate by public roads. Shorelines of all islands of limited access by public and private ferry service. Logs and beach drift are common.

Possible Sources of Spills: Loading and handling accidents at Anacortes, Ferndale, Cherry Point; waterborne traffic in Rosario, Haro, and Georgia Straits. Refined products are primarily transported by water.

Special Resources:[9] All islands of San Juan Archipelago display valuable shellfish resources and the area may be partially protected by dynamic or deflection booms. If spill is from Rosario Strait or eastward, dynamic booms may be attempted at Obstruction and Peavine Passes, Thatcher and Lopez Passes, and San Juan Channel with marginal success predicted.

Anacortes and Bellingham - Widespread property resources (piers, vessels, small boat harbors) might be boomed with marginal success except in Guemes Channel where tidal currents would restrict the effectiveness. Generous application of sorbents to shoreline would probably reduce damage.

NOTE: Because net water circulation in Guemes Channel is to the west, this tends to flush material into open waters; therefore, spilled refined products should not be dispersed mechanically. Such dispersal would probably tend to increase local damage by incorporating the contaminant into the water column. Shoreline sorbent application is probably the best approach for refined product spillage.

Lummi Island/Lummi Bay - Aquaculture experiment and biological resources may be partially protected by dynamic booming and the application of sorbents to the shoreline.

NOTE: During months of peak flow, the suspended sediment transport of the Nooksack River may alter the density of the fresh water near its plume. This increase in density of the surface water as well as the effects due to particulate surface adhesion may significantly affect the behavior of spilled oil and may cause some sinking of surface slicks.

Subzone 3: Whidbey Island/Everett

Environmental Conditions:[10] Western portion of subzone has open water conditions which significantly restrict emergency containment and clean up operations. With the exception of Deception Pass and its adjacent area, the waters east of Whidbey Island are relatively sheltered and tidal currents, winds, and waves may be often mild enough to use containment barriers with marginal success. Admiralty Inlet to the S.W. of Whidbey Island is probably not amenable to containment operations due to tidal turbulence and swells.

Shore Types: Predominantly sandy and rocky on western Whidbey Island with high banks. Eastern Whidbey Island, Camano and mainland shorelines are primarily narrow and rocky with banks of variable relief. Accessibility to shore from land is limited from public highways. Large logs and beach drift are common on beaches and may hinder shoreline operations.

Possible Sources: Western side of Whidbey Island - vessels in Rosario Strait, Eastern Strait of Juan de Fuca.
Eastern Whidbey Island and waters adjacent to Camano Island are not commonly used by larger vessels so only significant source would be oily material spilled outside the subzone entering by Deception Pass or Possession Sound.

Special Resources:[11] Although the waters surrounding Whidbey Island represent rich areas of recreational and commercial fishing, the prevailing environmental conditions probably preclude the practical use of anything except shoreline sorbents except in the sheltered waters to the east of the Island. All waters to the east of Whidbey Island are valuable recreational fish and shellfish areas.

The Skagit and Snohomish Rivers seasonally support the spawning of large numbers of salmon which must transit salt waters.

The waters of Skagit Bay, Saratoga Passage, Port Susan, and Possession Sound are locally amenable to containment and protective booming, but the ecologically productive tidelands and shorelines are generally all of equal value and any emergency response should endeavor to protect the entire area as best as possible from the encroachment of oil spilled in other zones.

The Port of Everett exhibits considerable property resources that may be locally protected by booms, but the effectiveness of barriers may not be great due to tidal currents and wind waves.

NOTE: The seasonal flow volume and sediment transport of the Skagit and Snohomish Rivers[12] (greatest in June and December) may affect the behavior of oil spilled near the plumes of the rivers. Density and particulate surface effects may induce sinking.

Edmonds has valuable property resources in the form of piers and small boat facilities and should be amenable to protective booming under most conditions.

Subzone 4: Northern Puget Sound

Environmental Conditions:[13] Generally the conditions of Northern Puget Sound are favorable such that containment and protective booming is possible with marginal success. Except in the constricted passages around Bainbridge Island, tidal currents for the subzone are normally weak and wind waves are often insignificant (although they may become significant during exceptionally windy periods).

Shore Types: On the eastern side of Northern Puget Sound, the shores tend to be sandy and rocky with adjacent banks where man-made structures do no intervene. Access to the shoreline from public roads is quite good along the entire eastern shoreline.

On the western side of Northern Puget Sound, numerous inlets and constructed embayments indent the normal rocky shoreline. With the exception of the heads of the numerous inlets which commonly contain estuarine tideland and mudflat areas of sensitive ecological and recreational value, the rocky beaches are generally narrow with adjacent banks of variable relief. Access to the shore from land is generally fair from public roads in this part of the subzone.

Possible Sources: All types (vessels, handling, municipal, industrial sources).

Special Resources:[14] Eastern Shore - All man-made structures and recreational facilities along the shoreline are vulnerable. Of particular value are industrial and commercial piers and small boat marinas.

Biological resources such as salmon spawning sites are seasonally important.

Western Shore - Inlets and bays to the west of Bainbridge Island and adjacent to Bremerton support valuable recreational and commercial fish and shellfish resources.

