FINAL REPORT

OF

ONSHORE SUPPORT ACTIVITIES PLANNING STUDY

FOR OUTER CONTINENTAL SHELF (OCS) CONSTRUCTION

GRAYS HARBOR, WASHINGTON

Prepared For

Grays Harbor Regional Planning Commission
207½ East Market Street
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By

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10 October 1978

ABAM ENGINEERS, INC.

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10 October 1978

Mr. Patrick Dugan, Executive Director
Grays Harbor Regional Planning Commission
207½ East Market
Aberdeen, WA 98520

Subject: Outer Continental Shelf Support
Activities Planning Program, Task A

Dear Mr. Dugan:

Attached are the required fifty copies of the final report. This submittal should complete our work for you under this study.

We appreciate the opportunity to be of service, and trust the study will be of real use both to you and to the Washington State Department of Ecology. If we may be of further service, please ask. It has been a pleasure to be associated with the work you are doing.

Thank you.

Very truly yours,

ABAM Engineers, Inc.

Philip W. Birkeland
Vice President

Attach: 50 copies Final Report
File: A 78055

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SECTION 1

1.0 INTRODUCTION AND SUMMARY

1.1 GENERAL

The Grays Harbor area has very evident potential for supporting Outer Continental Shelf (OCS) development. Specifically, this potential includes the construction of offshore oil production platforms, components for offshore or remote location onshore Liquefied Natural Gas (LNG) terminals, modules for remote crude oil and gas production areas, and components for gas treatment and gas pipelines. The probable market area for this construction includes the Gulf of Alaska, the other Southern and Western areas offshore mainland Alaska, North Slope, and offshore Southern California.

This study is intended to provide the information necessary both to assess the effect of such large, high-technology construction projects, and to plan properly for the future. This task is a challenge, as it must be treated with imagination and realism. The following discussion outlines the study approach, and follows the task sequence stated in the Scope of Service.

The preparation of this report has been supported by Grant No. G-78-060B from the Washington State Department of Ecology through a Federal Grant from the Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management. The Consultant has been assisted by Roger Lowe Associates, Inc., in geotechnical considerations, and by the Port of Grays Harbor in the interviewing of offshore energy companies and in determining local planning and community reception considerations.

1.2 DEFINITION OF OCS SUPPORT REQUIREMENTS

The information developed here is the baseline for all following work. Representatives of major firms engaged in offshore energy production were interviewed to determine the most probable timing, location and support requirements for OCS facilties.

From ongoing work in production platforms (preliminary design of hybrid concrete/steel production platform for Gulf of Alaska for Earl & Wright), liquefied gas terminals (design of floating LPG terminal for ARCO/Indonesia, studies of floating LNG terminal for California coast and for Canadian arctic), and various minor work on North Slope modules, the Consultant is familiar with the energy industry. The industry is extremely secretive. The Consultant believes that for information to be reliable, it must be obtained from line (not staff) personnel. Interviews were conducted with such people in Chevron, Kaiser, Texaco, Phillips, Exxon, Fluor, Tokola Offshore, Earl & Wright, ARCO, and American Bridge. It is believed that the interviews provided the required reliable data.

Data assembled included: Types and sizes of projects, probable time frames, skill mix/timing/source of construction personnel for both facilities and product, and physical requirements such as site geometry, access to open ocean, landside transportation, utilities and services, suitability for construction of graving docks and other construction facilities and local industrial infrastructure.

1.3 EVALUATION OF GRAYS HARBOR AREA

In many ways, the Grays Harbor area is ideally suited to OCS support activity. (See Figure 1.1, which shows Grays Harbor's proximity to open ocean and to land transportation). This study, therefore, is pointed towards defining aspects which are not so suited. The two obvious areas are the availability of large numbers of skilled trades personnel, and the consequences of compressible foundation soils underlying all the level waterfront sites.

From planning considerations, three alternative sites were identified. These are the Bowerman Field Area, Industrial Development District #1, and the area adjacent to Terminal 1, Slip #1 in the Port Industrial Area. Figure 1.2 locates these three sites.

1.4 PREPARATION OF SCHEMATIC PROPOSALS

Siting schematics were prepared for the more probable potential OCS activities which might be located in Grays Harbor. To assure adequate realism, this part of the work was approached as if the Consultant were to be made responsible for carrying the work through design and construction. The Consultants' design experience includes all likely types of facilities (graving docks, barge loadout facilities, etc.). The schematics show the principal physical requirements for each probable OCS activity.

1.5 CONCLUSIONS AND RECOMMENDATIONS

The principal concern identified in this study is the potential need to import large numbers of skilled construction personnel. Existing large construction projects in the Grays Harbor area are expected to employ up to 3,500 personnel of this type. It is quite possible that phasing and manpower demands of the more probable OCS projects will be such that little or no additional importation of labor will be required.

The second concern identified relates to the technical problems caused by the compressible soils underlying all three suitable sites. Solutions to these problems are technically feasible and are not constraining.

The principal recommendations are two: First, maintain contact with the offshore industry; and second, complete the Grays Harbor Estuary Management Plan. In this way, Grays Harbor can continue to plan coherently for its own destiny.