NOTE: Although dynamic booming is not practical in the narrow Rich and Agate Passages during maximum tidal currents, some deflection booming attempts might be marginally successful near specific inlets. Generous application of shore sorbents is the most effective method with existing technology to protect the valuable inlets.

Bremerton and Winslow are sites of valuable recreational, residential, and public property that may be partially protected by local booming and sorbent application.

Numerous other small settlements of private recreational and residential use are dispersed throughout the subzone and attempts should be made to include them in any program of protective response.

Subzone 5: Southern Puget Sound

Environmental Conditions:[15] Generally weak tidal currents and insignificant wind waves prevail except in constricted passages (especially the Tacoma Narrows) and during exceptional wind conditions. Booming may be marginally effective under most conditions except in the turbulent areas mentioned.

Shore Types: Rocky, narrow beaches with adjacent banks of variable height prevail; at the heads of inlets in the western portion, estuarine tidelands are present.

Accessibility to the shore from land is generally quite poor from public roads and may be difficult from most of the islands.

Possible Sources: Small to intermediate size vessels, handling accidents near Tacoma, spills from other zones.

Special Resources:[16] With the exception of Tacoma and Olympia, Southern Puget Sound is primarily recreational and residential with sport and commercial shellfish concentrations. Salmon enroute to spawning sites may be very important seasonally.

Property resources at Tacoma and Olympia may be protected with reasonable success by protective booming.

The biologically productive western inlets probably will be less amenable to booming because of locally rapid tidal currents; however, deflection booms and cleanup operations with sorbents may mitigate damage.

Nisqually Reach and Nisqually Delta are valuable ecological tideland preserves that may be marginally protected by booming or the application of shore sorbents if they are available.

In addition, numerous small settlements of recreational nature consisting of small boat facilities may be protected from damage by the use of protective booming.

Subzone 6: Hood Canal

Environmental Conditions: Generally weak tidal currents and insignificant waves. Booming possible with marginal success.

Shore Types: Rock and gravel, usually narrow beaches with banks of variable height. Access from land to shoreline is intermittent by public highway and is generally quite poor.

Possible Sources of Spills: Large vessel accident in Admiralty Inlet, or spilled material from Puget Sound passing through Admiralty Inlet.

Special Resources:[17] All of Hood Canal is rich in recreational and commercial shellfish resources, particularly Dabob Bay. Deflection and dynamic booming may be attempted at Foulweather Bluff in order to reduce the encroachment of spilled oil. Although there are numerous small recreational and residential settlements, all areas on the Canal are of almost equal high value. Sorbents on the shoreline as a defensive measure would probably mitigate damage.

d. Summary and Conclusions

The recommended minimum response capability of enough sorbent material for a 5000 gallon spill with appropriate deployment resources to be available to any site in the Puget Sound region within 4 hours after notification is probably the minimum preparation for improving Puget Sound oil spill response capabilities. The four hour maximum response time for all areas would probably require storage centers in subzones 1, 2, 4.

The optional "offensive" (containment) and "defensive" (protective) barriers suggested in the subzone presentations would probably require thousands of feet of very expensive equipment if duplication is not reduced by effective coordination of the emergency response resources. Therefore, it is recommended as an optional minimum response capability (if it is decided that conditions warrant it and that funds should be allocated) that 10,000 feet of high performance booming material be available for deployment within 12 hours of notification to any point in the area bounded by Point Pully, Port Angeles, and Bellingham (subzones 1, 2, 3, 4). This quantity of boom suggested was determined from an analysis of environmental conditions and geography (for example, the entrance to Dungeness Bay is on the order of several miles wide) as well as an examination of the behavior of past spills (as at Anacortes, April 26, 1971). Because of environmental conditions and possible spill frequency estimates, 5,000 feet of high performance boom might be stored at subzones 2 and 4 respectively. As an additional option, enough absorbent material for a response to 50,000 gallons should be available at the sites of the booming devices for deployment to any site in the region within 12 hours after notification.

In conclusion, it is emphasized that the recommendations made herein are subjective interpretations of all available data offered in good faith to present an optional plan for improving the emergency response capability for an oil spill on Puget Sound. It is not claimed that the recommended quantities or suggested deployment sites will be totally effective in the case of a spill. However, this information is based on the best data available at this time and is offered to those who must consider the appropriate levels of preparation for an oil spill emergency as an interim reference point from which further emergency planning will be developed. The purposes of this section will be well served if the presentation of this interim contingency plan stimulates active discussion and constructive criticism by the public, government, and industry to creat an optimum emergency response capability for oil spills in the Puget Sound region.

3. INTEGRATED CONTAINMENT CLEANUP SYSTEMS

The initiation of both the offshore and shoreside cleanup operations is somewhat a function of the resources available at the time of spill. However, assuming the necessary advance preparations are made (i.e., adequate response plan) then the material and equipment resources do not need to be the significant constraint. The following contains the results of an evaluation of the various methods that can be employed in the actual containment and cleanup. The systems suggested are the result of extensive evaluation of many techniques and are believed to provide the most effective control in the Puget Sound region. It is suggested that a discussion of this nature be a part of the field operations handbook, previously recommended in Part 1 of Section III-B1.

Integrated containment-cleanup systems are discussed here, along with deployment techniques. Evaluation of cleanup devices has shown that sorbents, which are spread in the water, and subsequently recovered, are effective in removing oil from the water.[1] This material, combined with various recovery devices form the basis of the cleanup systems evaluated. Additions of containment booms to this system give the user an integrated oil spill control capability.[2] The different cleanup methods are:

a. sorbent and suction pumps;
b. sorbent and conveyor;
c. sorbent and manual retrieval;
d. sorbent and clamshell.

Based on recent past experiences, straw has proven to be a cost-effective material for absorbing oil.[3] Thus, the following discussions utilize this type of sorbent with recovery devices. Dispersants and other similar channel cleanup materials are not considered here because of the recommendation of the State Department of Ecology.[4]

a. Evaluation of Sorbent Cleanup Systems

The straw manual retrieval system (c) has been the most successful of the sorbent cleanup systems utilized in actual oil spills. Its value has not been exceeded when coping with spills that have spread out into small patches. There are several ways of depositing the straw onto the spilled oil. These include:

1. drop by helicopter,
2. mulcher mounted on a barge,
3. spread by men in small boats,
4. dropped from large barges onto concentrated oil slicks.

Essentially the straw is spread on the various oil slicks and is then picked up by men in small boats with pitchforks. The straw can be delivered to the oil spill site by barge. A large barge, with a capacity of 300 tons of hay and equipped with mulchers (as used by the highway department) can be towed into position down current of the oil spill. These mulchers have a capacity of delivering two tons of straw per hour. Such a rig could stay near the oil spill site for several days before exhausting its supply and would therefore be very effective in dealing with the oil spill at its early stages. The straw absorbs about five times its weight in oil, so that one barge could effectively treat 1200-1500 tons of oil if properly mixed.

Manual methods by which the straw-oil mixture can be picked up include the following:

a. Manual retrieval by men with modified pitchforks on small boats (such as purse seiners, flatties or Boston Whalers).
b. Purse seiners or other fishing boats could be hired to pick up the straw-oil mixture with modified nets. These nets should be specifically constructed for oil-straw recovery and could be owned by the oil cooperative organization in the Puget Sound area. The nets could be stored at strategic locations on Puget Sound to minimize the response time to reach the oil spill site. Construction of nets for oil-straw removal should be as follows: The nets should be approximately 20-30 feet deep and double reinforced for the top 5 feet. A batten and flotation arrangement should be constructed so that the net has at least one foot of freeboard. Preliminary models should be tested to determine the best anchoring system when the boats are towing the net to optimize the pickup

effectiveness of the oil-straw mixture. Along with the purse seiners should be barges and other equipment which could pickup the straw corraled by the purse seiners.

Method 2 can be implemented by clam shell operations. A clam shell would be positioned on top of a barge located downwind from the mulching operations. The purse seiners could then drift downwind with their catch and deliver the oil-straw mixture to the clam shell. The straw-oil mixture could then be herded close to the barge so that it could be picked up more efficiently by the clam shell. Such a clam shell was used at the San Francisco oil spill and was recorded as having picked up the most volume of oil-straw mixture of any system in operation at that time.[5] The disadvantages of clam shells are: its size and weight which limit its maneuverability; it cannot operate in rough sea states and can only work in areas where the oil-straw concentration is large.

Sorbent in conjunction with oleophilic conveyors or other mechanized equipment has had some success. These systems have picked up moderate amounts of oil during actual oil spill conditions. The main problems of such mechanized systems seem to be the high rate of equipment failure, their ineffectiveness in rough weather, clogging by floating debris.

Sorbents in conjunction with vacuum or other type of suction pumps have also been used at oil spill locations. Their effectiveness is rather limited to locations that have high concentrations of the mixture. (This could be accomplished by the use of small craft and booms to herd the mixture to the vacuum pump.) Other limitations of the vacuum system are that it can only operate in relatively calm water and is very easily clogged by debris.

b. Evaluation of Oil Spill Treatment Methods

At the present time there is no physical means possible to completely enclose an oil spill in open waters except under calm water conditions. Oil is driven to the downwind/downcurrent side of a containment boom and through various physical forces passes beneath the boom by the flow of water past the boom.[6] All that can be hoped for is some type of temporary containment or deflecting booms to be employed in the waters of Puget Sound. The following discussion treats two aspects of the oil spill control problem.

1. The treatment of oil spills in open water using booms to deflect the spread of oil, that is to exercise some control as to where it goes.
2. The treatment of oil spills close to shorelines primarily using booms to direct oil onto beaches for water cleanup.