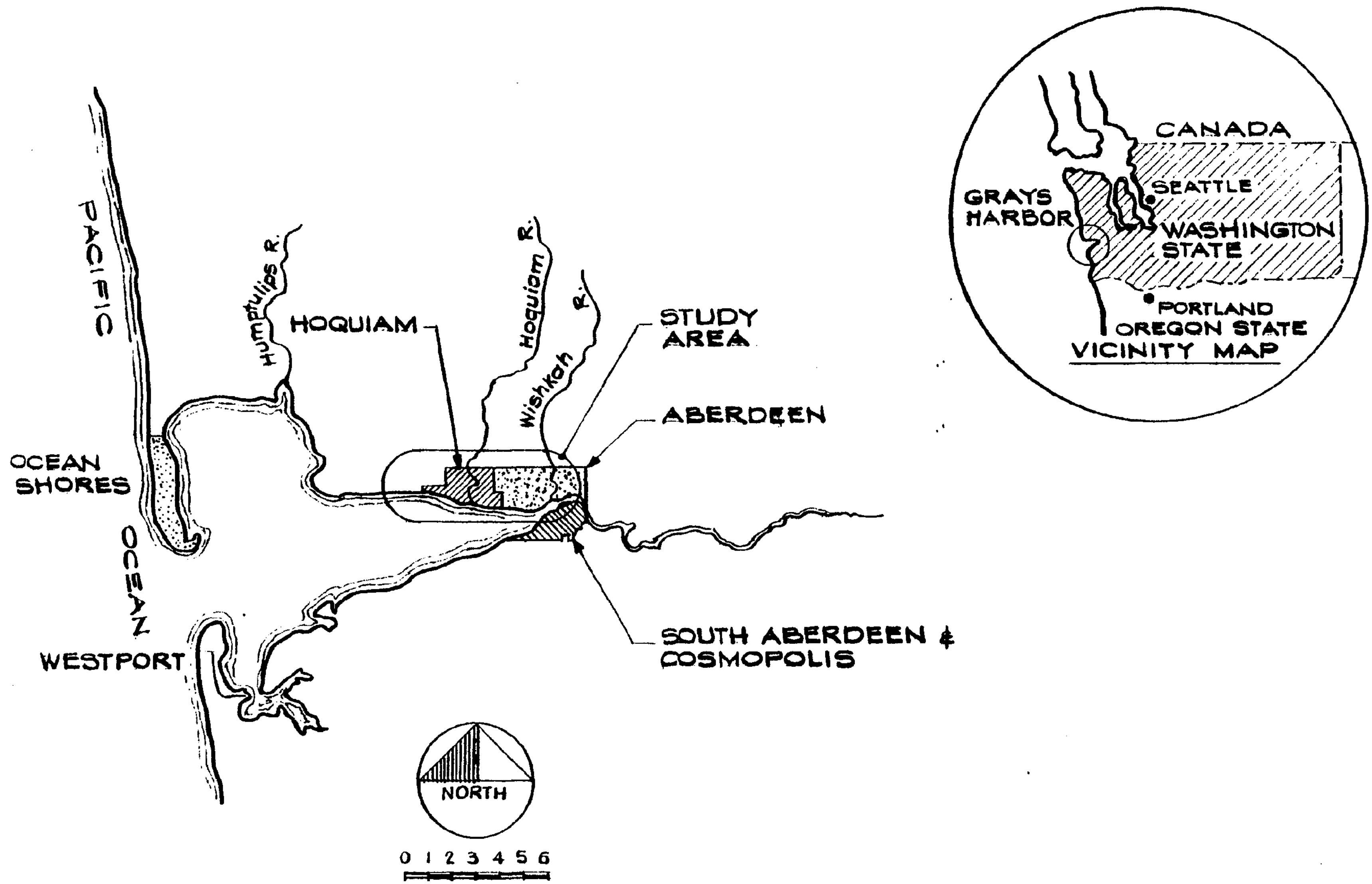


FIGURE 1.1 GRAYS HARBOR AREA WASHINGTON STATE

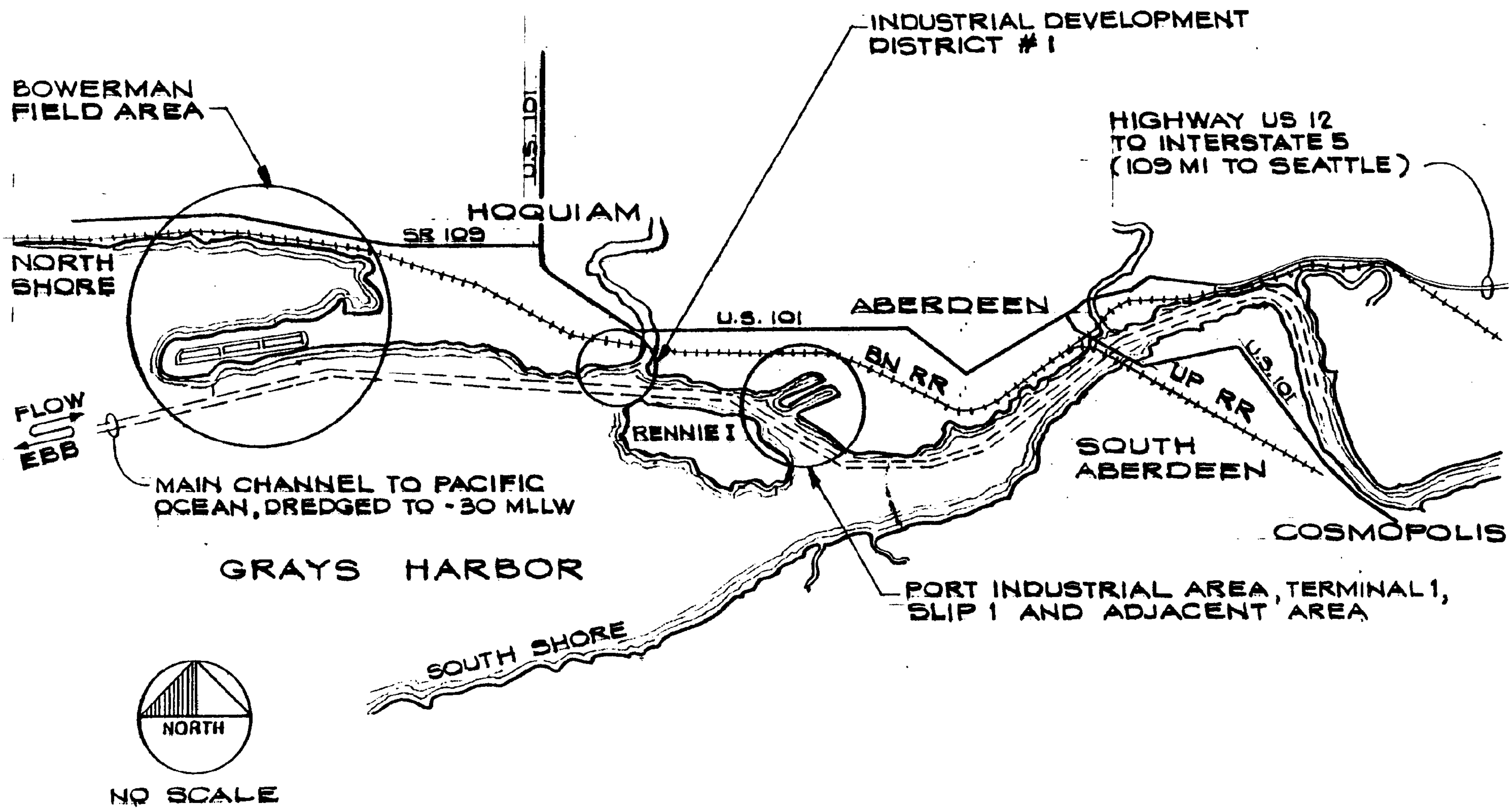


FIGURE 1.2 LOCATIONS OF ALTERNATIVE OCS CONSTRUCTION SITES
(ABERDEEN - HOQUIAM AREA)

SECTION 2

2.0 DEFINITION OF OCS REQUIREMENTS

2.1 SUMMARIES OF INTERVIEWS

2.1.1 Firms Interviewed

Representatives of major firms involved in offshore energy construction were interviewed. The purpose was to obtain firsthand information concerning types of construction activities, probabilities and timing of the market, and site support requirements, and any other data which might be useful. Representatives were selected for their knowledge specific to OCS planning and construction, based upon the Consultant's prior energy industry contacts. Most are "line" as opposed to "staff" people. All those interviewed would directly participate in site selection and in planning or execution of on-shore construction facilities, should their firms be involved in OCS-related construction on the West Coast of the United States. Data received in the interviews are therefore felt to be realistic.

Table 2.1 lists the firms interviewed and their representatives. Because many of the representatives were not willing to have specific statements personally attributed, interview data is reported herein in a summary form. Detailed interview records are retained in the Consultants' project files, but are confidential to the interviewees. The firms interviewed include users (oil companies), OCS constructors/construction managers, and designers and construction consultants. Data from each group of firms have been compared with data from the other two groups to aid in proper interpretation.

The oil companies interviewed were all "majors," chosen for their activity offshore California, in the Gulf of Alaska, and in the Pacific, or for their activity in land-based construction which is likely to be associated with modules constructed on the West Coast for use in southern Alaska or in the high Arctic. ARCO is heavily committed to North Slope work. Phillips is active in Indonesia. Fluor is becoming active in offshore design work and construction, where their response may be considered representative of firms such as Brown & Root, Santa Fe Offshore, and McDermott. Fluor is also active in the design

FIRM NAME	TYPE OF FIRM	REPRESENTATIVE'S NAME AND POSITION	LOCATION	INTERVIEW TYPE	DATE
Atlantic Richfield	Oil Company	James Middleton, Project Manager Prudhoe Facilities Group	Pasadena, Ca.	Telephone	4-24-78
Atlantic Richfield	Oil Company	Donald B. Helm, Construction & Logistics Manager, Prudhoe Facil-ities Group	Pasadena, Ca.	In person	4-27-78
Fluor Engineers	Designers & Construc-tion Managers	K. J. Patelski and J. R. Fitch, Project Mgmt. (Design)	Irvine, Ca. (Los Angeles)	In person	4-27-78
Texaco	Oil Company	James B. Coffee, Petroleum Engineer	Los Angeles	In person	4-27-78
Phillips	Oil Company	Earl Kleinman, Manager of Central Engineering	Bartlesville, Oklahoma	Telephone	5-12-78
Exxon	Oil Company	Nate Bauer, Division Civil Engineer, Western Division	Los Angeles	Telephone	5-17-78
Exxon	Oil Company	John J. Bardgette, Project Manager Offshore Construction, Western Div.	Goleta, Ca.	Telephone	5-26-78
Tokola Offshore	Offshore Construction Managers & Consultants	Edward J. Wortman, Vice President	Portland, Or.	In person	7-19-78
Fluor Engineers	Designers & Construction Managers	A. F. Vieweg, Manager, Projects (Construction)	Irvine, Ca. (Los Angeles)	In person	8-23-78
Fluor Constructors	Contractors	T. J. Richardson, Vice-President (Corporate)	Irvine, Ca. (Los Angeles)	In person	8-23-78
American Bridge (U.S. Steel)	Steel Fabricators and Erectors	Bruce Glidden, Vice-President (Western)	City of Industry (Los Angeles)	In person	8-23-78
Tokola Offshore	Offshore Construction Managers & Consultants	F. J. Murphy, President, K. A. James, Supervising Engineer	San Francisco	In person	8-24-78
Standard Oil of Calif. (Chevron)	Oil Company	Thomas Hudson, Manager, Offshore Planning	San Francisco	In person	8-24-78
Kaiser Engineers	Steel Fabricators, Construction, Designers	W. C. Carson, Manager Administration (Offshore Construction)	Oakland, Ca.	In person	8-24-78
Earl & Wright	Designers	John O. Glover, Vice-President Marketing	San Francisco	In person	8-24-78

Table 2.1 Listing of Firms Interviewed

and construction of LNG (liquefied natural gas) terminals in Alaska (Kenai) and California. American Bridge, Kaiser, Fluor, and possibly ARCO, are representative of the fabricators or assemblers which would be the actual lessors of OCS construction sites in Grays Harbor. Tokola Offshore manages offshore construction of major projects (example: Ninian Central Platform in North Sea) for oil companies and others. Earl & Wright is the world's foremost designer both of steel platforms (jacket, deck, and equipment) for deep-water offshore oil production, and of semi-submersible drilling vessels. Both Tokola and Earl & Wright perform siting studies for oil companies and for fabricators.

2.1.2 Types of OCS Construction Suitable for Grays Harbor

All firms interviewed were questioned as to the kinds of OCS construction suitable for Grays Harbor. The answers were fairly uniform, and are summarized below:

a. Offshore Production Platforms: These are permanent structures which are constructed on or near shore, towed out to the site and sunk in place onto the sea bottom. The platform consists of two parts, the tower (which extends from the bottom to just above the sea surface) and the deck (which contains drilling and production equipment, hotel facilities, etc.). After installation, a series of wells (oil and/or gas) are drilled, and the field is produced.

   There are two types of towers for platforms, "jacket" and "gravity." Gravity platforms are generally constructed of concrete, and have been utilized in the North Sea. They depend on their weight for stability. North Sea type gravity platforms are probably not suitable for Grays Harbor, because of large water depth requirements. Jacket platforms are used the world over. They are generally constructed of steel, in the form of a laced or trussed tower, and depend on piling driven into the sea bottom for stability.

   Jackets are very suitable for Grays Harbor, as are hybrid concepts (steel tower on concrete gravity base). Grays Harbor would most likely be used for jacket assembly, rather than fabrication (which requires extensive shops which are too expensive to write off against a small number of projects).

Decks are of two types, "modular" and "integrated." Modular decks are built on shore as a series of box-shaped modules. They are erected onto the tower after its installation, in an open ocean environment. Integrated decks are built on shore in one piece, and are floated into place on the tower at either a protected water intermediate assembly site or at the final installation site.

b. Machinery and Hotel Modules: These are very large barge and crawler transportable assemblies, similar to those currently installed in the North Slope of Alaska at Prudhoe Bay. Uses would include oil and/or gas field primary production, oil and/or gas pipeline pump or compressor stations, gas treatment, and oil field secondary (by means of waterflood) production. Assembly requires a very large number of skilled trades locally available, a problem at most sites. Grays Harbor is otherwise ideally suited for this type of work.

c. Piping Modules: These are very large barge and crawler transportable assemblies. Uses would include oil and/or gas field production, and LNG (liquefied natural gas) liquefaction and loadout terminals, as currently proposed at Nikisi on the Kenai Peninsula in southern Alaska. A fairly large yard area is required for assembly.

2.1.3 Market Prospects

The OCS construction activities suitable for Grays Harbor have widely variable probabilities of occurrence. The principal uncertainties lie beyond the arenas which can be affected by action or inaction of the Grays Harbor community. Perhaps half the total interview time was spent on this subject, as it is by far the most important in quantifying the effects which can be reasonably expected. The necessary questions for each kind of OCS construction are: Is there a market? If so, where? When? If there is a market, will Grays

Harbor be considered a viable location relative to competing sites elsewhere on the West Coast and in the Pacific? Answers to these questions were solicited from the firms interviewed and were compared among types of companies (oil "major," fabricator, designer, construction manager) to minimize inherent bias. A summary by kind of construction is:

a. Offshore Production Platforms: Only the jacket type is probable, considering current oil company preferences. The potential near-term markets include offshore California, Gulf of Alaska, and Lower Cook Inlet. Much of California is tied up in regulatory problems; e.g., Exxon just shut Hondo down completely (no oil production, and expenditures into hundreds of millions). Gulf of Alaska has shown only dry holes (as did the North Sea at this stage). Moreover, the current West Coast crude glut would not make aggressive development of a high cost area such as the Gulf particularly attractive, as compared with other investment alternatives. All exploratory drilling is now being done in Lower Cook Inlet, with encouraging results. A major strike would produce orders for 10-40 small to medium platforms, spread over the 1980's. Should offshore California break loose the combined market could reach 80 platforms. However, the outlook is quite speculative, even for Lower Cook Inlet.

   Should a major strike occur, it is probable that initial jacket orders will go to existing yards. As long as the world's shipbuilding and steel markets are soft, and there is no Jones Act-type legislation for platforms, Asian shipyards are likely to capture many early jacket orders. Recent bidding for two jackets offshore California produced Japanese prices 30% below very tight domestic bids. However, one West Coast fabricator has just received an order for a similar jacket, to be located offshore Southern California. The picture is therefore mixed.

   Deck orders are a different story. Deck modules require American-built machinery. Modules built on the Gulf or on the West Coast are more than competitive with Japan, Singapore, Korea, etc.