1. Treatment of Oil Spill in Open Waters

Channeling of oil slicks leaving the vessel - This suggested use of booms to channel oil downwind of the source is recommended in all spill situations to define the oil control area and should be implemented as a first step if control action is undertaken. The only limitation in the use of booms in this matter would be where weather conditions are so severe that the boom-towing vessels are unable to maintain their positions relative to the source. Considerations in the use of booms to channel the oil are as follows:

a. The boom walls or channel walls should be independent of each other to limit the coordination required by the marine units positioning the walls.
b. The boom walls should be dynamic or under tow rather than static or at anchor to permit adjusting and repositioning the wall to suit the rate of oil release, the oil drift direction and velocity, weather conditions, and general operations in the area.
c. The upwind end of the boom or bow of the towing vessel should be sufficiently downwind of the course to avoid interference with salvage operations. At the same time, the upwind end of the boom wall should be close enough to the source to be effective in limiting the spread of the oil.
d. The upwind ends of the boom walls should be as close together as the situation permits, but should be spread sufficiently to enclose all the oil drifting downwind from the source.
e. The downwind ends of the boom walls may be permitted to position themselves in which case the channel area will be rectangular or they may be pulled toward the center of the channel to concentrate the oil. The objective would be to close the boom walls on the downwind side as much as possible to concentrate the oil while not losing significant quantities of oil over or under the walls. It is recommended that a minimum of 2000 feet

of heavy duty boom (see Appendix 5) be available for use by the regional cooperative response organization in the Puget Sound area in implementing this control action.

f. The boom-towing vessels should be equipped with radar to permit positioning and station keeping at night and should be manned and provisioned to remain on station for several days at a time before being relieved. The boom itself should be equipped with lights and radar reflectors so that its location can be readily determined in low visibility conditions, and at night.[7]

The treatment of the oil in the channel should involve the use and retrieval of sorbents in the channel area and downwind or downcurrent from it (see Figure III-B2). The purse seine, and clam shell methods have been discussed previously.

A mechanical cleanup method, the boom-skimmer system can also be an integral part of this treatment. The collection of oil spilled from ships or barges can also be handled by a sweeping boom and skimmer retrieval operation (see Figure III-B3). Such a system is available complete from Bennett Pollution Controls Ltd.[8] This system is very effective since their boom is specifically designed for sweeping operations. The following paragraphs are excerpts from their oil pollution cleanup system manual.

> The two 500 ft. lengths of heavy duty boom are held to the skimmer (at a distance of less than 3 ft.) by means of two rigid arms, fitted with universal joints at both ends. The resulting gap between the skimmer and boom is sealed with a small section of boom. The first 100 ft. of each boom section (starting from the skimmer) are held together by cross cables at the 10, 30, 50, 70 and 100 ft. Each joint to the boom is made by a wire bridle, distributing the load across the boom. The cross cables are of a pre-determined length to maintain an angle of 30° maximum.
>
> The towing plane at the end of each 500 ft. boom section consists of a vertical steel pipe, attached to each longitudinal boom cable, and is headed by a torpedo shaped float.
>
> The attachment to the tugs (1) and (2) from the towing plane is via 2" nylon rope, approximately 100 ft. long. This is the safety link in the system and the rope will break if the tow tugs accidentally move in opposite directions.
>
> The angle of two depends on the current and a table is given on Figure III-B3.