Gulf Coast contractors are highly experienced and efficient at this type of work, and utilize non-union labor. Gulf yards are currently very busy with Gulf of Mexico work. Should integrated decks be used, size (transit through Panama Canal) would preclude Gulf Coast construction, making the West Coast and Grays Harbor attractive to firms engaged in OCS activities. The outlook, though, is still difficult to predict.

b. Machinery and Hotel Modules: The potential markets are very large. There is apparently sufficient miscellaneous Prudhoe work to keep ARCO's Tacoma yard going indefinitely. In addition, there are three projects, each of a size comparable to all of the Prudhoe module work constructed at that yard to date: The Prudhoe waterflood (secondary recovery of oil from existing developed fields), the Prudhoe gas treatment plant (treatment of associated gas to make it suitable for pipeing to the lower 48 states), and the gas pipeline (modules constructed for the compressor stations) to transmit the gas are potential projects.

The waterflood project apparently has no impediments, and may be expected to begin around 1980. The gas treatment and pipeline projects are both completely dependent upon resolution of serious legislative and regulatory problems. However, there appears to be considerable impetus to achieve that resolution; the unanswerable question is, when? Should two of the three projects occur at the same time (and it is entirely possible all three could occur simultaneously), existing West Coast capacity would be tight, and Grays Harbor could be a very viable location. As with integrated platform decks, foreign yards are not expected to be competitive, due to the high content of American-built machinery and components.

There is a realistic potential that Grays Harbor could be a preferred site, but it depends upon a high enough level of total module work to saturate existing yards.

c. Piping Modules: See above for discussion concerning modules for Prudhoe projects. The potential there is significant.

Another possibility is the Southern California Gas Company's long-planned LNG liquefaction and shipping terminal, located at Nikisi, on the Kenai Peninsula (near Anchorage). This project, although small compared with jobs like the waterflood project, is reasonably large. However, the project is completely tied to the gas company's success in obtaining state permits for the receiving terminal in southern California. There appears to be little or no net progress with these permits. The potential is slight, barring a substantial change in the political climate in California concerning energy projects. However, should the Gas Company's predicted gas shortages become reality, this would provide the impetus for the necessary change.

In summary, the potential that OCS construction may occur in Grays Harbor is realistic for Prudhoe modules (waterflood, gas treatment plant, and gas pipeline), but not for the Nikisi LNG terminal modules. The situation regarding offshore oil production platforms appears more uncertain.

2.1.4 On Shore Support Requirements

All firms interviewed were questioned as to their feelings concerning the requirements for on-shore support of the various kinds of OCS construction. The universal requirement is a usable site that has both a good, predictable permit situation and a sensible labor situation (adequate supply, and absence of jurisdictional problems) that allow timely, economical yard construction and efficient assembly and/or fabrication of the end product. Requirements are both highly project-specific and, for special facilities, highly constructor-specific. This is because each constructor will favor a different construction method, and these will require different facilities. Discussion is therefore presented in composite form. Details are given in subsequent sections of this report.

a. Offshore Production Platforms: Jacket towers would, in all probability, be assembled, not fabricated, at Grays Harbor. Facility-intensive fabrication of nodes, pipe sections, etc., would probably be done at the constructors' home yard.

The assembly site requires 40-80 acres of level yard space, adjacent to a deep water channel (20-30 feet of water at low tide). Should fabrication be performed at Grays Harbor, the site area requirement would increase to over 100 acres. Depending upon type and size of jacket, a barge platform, marine ways or railway, or graving dock is needed for loadout or launch. Up to 40 feet of water may be required for launching from marine ways. A graving dock is necessary only for very large North Sea type "self-floating" jackets or for the concrete gravity base of a "hybrid" platform. Rail access is highly desirable. There are no unusual requirements for warehousing, field offices, utilities, etc. Peak manloading might be 300-400 men (mostly skilled trades), 200-300 men average, for a total time of six to twelve months for a single jacket tower. For fabrication, these manloadings might double.

Integrated decks would also be assembled at Grays Harbor. Requirements are similar to jacket towers, except that the construction process is more labor intensive. No need for a graving dock is anticipated. Substantial, secure warehouse and laydown areas are needed to accommodate high value equipment and materials.

b. Machinery and Hotel Modules: A typical module might be 100 feet square by 80 feet high, weighing 1,500 tons. Depending upon project size, requirements include a 25-100 acre yard adjacent to deep water (20-30 feet at low tide). Secure laydown areas, substantial warehousing space, and considerable field office space are required. Nearby cargo pier and warehousing are required. Rail service is highly desirable. A barge loadout platform (one where the barge is ballasted to rest on a prepared bottom or pile-supported platform) is necessary to assure the safe loadout required by most oil companies. A single large project might require 1,500-3,000 men (majority, skilled trades), fairly steadily over a two- to four-year period. The magnitude of labor force mandates it be obtained from outside the Grays Harbor area; the impact on the community due to the influx of people will be substantial.

c. Piping Modules: Unless part of a larger project, this type of project has relatively moderate support requirements. This includes a 25-100 acre yard, adjacent to deep water, and with a barge loadout platform. Manloading might be 200-400 people for six months to two years.

In summary, most types of OCS construction require similar support facilities. The principal exception is a graving dock, which appears to be required only for a large self-floating jacket. A "composite" OCS construction site is developed in subsequent sections of this report. Different types of OCS construction have considerably different staffing requirements ranging from as low as 200 for jacket assembly to as high as 3,000 for the largest module project.

2.1.5 Summary of Interviews

It is felt that the data as reported are reasonable for the purposes of this report. The results of several interviews indicate that the reader should accept projections from oil industry interests and from certain government agencies only with considerable caution. The purchasers' interests are best served by maximizing competition for OCS construction contracts. The traditional way to do this is to publicize the quantity of work anticipated, and to attract enough constructors that bidding will always be "hungry." Agencies are often interested in showing that there is a very serious problem which they can be instrumental in solving. Both industry and government interests are, therefore, often served by generating and publicizing very high estimates of construction volume. Scotland, where approximately twice as many platform yards were built for North Sea OCS construction as were required, provides an example of this industry/government interaction. A substantial number of constructors and local governments have been seriously impacted there because of the over-optimistic projections.

It appears reasonable to assume that Grays Harbor may attract piping module or jacket assembly work. Labor availability may be a factor for the larger machinery and hotel module projects. It is discussed in Section 3.3.3. It was shown that OCS sites must be adjacent to deep water. Other facilities requirements were as might be expected, except that a graving dock appears to be needed only for one very specialized type of project. The principal potential impact item on the community appears to be people, should Grays Harbor attract a large module project.

Environmental impacts associated with the daily operation of any of the facilities are envisioned to be minor. The activities would generally be categorized as being "environmentally clean".

Construction of jackets, and possibly some types of modules, may result in aesthetic concerns because of the size and bulk of the structures being constructed. By their nature, these concerns are highly individual. Aesthetic impacts are envisioned to be of the same general order as those produced by existing industrial uses (large sawdust piles, cargo cranes, etc.). OCS construction, however, offers the advantage that the impacts are temporary and not permanent.

2.2 DEVELOPMENT OF COMPOSITE SITE REQUIREMENTS

As can be seen from the interview data, OCS construction activities of the various types all involve common requirements. These requirements vary enormously, more by specific project and by the particular constructor than they do by type of project. To facilitate evaluation of the various potential sites in the Grays Harbor area, it is appropriate to develop a "composite" site which incorporates the requirements common to the various kinds of construction. This is done in the subsequent paragraphs.

2.2.1 Description of Typical OCS Construction Activities

The general activities involved in the construction of OCS support facilities are common to construction projects of many magnitudes and varieties. The operations to be expected are, in general, environmentally clean and are consistent with the current uses of the Port of Grays Harbor industrial lands. The operations are also believed to be consistent with uses contemplated in the Grays Harbor Estuary Management Plan.

2.2.1.1 Offshore Production Platforms, Towers and Decks

Offshore production platforms of the "jacket" or "hybrid" variety might be constructed or assembled in Grays Harbor. The procedure for a conventional jacket would involve attaching very large prefabricated subassemblies of steel, one to another, by welding. Specific on-site operations might include welding, sandblasting and painting. The completed tower is then loaded onto a barge for transport to the emplacement site, where it is sunk into position and pinned to the bottom by piling. A self-floating jacket utilizes its own buoyancy, and is towed to the site without a barge. This type of jacket may be launched either by marine ways or by flooding of a graving dock.

"Hybrid" structures are assembled by erecting a steel tower on a floating concrete gravity base. Water depths of 30 - 50 feet are required for this assembly. Upon completion of the tower structure, the platform is towed out to a deep-water intermediate site and ballasted until only the top of the tower is above water. An integrated deck, constructed on-shore in one piece, is floated into place and attached to the tower. Deck construction support would require substantial yard area and warehousing, varying according to the type of deck and the particular constructor.

2.2.1.2 Hotel, Machinery and Piping Modules

Materials and equipment are received by rail, truck, and possibly by ship or barge. These are then stored in secure laydown areas or in covered warehouses, to await assembly. The module structures are then erected, and machinery and piping are installed. Typical operations might include steel erection, structural and piping welding, painting, carpentry, electrical wiring, heavy machinery installation, etc.

At the time scheduled for load-out, the modules are towed to the barge terminal by wheeled or tracked transporters. The barge is ballasted down onto solid bearing (the platform consisting of either an underwater, pile-supported grid, or a level, prepared sand bottom), so that when the module is transferred onto the barge, the barge deck remains level. This procedure is independent of tide, and provides the safety required, where loss of one module may cost an entire year in overall project schedule.

Break-bulk and other ordinary cargo is loaded onto barges at adjacent cargo piers, to avoid longshore/construction craft jurisdictional problems. The loaded barges are then marshalled in the harbor for tow to the ultimate unloading site, where the procedure is reversed.

2.2.2 Examples of Existing OCS Construction Facilities

Examples of existing OCS construction facilities are shown in Figures 2.2, 2.3 and 2.4. Figure 2.2 shows Kaiser's marine assembly yard at Vallejo, California (source: Kaiser Site EIS, U.S. Corps of Engineers). Notice the semi-submersible platform being towed out to sea. This site has been used both for construction of piping modules for Alaska, and for construction of smaller semi-submersible drill rigs, platforms, deck units, and prefabricated docks. Figure 2.3 shows the Wright-Schuchart-Harbor module yard at Tacoma, Washington (source: Ralph M. Parsons). This site has been used for construction of hotel, machinery and piping modules for ARCO's work at Prudhoe Bay. It is the largest and most cost-competitive yard of its type, and incorporates a double-slip barge loadout platform (center left of photo). Note the adjacent rail, highway, warehouse and cargo pier facilities. Figure 2.4 shows Snelson-Anvil's North Yard at Anacortes, Washington (source: Snelson-Anvil). The barge shown (lower left of photo) is resting on a loadout platform.

The Vallejo and Anacortes yards are representative of good, smaller OCS construction facilities. The Tacoma yard is a large, efficient facility, which apparently has proven to be very cost-competitive with other yards on the West Coast. Peak employment at this yard was approximately 4,000 the first year. Subsequent peaks were in the 2,000 to 2,500 range.

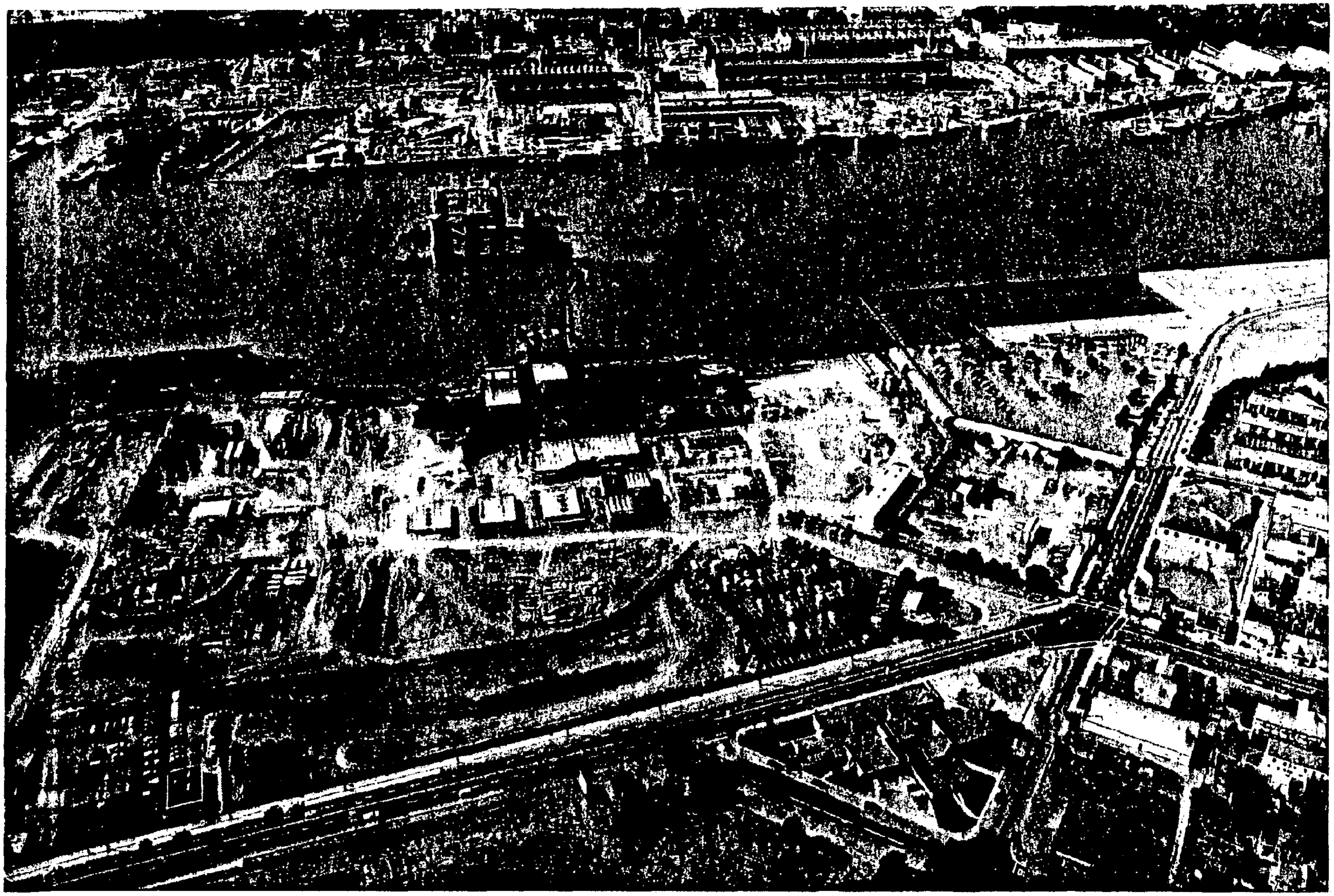


FIG. 2.2 - KAISER

ASSEMBLY YARD, VALLEJO, CALIFORNIA

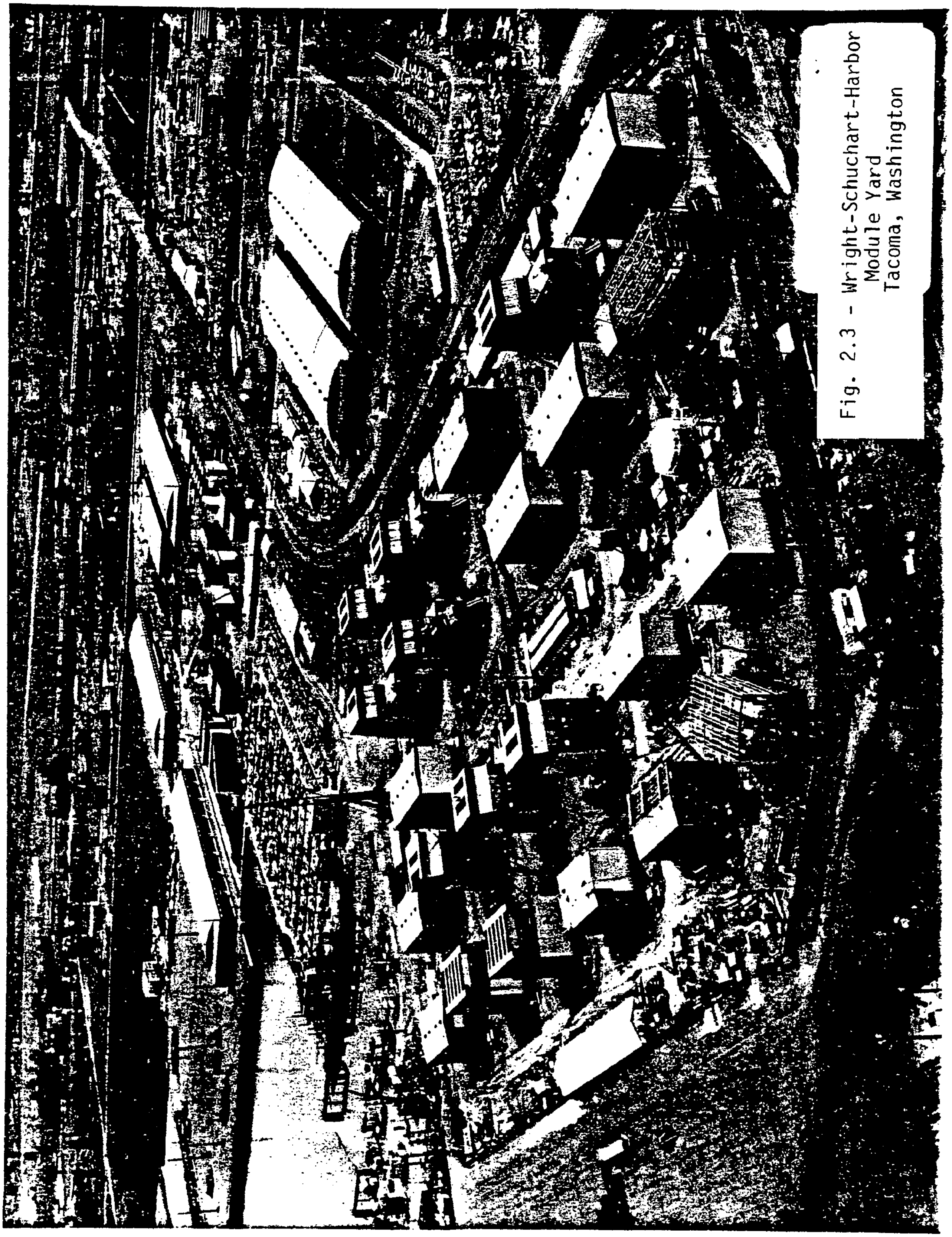


Fig. 2.3 - Wright-Schuchart-Harbor Module Yard Tacoma, Washington

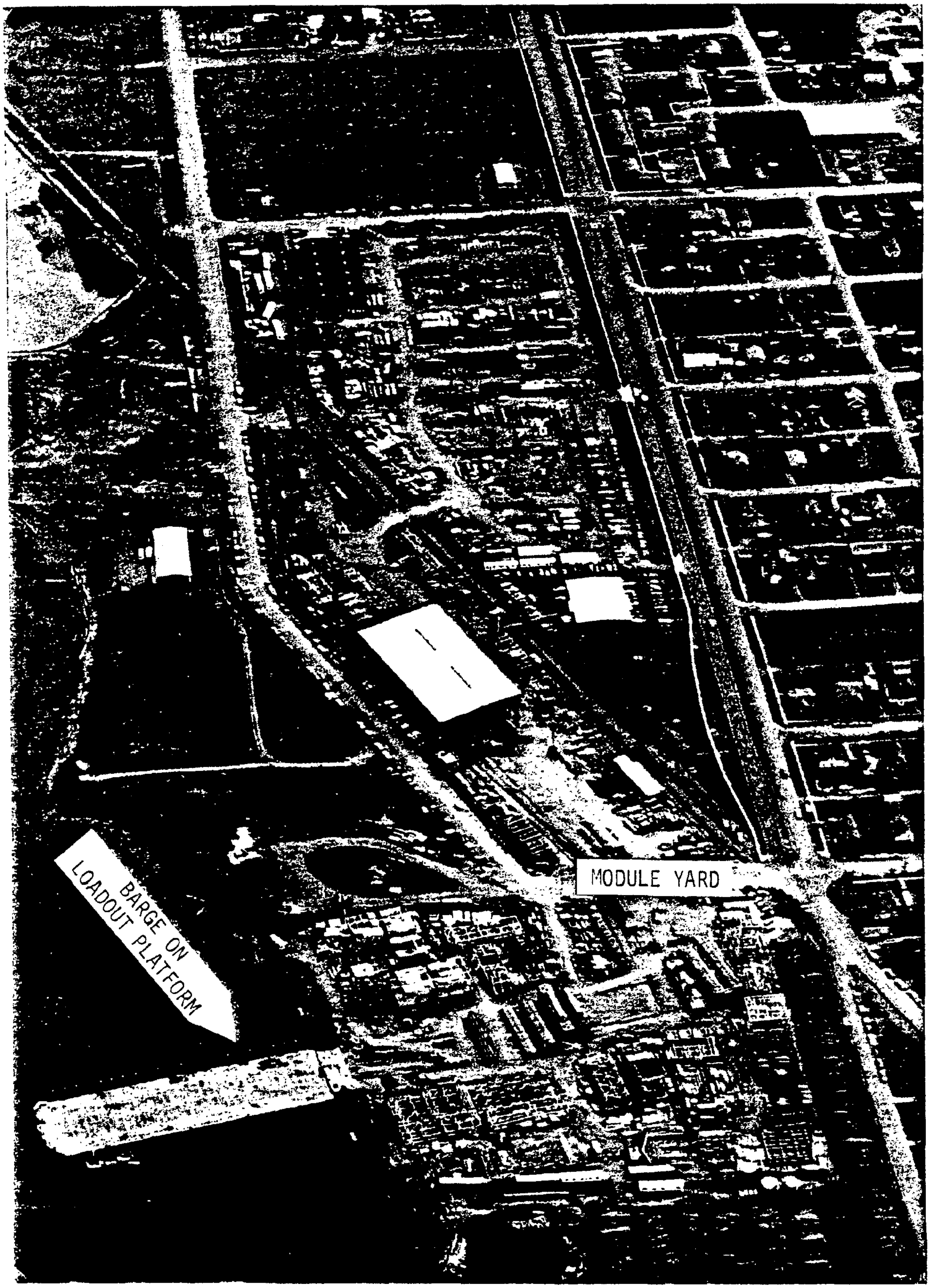


FIG. 2.4 - SNELSON - ANVIL
MODULE YARD WITH BARGE LOADOUT PLATFORM
ANACORTES, WASHINGTON

2.2.3 Description of Required Construction Facilities

The required construction facilities are generally common to more than one type of OCS project. The requirements are discussed below for transportation, utilities, warehousing, laydown area and assembly yard, graving dock, marine ways, barge loadout platform, graving dock and general cargo piers.