FIGURE III-B2
CHANNEL CONTAINMENT & CLEANUP SYSTEM

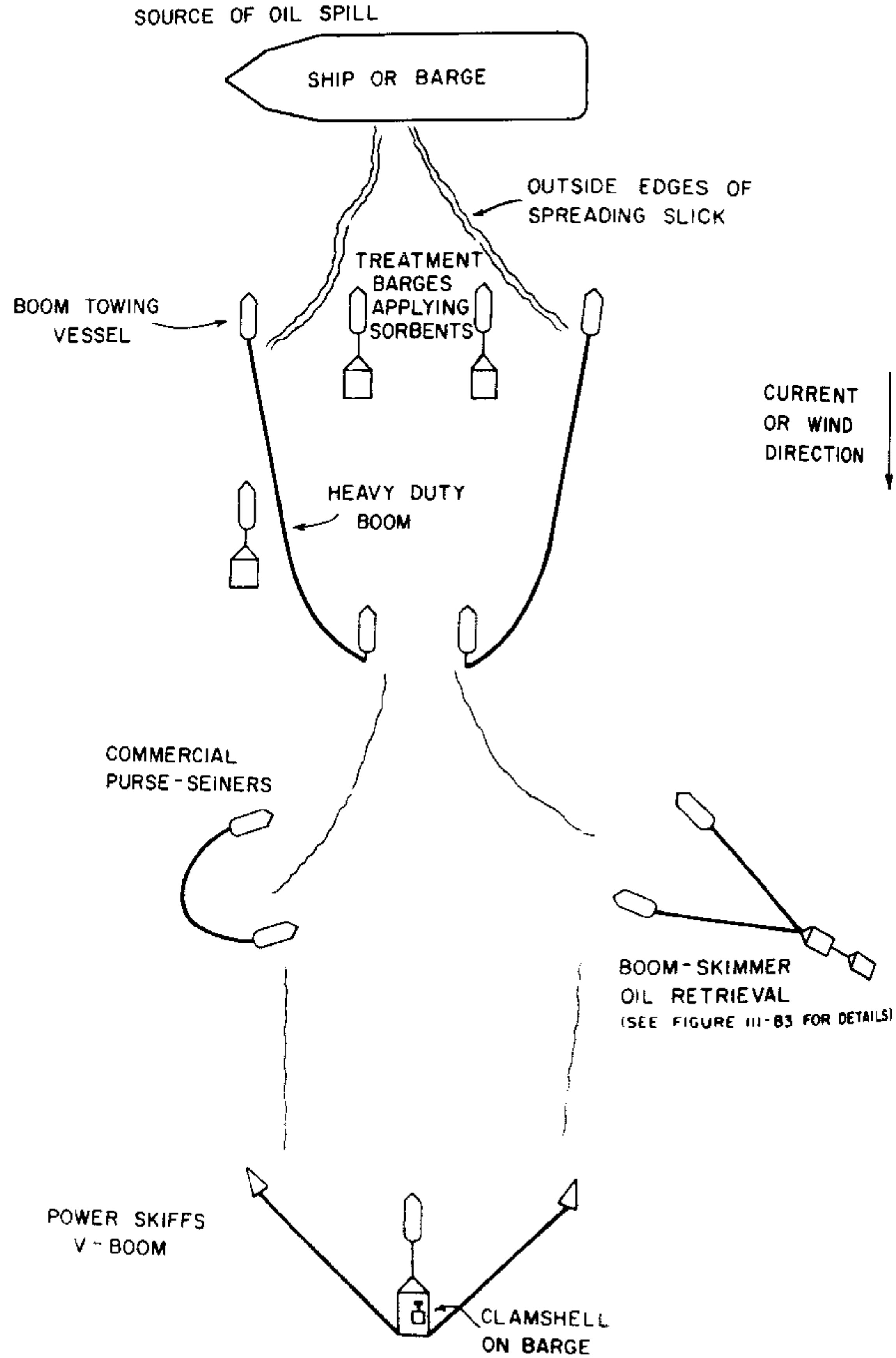
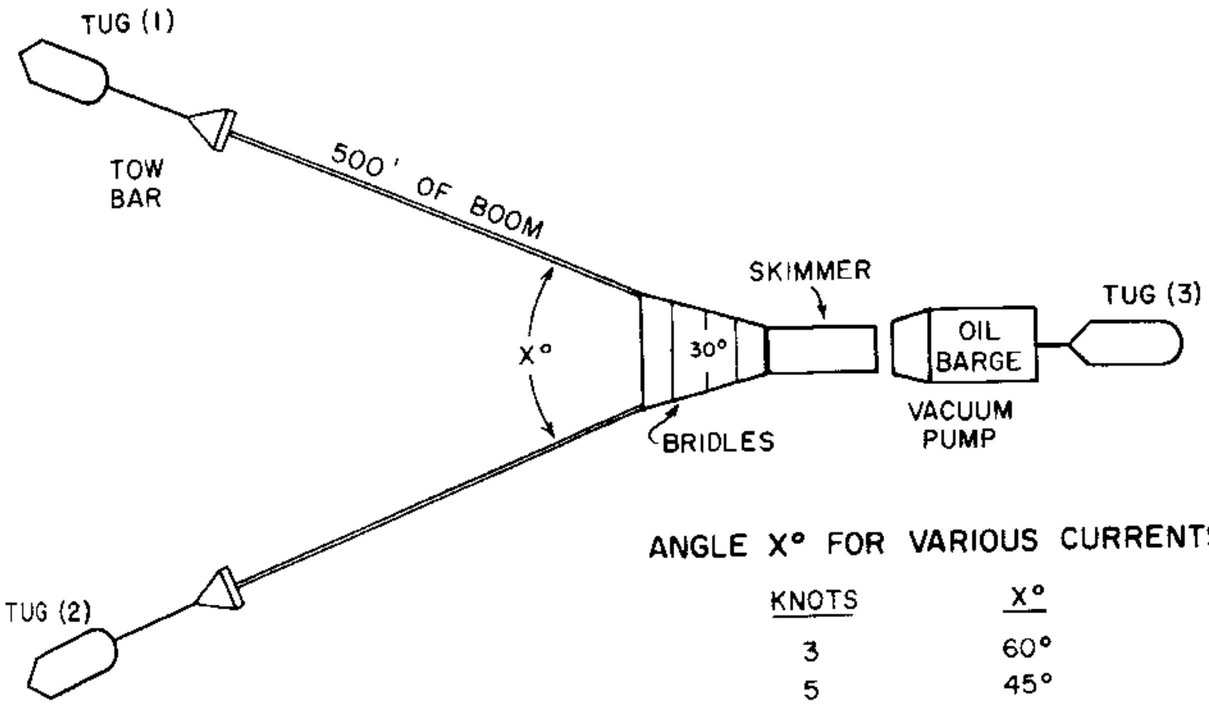


FIGURE III-B3

BOOM-SKIMMER SYSTEM



ANGLE X° FOR VARIOUS CURRENTS

KNOTS	X°
3	60°
5	45°
8	30°

No. 3 tug is the control tug, maintaining the position of the oil barge and skimmer, keeping tension on the booms and directing tugs (1) and (2).

The total recovery unit is assembled in a harbor or protected bay and towed to the oil spill area 5-8 knots, depending on sea conditions. In this operation no. 3 tug becomes the lead tug and no.'s 1 and 2 trail, keeping the booms straight and as close together as possible. The limitation on this system is the skimmer barge, which becomes inefficient in seas in excess of 4 feet, due to its pitching which allows oil to pass underneath. With the inclusion of an oilevator instead of skimmer (an absorbent belt machine), it is considered possible to maintain a 90% efficiency up to 6-foot sea conditions.

A simple v-boom arrangement and two skiffs shown in Figure II-B2. can be used to collect oil-straw mixtures and bring the mixture to either the clam shell operation or to suitable beach areas where the mixture can be easily collected and disposed. All recovery systems discussed earlier are applicable here.

2. Treatment of Oil Spills Close to Shorelines

If floating oil is approaching the shoreline in large quantities, or if the source of the spill is located close to the shore so that adequate control of the oil as it is released is not possible, it must be assumed that a significant quantity of oil will actually reach the shore. The control approach recommended is therefore one of protecting those areas where oil pollution will create the most damage or be the most difficult to cleanup, while sacrificing sections of the shoreline to use as collection points or catch basins and directing the floating oil toward these points. In many respects the strategy is to bring the oil ashore as rapidly as possible where positive control methods may be applied and to limit the opportunity for the oil to refloat or drift along a shore, contacting miles of shoreline in the process.

There are several considerations in the application of this control approach.

First, the topography and uses of the threatened shoreline must be reviewed and an early determination made as to what areas should be protected. Inlets to bays, harbors, marinas or other inland bodies of water should receive primary protection to prevent oil from entering these areas. Secondary concern should be directed toward protecting areas where damage to the ecology may be incurred such as shellfish beds, nesting grounds and saltwater marshes. Finally, those areas which are most difficult to cleanup or have large included shorelines such as rocky promontories, or irregular coasts should be shielded where possible.

Booms should be used to direct the incoming oil away from inlets, around promontories, or to bring drifting oil ashore into open beach areas. As in the case at sea, booms should not be expected to contain the oil or prevent its passage by positioning directly in the path of the drifting oil.

However, booms can be expected to be effective in redirecting the oil as is illustrated in Figure III-B4. Booms used in this manner must be attended at all times, since they must be continually positioned to suit changes in the wind and sea conditions and in the drift direction of the oil. Booms at the sea end of inlets should be backed up by secondary booms spanning the inlet, with floating sorbents on the water to pickup whatever oil passes the seaward boom. Aerial reconnaissance from helicopters will greatly assist in planning the strategic location of booms and in adjusting and positioning.

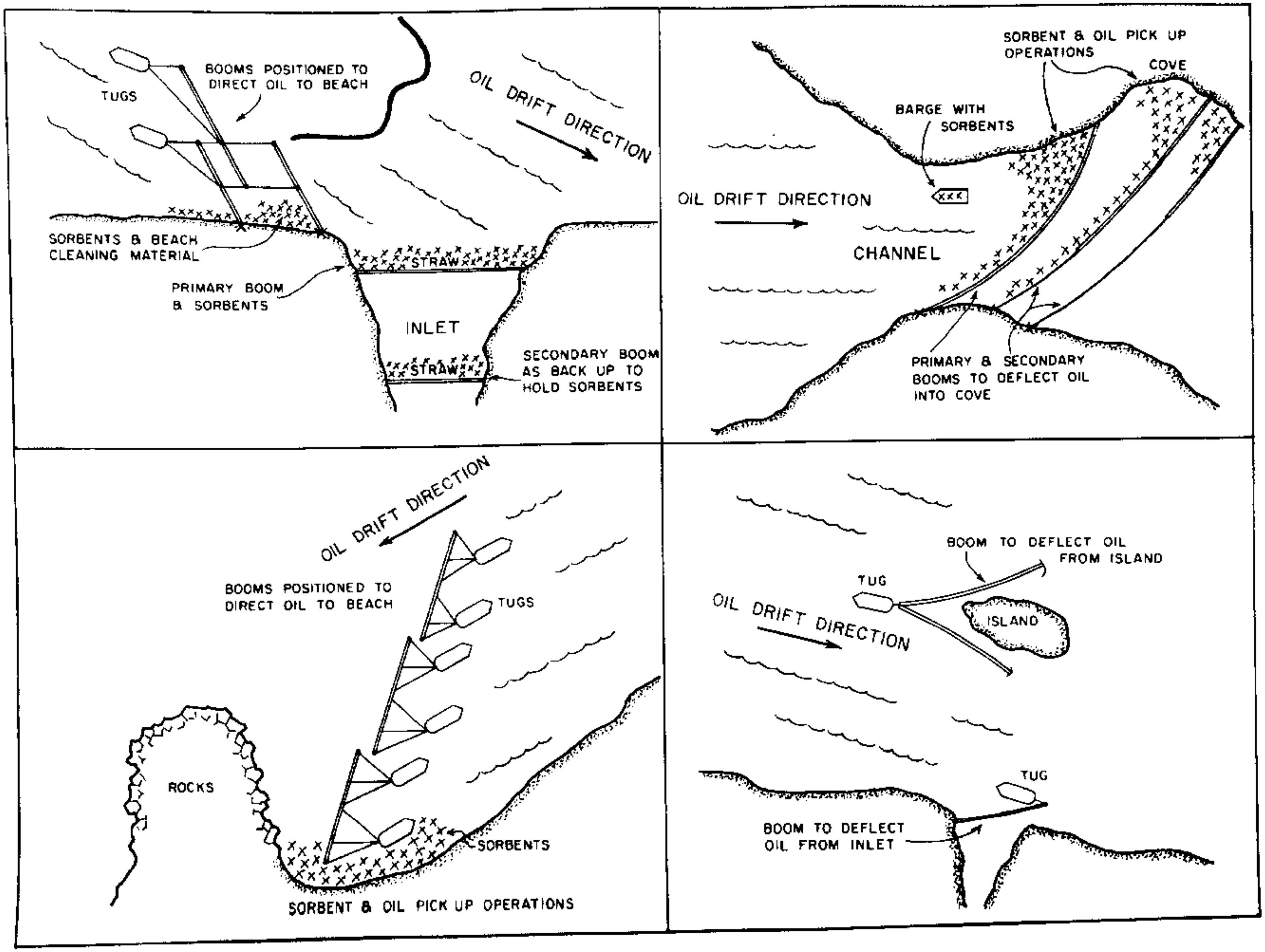
Booms can be used effectively to control the passage of oil. Since booms are ineffective when currents are large, they cannot be used to contain oil by positioning directly in the path of the drifting oil. Therefore booms should be used to deflect oil to specified areas by positioning them at a relative angle to the uncoming oil. (See Figure III-B4.) When booms are used to block inlets, they should be backed up by secondary and even tertiary sets of booms. Sorbents can also be used in between the booms to catch any oil that leaks through.