2.2.3.1 Transportation

Ready access to site by highway and rail is required. Access to nearby cargo terminal by barge or ship is generally necessary.

2.2.3.2 Site Utilities

Power, water, fire protection, sewer and storm drainage are required, in kind and quantity similar to industrial development existing in Port lands.

2.2.3.3 Warehousing

It is required for high-value materials and equipment which must be protected from weather and which must be on site or adjacent to it.

2.2.3.4 Laydown Area and Assembly Yard

Land areas must be level, drained and capable of withstanding traffic with temporary wheel loads of 50 tons (100-ton axle) and non-critical building foundation loads of 2,000 - 4,000 pounds per square foot. The laydown area must be secure (fenced and lighted), to safeguard high-value materials and equipment stored outdoors, and must be adjacent to the assembly yard. The assembly yard must be adjacent to deep water for loadout.

2.2.3.5 Barge Load-out Terminal

This consists of an underwater surface (pile-supported grid or artificial beach) for the barge to rest upon while being loaded, and a pier or wharf to allow transfer of the load from the yard to the deck of the barge. The vertical distance from the pier deck to the platform is equal to the moulded depth of the barge; that is, 20 feet for the standard 100-ft x 400-ft ocean going barges generally used to transport structures for OCS operations.

The platform must be maintained in a smooth condition and might preferably conform to the shape of the barge hull. The barge is floated into a slip and ballasted with water until it rests uniformly on the platform. During loading, there is then no tendency for the barge to roll or list and the deck remains at the same level as the dock.

After the loading operation is complete, the water is pumped from the barge's interior and it again floats. The procedure eliminates much of the risk of damage to expensive structures during load-out.

Barge loadout terminals are shown in Figures 2.2, 2.3 and 2.4.

2.2.3.6 Marine Ways

These are also called marine launchways or marine railways. Figure 2.5 is a handbook illustration of marine ways for ship launching (source: Abbett). Ways for launching jackets are similar. When such a facility is to be used to launch a structure into the water, the structure is assembled in a level position, followed by side launching from the inclined way. During construction, the structure is supported by blocking and shores. During descent into the water, the structure is supported by the launchway. Side-launching ways are common on inland waterways where there is limited width for travel.

As shown in Figure 2.5, the launching ways consist of two parts. The upper part, sliding ways, constitutes the cradle which moves the ship or structure. The lower part, ground ways, usually consists of multiple parallel strips which are fixed in position and extend into the water to provide support for the ship or structure until it is waterborne. A side-launching way requires a waterfront area of greater length than a structure and of sufficient width to provide working space between the waterfront and the ship. The ground ways

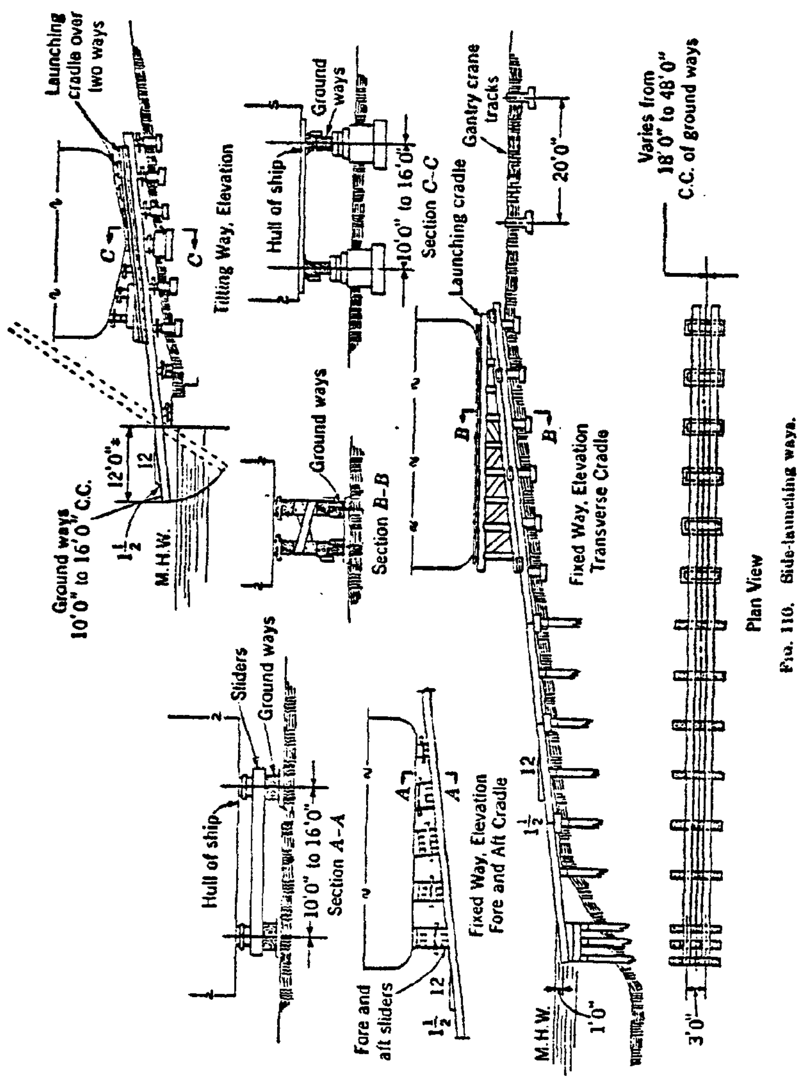


FIG. 2.5 - MARINE WAYS

extend from the water's edge, across the working space, to the inshore side of the structure in its building position. The width of the launching slip should be a minimum two-and-one-half times the structure width. The depth of water in the slip should exceed the structure's launching draft by 50 - 75%.

2.2.3.7 Graving Dock

A graving dock is a rectangular lined excavation located in the foreshore of a navigable body of water. It has an entrance gate or cutoff wall which may be opened and closed and a pumping system for dewatering the interior.

The ship or structure is constructed inside the dewatered interior. When ready for launch, the basin is flooded, the gate or cutoff wall removed, and the ship or structure floated out. This procedure must be closely coordinated with the tide. The gate or cutoff wall is replaced, the basin is dewatered, the next structure is begun, and the cycle is repeated. The graving dock shown in Figure 2.7 is a very low-cost type, utilizing steel sheetpile walls and cutoff and an earth floor.

Alternatively called a "construction basin", it is required only for self-floating jacket or for the gravity base of a hybrid platform. The dimensions in plan would be up to 300-ft wide by 1100-ft long for a jacket, or 250-ft wide by 450-ft long for a gravity base. The required depth depends completely upon the concept and detailed design of the jacket or base structure. Figure 2.6 shows the graving dock (construction basin) used for construction in Tacoma of the hull for ARCO's Ardjuna Sakti, a 55,000-displacement-ton floating LPG refrigeration/storage/loadout facility now moored and in production in the Java Sea (source: Concrete Technology Corporation). The dimensions of the basin are approximately 150-ft wide by 500-ft long.

The choice of site for a graving dock is influenced by navigability of approach, cross-currents and wave action, prevailing winds, silting or scouring of channel and entrance, working and shop areas, and foundation considerations. The latter are extremely important and have profound effects on technical feasibility and cost.