> "Temporary earthen dikes may be constructed where the situation permits to provide a solid barrier to floating oil. Dikes should be considered for small inlets and entrances on quiet water where the temporary closure will not cause excessive inconvenience and the construction and removal of the dike will not be a major inconvenience."[9]

When oil threatens a shoreline, the most effective and immediate method of protecting and catching the oil is to use sorbents. These sorbents can be applied to the oil before it reaches the beach by the use of small boats. The beach can be further protected by applying sorbents directly from the beach to the water. If the oil extends over a large portion of a beach, booms can be used to concentrate the oil mixture. This is done by putting booms out from the beach which can deflect the oil-straw mixture to those areas where the oil can be collected.

Mechanical devices can also be used to treat the oil if the weather and sea state is calm enough to permit operations. In general, however, where the oil is wide spread or thin and the slick is moving fairly rapidly, a defensive approach of directing the oil with booms rather than attempting to collect it will probably be more successful.

FIGURE III-B4, DEFLECTION OF OIL SLICK WITH BOOMS



Many boom systems are available that can be used to deflect oil or collect oil on beach areas. The main requirement is that the booms have to be effective in currents. Such booms are:

a. Heavy duty or medium duty booms with long skirts (at least 24" of draft).

b. Booms made with fir trees connected end to end. These booms can be improved by using seine net that goes down at least 4 fathoms.

c. Double row of log booms with straw in between. These can also be improved by the addition of seine net that can trap the sorbent-oil mixture. (This is a specially favorable system since log booms are easily available in large quantities in the Puget Sound area.)

c. <u>Summary</u>

Since no cleanup system is the cure-all for oil spills, a thorough treatment of oil spills will require the use of most systems mentioned. A combination of systems will probably be most effective for a particular situation, whether it is in open water or close to shore. These systems should be deployed to the areas where they can be used most efficiently. This will require studying the local geographical conditions, weather conditions, before the deployment of the required systems. A cursory survey has been conducted in the region in an effort to determine the actual ability to cope with a spill situation. The data collection was geared toward controlling an oil spill in Subzone 2,[10] though two regions were examined - (1) the Anacortes-Bellingham area (Subzone 2,) and (2) the rest of Puget Sound and the Strait of Juan de Fuca. The specific deficiencies are reported as follows:

Subzone 2: In the immediate area, a maximum of three helicopters are available; there is only one source of contractual manpower. Vacuum trucks in the area have a limited capacity and no proven marine effectiveness. Subzone 2 has only 1300 feet of oil boom; this is only effective for harbor spills. These could do no more than protect 1 or 2 calm bays. There are no waterborne skimming units in the region, and the capacity to improvise is limited in comparison with San Francisco. There are no oily waste dumping sites in the zone. The nearest dumps are in

Marysville and Port Townsend. Subzone 2 has no heavy cleanup specialists. Perhaps most significantly, there are no standby service boats in the vicinity. A small number of tugs can be reasonably depended on in 2-3 hours, but nothing is ready to go. The region has no high speed craft capable of moving men and equipment; the existing ferry fleet offers the only means of effective transport to the San Juan Islands. No appropriate craft are available for putting equipment on isolated beaches.

Rest of Puget Sound: Many of the same criticisms apply. An adequate number of service boats exist, but there are not any high speed craft suitable for the purpose. The area has only 1700 feet of boom; the boom can be used for harbors, etc. There are 4 helicopter outfits, and only 2 skimmers, based on available information. The capacity to turn skimmers out of shops on short notice is greater than in Subzone 2. Personnel problems are present in both regions; there are no numbers of trained people; there are no groups ready to respond in short order as there are for other types of disaster.

The thrust of this cursory review suggests that the ability to respond quickly to a spill situation is severely restricted by a lack of immediately available material and equipment resources. The general public in this region should not be lulled into a false sense of security by the claims of a "paper" readiness.