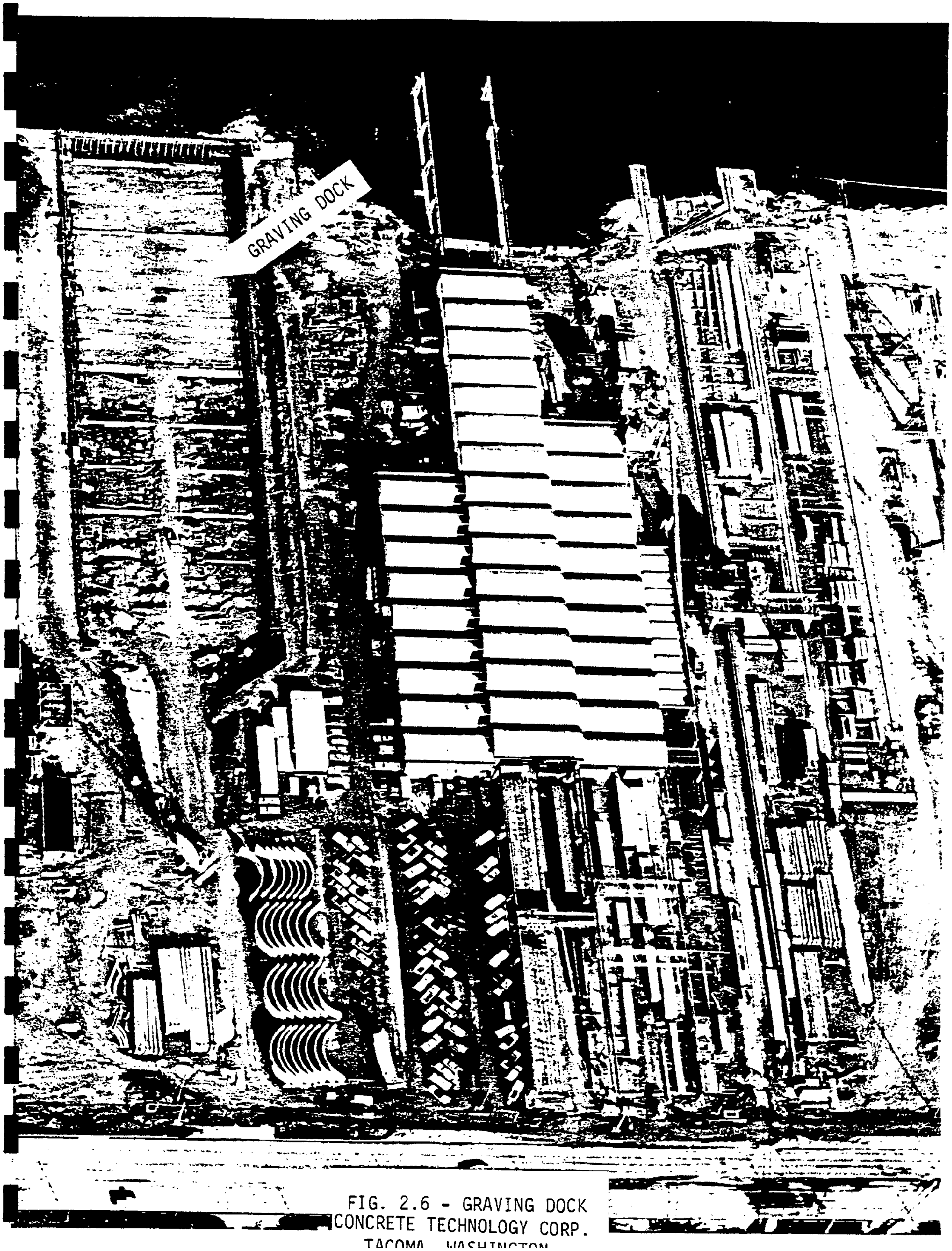


FIG. 2.6 - GRAVING DOCK
CONCRETE TECHNOLOGY CORP.
TACOMA, WASHINGTON

2.2.3.8 Cargo Piers

Cargo piers are generally required. They should not be part of the site proper, to avoid the mixing of longshoremen and construction crafts and the consequent jurisdictional problems. They should be nearby, and capable of loading both ocean-going barges and ships. The requirements are similar to those satisfied by the Port of Grays Harbor's existing Terminal 4 and the planned Terminal 2. These are capable of berthing ships 600 - 700 feet long, have crane service, and provide 30-foot draft at low tide. See Figure 2.8.

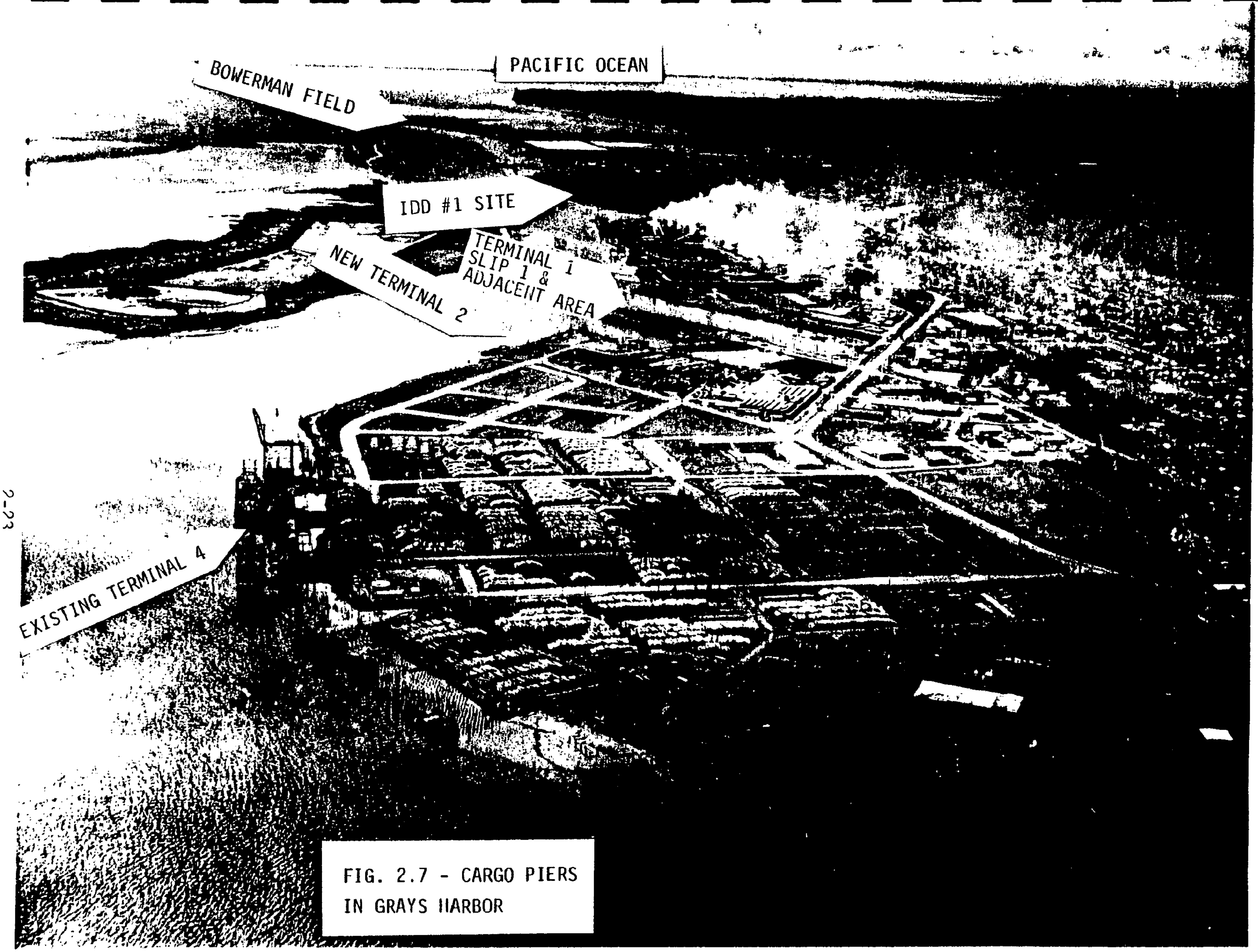


FIG. 2.7 - CARGO PIERS
IN GRAYS HARBOR

2.2.4 Requirements for a Composite OCS Construction Site

Table 2.8 summarizes the onshore support requirements for the various suitable types of OCS construction. A "composite" site is useful in the planning process. It may be categorized as follows: A level, well-drained, 25 - 100-acre site, adjacent to 20 - 30-ft deep channel to open ocean, adjacent to rail and highway transportation, and near deep-water cargo piers. Waterfront facilities at the site will include a barge loadout terminal. Marine ways or a graving dock may be required. Onsite warehousing to 150,000 sf will be required. The site must be served by the usual industrial utilities (power, water, fire protection, sewer, etc.), and must have a surface capable of withstanding light building foundation loads (2,000 - 4,000 psf) and heavy wheel loads (to 100 tons/axle).

TYPE OF OCS CONSTRUCTION	MANNING REQUIREMENTS		LAND AREA	WATER DEPTH	BARGE TERMINAL	MARINE WAYS	GRAVING DOCK	WAREHOUSE AREA
	NUMBER	DURATION						
Offshore Platform Tower (Jacket)	200-400	6-12 mos	40-80 acres	20-40 feet	Yes	Yes	Possible	Nominal
Platform Deck	300-600	6-12 mos	40-80 acres	20 feet	Yes	No	No	50,000
Machinery and Hotel Modules	1,500-3,000	2-4 years	25-100 acres	20-30 feet	Yes	No	No	100,000-150,000sf
Piping Modules	200-400	6 mos to 2 years	25-100 acres	20 feet	Yes	No	No	20,000 sf

Note: All types of sites require highway and rail transportation, and must be near cargo piers.

Table 2.8 SUMMARY OF OCS CONSTRUCTION SITE REQUIREMENTS

SECTION 3

3.0 EVALUATION OF THE GRAYS HARBOR AREA

Grays Harbor is the only deep-water harbor on the coast of Washington State. It is located about 45 miles north of the Columbia River and 110 miles sough of the Strait of Juan de Fuca. See Figure 3.1. The harbor has been extensively modified to accommodate deep-draft marine commerce. Vessel access is provided by a -30 foot mean lower low water (MLLW) navigation channel, maintained from the bar to the main port cities of Aberdeen and Hoquiam. Plans are currently before Congress seeking authorization to widen the channel and deepen it to -40 feet.

Approximately 3 million tons of bulk cargo are shipped out of Grays Harbor each year, the majority of the shipments being timber export products.

The area also has good highway, rail and air transportation facilities. Connection is made to major airports, the main interstate highway system, and the main railroad lines serving all major cities in the United States.

The harbor itself broadens gradually from the Chehalis River channel at Aberdeen to a broad pear-shaped estuary encompassing North and South Bays. See Figure 3.2. The estuary is enclosed on the ocean side by two long sand spits separated by a two-mile wide opening which forms the natural harbor entrance. The harbor is 19 miles long from Aberdeen to its entrance. Two convergent jetties extend seaward from the points of the spits, constricting the entrance width to about 6500 feet.

3.1 REVIEW OF PLANS TO DETERMINE SITE AVAILABILITY

In order to refine the scope of the study area to include only those areas or locations which are socially, economically and environmentally feasible or acceptable, the site requirements have been prioritized as follows:

- o Deep water access with no navigation impediments.
- o Environmentally acceptable.
- o Adequate size, with limited topographical relief.
- o Loading: foundations, axle.
- o Access: highway and rail.
- o Warehousing.
- o Possibility of a graving dock.

Of these priorities, the first two are of particular concern.

Deep Water Access: Because Grays Harbor is a shallow water estuary, most of the shoreline is separated from navigable water by a broad expanse of tidelands. Deep water access from these areas would require development of spur channels, connecting the main navigation channel to a particular site. Current limitations on dredging in environmentally rich tidelands and the difficulty of disposing of dredged materials, even if dredging were allowed, makes any consideration of sites more than 1/3 of a mile from the main navigation channel impractical. It should be noted that even though sites which are relatively close to the main channel exist in the Westport area on the south side of the entrance to Grays Harbor, winter storms and heavy seas make this area unsuitable for marine commerce.

The shoreline of the upper harbor area, particularly along the north shoreline within the Cities of Hoquiam and Aberdeen and downstream of the rail and highway bridges, provides the only area on Grays Harbor which satisfies the first criteria. Because of the proximity of the navigation channel to this approximately 6.5-mile stretch of shoreline, its use has been historically closely tied to marine commerce.

Environmental Concerns: Environmental evaluation of potential sites for OCS construction activities within this area is simplified by the fact that land use planning, zoning, and, more recently, an interagency (local, state and federal) estuary management plan have all identified the appropriate areas of the estuary for heavy industrial use. The estuary management plan, in draft form at this writing, has given a particular priority to use of the sites discussed herein for water-dependent industrial uses. In the development of the estuary plan, detailed consideration was given to the biological production of various areas and other potential environmental concerns related to alternative sites for industrial use.

Because it is a busy port community, a substantial portion of the identified shoreline is presently being utilized and, for purposes of this study, is not available. However, three sites which are, to different degrees, available are described below and are shown on Figure 3.3.

3.1.1 Bowerman Field Ares - Site 1

The airport and adjacent tidelands are owned by the Port of Grays Harbor. The airport itself occupies 142 acres of land, with approximately 500 additional acres of tideland. Use of this area for OCS activity is only possible if the portion of the site presently occupied by the airport were made available and, in all probability, such a situation would not occur in the short-range future. This possibility is, however, considered in order to examine all potential opportunities consistent with the estuary plan.

The question of the ultimate location of the airport is currently the subject of a study to evaluate alternative airport sites. If a suitable site can be identified, necessary funding developed, and arrangements made to relocate the facility, the present airport site could meet the site requirements listed in Section 3.1, with the exception of warehousing, which would have to be constructed. Of the sites considered, it has the least technical problems for development of a graving dock, due to the presence of previously compressed soils.

The airport site is recognized in the draft estuary management plan as a prime location for water-dependent industry. Limitation contained in the plan on filling of the inter-tidal area along the southern edge of the property would require the use of pile support structures to provide access to the navigation channel.

Adverse environmental impacts associated with the use of Bowerman Field would consist of limited filling for approaches to over-the-water structures. Careful design of these structures will aid in reducing the impact to the aquatic habitat.

3.1.2 Industrial Development District No. 1 - Site 2

This site, located at the confluence of the Hoquiam and Chehalis Rivers, is also owned by the Port of Grays Harbor. The 45-acre site has recently been filled and final work to make the site usable is now under way.

The site is identified in both the draft estuary plan and in the Hoquiam Zoning Ordinance as an industrial area. Use of the site has been restricted to water-dependent activities by the Port Commission, as well as in the estuary plan.

The site is currently under option to Kaiser Steel Corporation for use as an assembly yard for offshore oil production platforms. The current option, however, expires in December of 1978.

Extensive soils testing has been performed on this site and discussion of those tests is contained in Section 3.2.2.

Due to the existing fill and its proximity to the channel, further modification to the estuary to accommodate its use for an assembly yard would be quite minor and would consist of over-the-water structures rather than fill. Permits for construction of specific related facilities have already been obtained.

3.1.3 Terminal No. 1, Slip 1 - Site 3

This site, including the navigation slip, adjacent land, and warehouses are owned by the Port of Grays Harbor.

This site's principal attribute, and the reason for its selection and evaluation in this study, is the existence of a navigation slip which appears suitable for use as a graving dock and barge loading terminal. The slip is approximately 500 feet wide by 1800 feel long with water depths ranging from 0 to -37 feet MLLW. Water surface area within the slip is approximately 20 acres. Soils conditions are discussed in Section 3.2.2.

Site 3 also includes approximately 40 acres of adjacent land with two warehouses of 30,000 and 40,000 square feet. Approximately 3400 square feet of office space is also available on-site.

This site is zoned for industrial use and has been identified in the draft estuary plan as an industrial area. Redevelopment of the Slip, either through filling or use as a graving dock, is a permitted activity in the estuary plan.

The adverse environmental impact of use of this site consists of removing the slip from the aquatic area of the estuary. However, this site has already been extensively modified by man's activity and tends to be subject to heavy siltation which reduces its value as an aquatic habitat.

3.2 AVAILABILITY OF SUPPORT REQUIREMENTS

As discussed in Section 2, most OCS activities have similar support requirements. These requirements can be divided into three categories; land, utilities and services, and labor.

3.2.1 Land

Our evaluation of the Grays Harbor area (Section 3) has produced three potential sites for OCS activities. These sites are identified in Figure 3.3 and are discussed in greater detail in later sections of this report.

3.2.2 Utilities and Services

Utilities necessary to support OCS activities are those normally available in industrial areas: Demands placed on such facilities are nominal. Of the three sites identified on Grays Harbor, all are presently served by potable water, sanitary sewer, and electrical power systems. Some enlargement or extension to these systems may be required. These are not significant items, however. Overall, it appears that little, if any, problem is present in supplying common utilities to possible OCS activities on these sites.

Services which are needed to support OCS activities include both rail and highway. Site 1 is situated within 3000 feet of a state highway and mainline railroad. An industrial roadway was constructed into the site in 1977. Rail service into the site would require the construction of a spur.

In the case of sites 2 and 3, rail access is available at the perimeter of both. A state highway is located within 2000 feet of each site, and both are connected to the highways by existing industrial roadways.

Since all of the sites are generally in committed industrial areas, extensive new development of utilities and roads is minimized. The potential adverse impacts of developing this infrastructure are thereby reduced in that these utilities and services would not need to be extended through undeveloped areas, therefore encouraging further development with related adverse environmental impacts.

3.2.3 Labor

Manpower requirements for the types of OCS activities likely to locate in Grays Harbor range from 200 to 3000 skilled laborers. Until recently the regional labor pool would not have been capable of supplying the necessary skills: Training of a large pool of trainable, unemployed workers or in-migration of skilled workers would have been the options. Currently, however, a twin nuclear generating facility is under construction near the City of Elma, east of the estuary. The project is in the first year of construction and is expected to peak at 3500 workers in 1981. This project will attract a labor force with the suitable skills for OCS activity, but OCS activity will need to compete with the nuclear construction project for these workers until 1981.

The competitive factor may not be significant at the lower range of the OCS manpower requirement since 200 would be only a 6% increase in the total labor force needs in these skills. The competition will become more significant for the larger projects. However, after 1981 the situation will dramatically change since a surplus of skilled labor would be available as the manpower curve on the nuclear project declines. An OCS activity coming into the area at that time could aid in reducing potential adverse socio-economic impacts of the nuclear project by reducing the outmigration of construction workers.

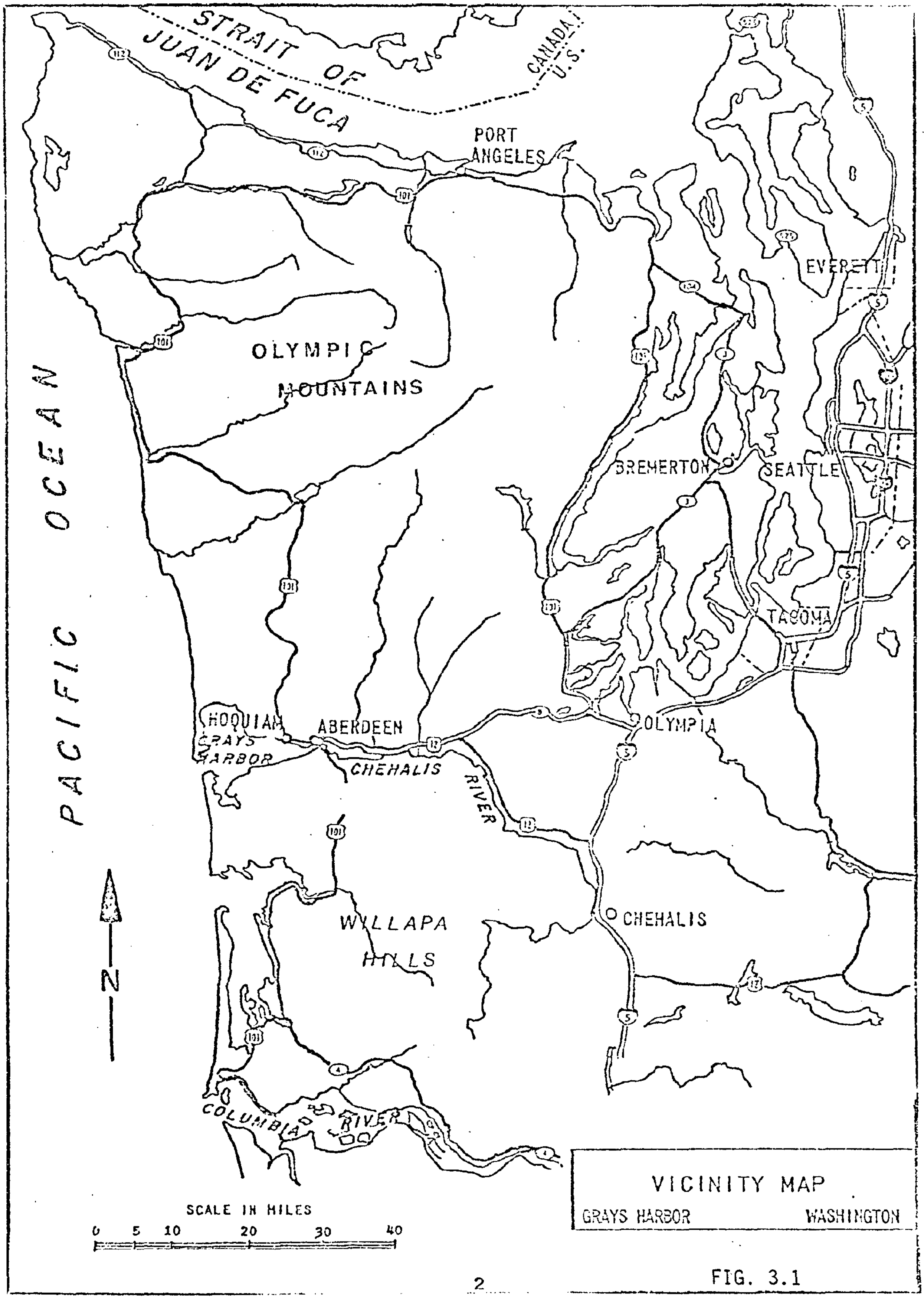
3.3 EXTENT OF LOCAL RECEPTIVENESS

Discussions have been held with the Hoquiam City Council (September 18, 1978,) and with the General Manager of the Port of Grays Harbor. All persons involved in these discussions have voiced concern over the fact that the economy of the region is so closely tied to the forest products industry and have expressed general support for new industry which would diversify the economic base of the area.

While some concern has been expressed over the ability of Aberdeen and Hoquiam to house new residents, most feel that residential opportunities exist within a reasonable distance (25 miles) from the potential sites. The area most frequently mentioned was the City of Ocean Shores, approximately 20 miles from Hoquiam, where approximately 8000 homesites with sewer and water service are currently available. Conversations with the City Manager of Ocean Shores reveals that the City is receptive to the idea of serving as a "bedroom" community for the Aberdeen-Hoquiam area and the city, in conjunction with the Grays Harbor Regional Planning Commission, is currently engaged in a comprehensive planning program to explore its development in this regard.

Another indication of local receptiveness to OCS activities in Grays Harbor is the Overall Economic Development Plan for Grays Harbor County. The Annual Progress Report for the O.E.D.P. Committee published in June 1978 includes this statement: "The heavy reliance of the region's economy on forest products causes the entire economy to perform in direct response to the factors affecting that industry. This industry is highly cyclical causing the region's economy to be cyclical. Diversification would reduce this dependence and produce a more stable economy."

Discussion with representatives of the Regional Planning Commission has pointed out the potential complementary nature of OCS activity to the nuclear power plant construction project currently underway approximately 20 miles east of Aberdeen. The OCS labor requirements could be increasing as the labor requirements on the nuclear project declines. The Regional Planning Commission is also actively engaged in several activities to stimulate new housing starts.