An optimal integration of equipment requires a continual updating of testing and evaluation by private and public agencies. An effort should be undertaken to establish minimum standards for equipment and materials. For example, straw mulchers that break straw too finely are of little value, as there is an optimal size for straw that soaks oil.[11]

ENDNOTES SECTION III-B, Part 1

[1] Systems Study of Oil Spill Cleanup Procedures, Dillingham Environmental Company, February 1970.

[2] Anacortes Oil Spill, April 26, 1971; San Francisco Bay Spill, January 18, 1971.

[3] Original estimate was 5,000 gallons. Not until 40 hours after the spill was the final estimate of 5,000 barrels confirmed. See Appendix 12 for further discussion.

[4] "Puget Sound Oil Spill Response Plan," formulated by Puget Sound Tug and Barge Co. & Pac-Mar Services, Inc.

[5] R. W. Roe, "Report on Barge 17 Oil Spill," Texaco Refinery Dock, Anacortes, Washington, April 26, 1971, United Transportation Company.

[6] Section III-C, Part 4, and Appendix 1 of this report present detailed findings of these facilities.

[7] 33 CFR 126, revised September, 1970.

[8] See appendix 1 of this report.

[9] Seattle Coastal Region Oil and Hazardous Materials Pollution Contingency Plans, U.S. Coast Guard, dated December 1, 1971, Annex XX, Appendix 1, Table F.

[10] 3406 - 11th Ave. S.W., Seattle, and Terminal 105. On the Duwamish River.

[11] 13th Coast Guard District Headquarters are at 618 2nd Avenue, Seattle, Captain of the Port office is at Pier 90, Seattle.

[12] Dillingham, Volume II, p. 26.

[13] See Appendices 2 & 3 of this report for critiques on state and federal laws.

[14] Coast Guard Plan, Annex XX, Appendix I, Table C.

[15] RCW 90.48.325, 90.48.330, 90.48.335 of Washington State Statutes.

[16] Conversation with Harry Tracy, biologist for Department of Ecology at the University of Washington, February 11, 1971. Also stated in Department of Ecology internal memorandum, dated May 10, 1971 from H.B. Tracy to J. Behlke.

[17] See Appendix 7 of this report for a critique of the Coast Guard regional contingency plan for Puget Sound.

[18] Dillingham Report, Vol. II, pp. 43-110.

[19] The effectiveness of the present arrangement, under contract no. 68-01-0017, wherein EPA has designated Texas Instruments, Inc. to assess damages in Puget Sound waters in questionable. TI's required response time by contract is 48 hours after notification by EPA. The firm's distant location plus their unfamiliarity in the Puget Sound area are just two factors involved. For a news media evaluation, the reader is referred to the Seattle Post Intelligencer, August 15, 1971, page 1. A critique of TI's performance at the Anacortes spill is documented on Appendix 12 of this report.

ENDNOTES SECTION III-B, Part 2

[1]See section II-A of this report.

[2]See Appendices 5 & 6 of this report.

[3]Undersea Technology, July 1971, Vol. 12, no. 7, p. 8.

[4]See Section III-A & appendix 13 of this report for statistics & potential sources of oil spill.

[5]See section II-D of this report.

[6]See Section II-A; part 3, for environmental description of subzone and appendix 5 for boom evaluation.

[7]See section II-A, part 3 for discussion of man-made and natural resources of Subzone 1.

[8]See section II-A, part 3, for environmental description of Subzone 2, and appendix 5 for boom evaluation.

[9]See section II-A, part 3 for discussion of man-made and natural resources of subzones 2.

[10]See section II-A, part 3, for environmental description of subzone 3.

[11]See section II-A, part 3, for discussion of man-made and natural resources of subzone 3.

[12]Friebertshauser, M. A. and A. C. Duxbury, "A Water Budget Study of Puget Sound and Its Subregions," Limnology to Oceanography, in press.

[13]See section II-A, part 3, for environmental description of subzone 4.

[14]See Section II-A, part 3, for discussion of man-made and natural resource for subzone 4.

[15]See Section II-A, part 3, for environmental description of subzone 5.

[16]See section II-A, part 3, for discussion of man-made and natural resource of subzone 5.

[17]See section II-A, part 3, for discussions of man-made and natural resources of subzone 6.

ENDNOTES SECTION III-B, Part 3

[1] See appendix 6 of this report.

[2] See appendix 5 for evaluation of containment devices.

[3] Santa Barbara Spill, January 1969; and San Francisco Spill, January, 1971.

[4] Laws and Oil Spill Emergency Procedures, Department of Ecology, p. 10.

[5] Conversation with Jules Mayer of Standard Oil Company of California at University of Washington, February 23, 1971.

[6] See Appendix 10 of this report for a theoretical analysis of this phenomenon.

[7] This suggested set of recommendations has been excerpted from Dillingham, Volume II, pp. 69-70.

[8] See Appendix 5 of this report for evaluation of the Bennett Boom.

[9] Dillingham, Volume II, p. 88.

[10] See Section II-A, part 2, for subzone boundaries.

[11] Coast Guard Plan, Annex XV, 2800, Technical Information, p. XV-14.