STRAIT OF JUAN DE FUCA
CANADA
U.S.
PORT ANGELES
EVERETT
OLYMPIC MOUNTAINS
PACIFIC OCEAN
BREMERTON
SEATTLE
TACOMA
HOQUIAM
ABERDEEN
OLYMPIA
GRAYS HARBOR
CHEHALIS RIVER
CHEHALIS
WILLAPA HILLS
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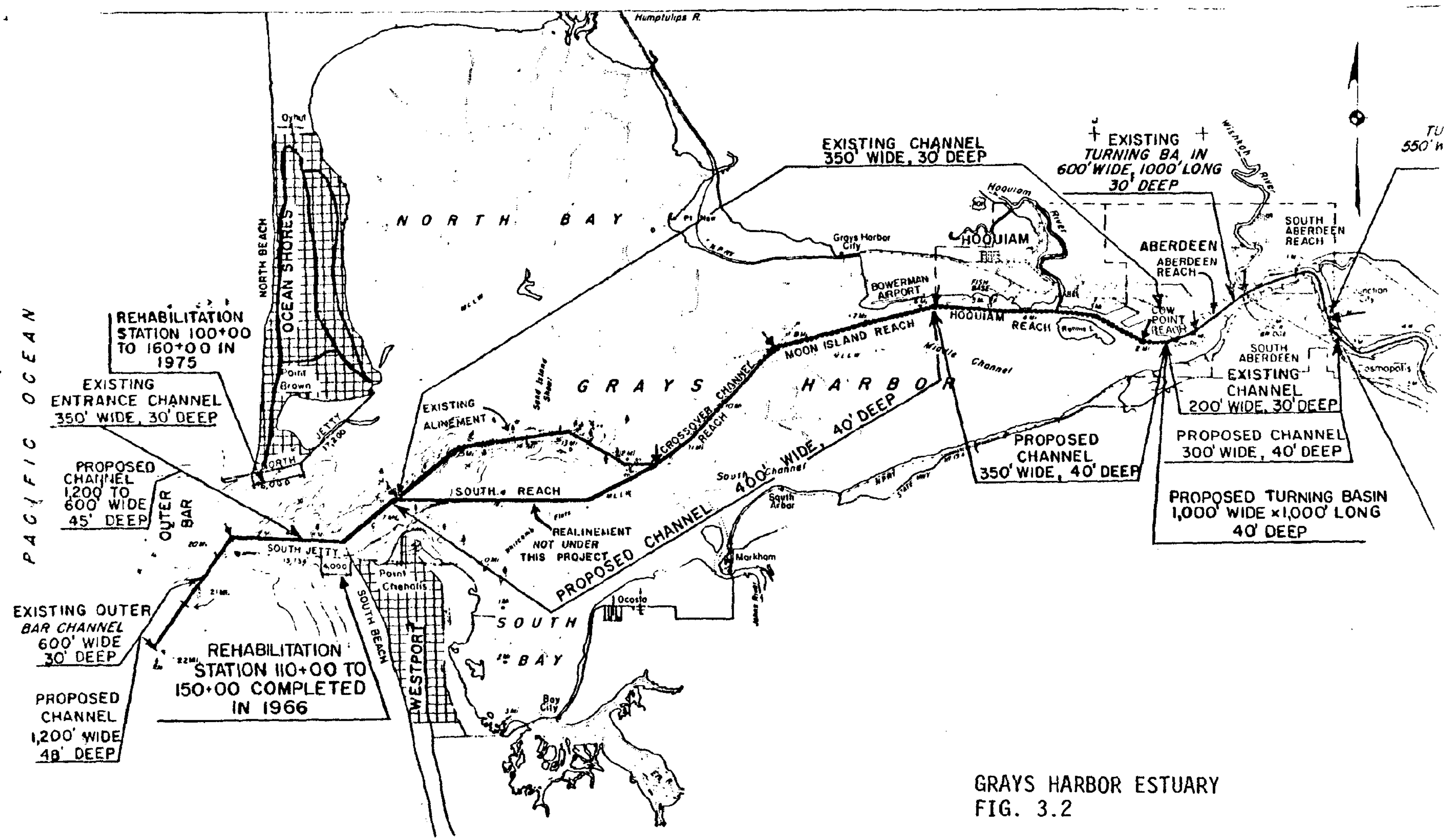
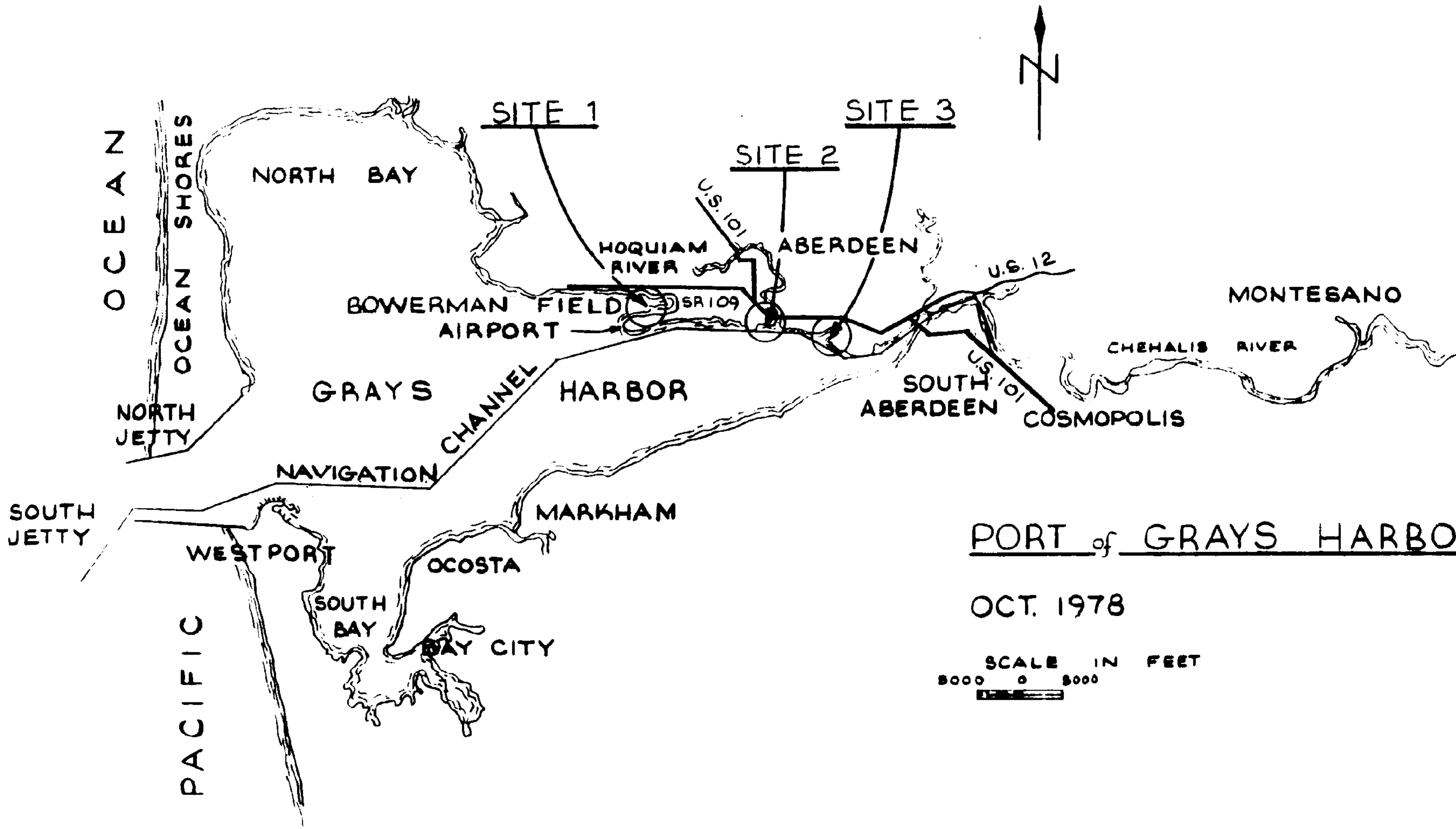
COLUMBIA RIVER
SCALE IN MILES
0 5 10 20 30 40
VICINITY MAP
GRAYS HARBOR WASHINGTON
2

FIG. 3.1



GRAYS HARBOR ESTUARY
FIG. 3.2



PORT of GRAYS HARBOR

OCT. 1978

SCALE IN FEET
5000 0 5000

FIGURE 3-3

3.4 PHYSICAL SUITABILITIES OF ALTERNATE SITES

3.4.1 Introduction and Comments

As described previously, all three alternative sites (Bowerman Field, IDD #1, and Terminal 1, Slip 1) possess the requisite geometric attributes (deep water, sufficient land area and shape, rail and highway access, etc.) However, the predominant subsurface soils are soft, compressible silts, typical of most developed industrial sites in the Grays Harbor area.

The principal question of technical suitability is thus one of soils engineering. Attached as Section 3.2.2 is a geotechnical study by Roger Lowe Associates, Inc., discussing this question. It will be noted that their report identifies several technical concerns, but that each concern has a feasible and reasonable economical solution. It is felt that the alternative sites are all suitable for the potential uses and facilities.

3.4.2 Geotechnical Report by Roger Lowe Associates, Inc.

(attached)

ROGER LOWE ASSOCIATES INC.
EARTH SCIENCES

September 14, 1978

ABAM Engineers, Inc.
1127 Port Tacoma Road
Tacoma, Washington 98421

Attention: Mr. Phil Birkland

Report
OCS Study
Port of Grays Harbor
RLAI Project No. 210-06

Gentlemen:

This letter presents the results of our feasibility study of the sites for facilities related to outer-continental shelf activities in the Grays Harbor area. The facilities and the sites studied are as follows:

A. Dry Dock at slip Number 1
B. Cargo Dock and/or barge load out at IDD #1 site
C. Operational area at Bowerman field
D. Marine railways at IDD #1 and Bowerman field sites

We have based our evaluation of the subsurface conditions on information obtained from our reports covering this area and from reports by others provided to us. The Kaiser site, in particular, was investigated by us in 1976 and 1978. The design specifications for the various facilities were obtained verbally at a meeting and in several conversations with Mr. Gary Henderson, of our office, and yourselves.

GEOLOGIC HISTORY OF GRAYS HARBOR

Geologic events have had a substantial effect on the present subsoil conditions in the Grays Harbor area. During the past 10,000 years continental glaciers covered the area north of the Puget Sound, halting the then existing northward drainage pattern and forcing drainage of the meltwater streams into the present Chehalis River System and eventually into Grays Harbor. The meltwater

MAIL: P.O. BOX 3885, BELLEVUE, WA. 98009 - TELEPHONE (206) 453-8383
LOCATION: BENAROYA BUSINESS PARK, BLDG. 4, SUITE 219 - 300 120th AVE. N.E., BELLEVUE, WA.

streams transported enormous quantities of sand and gravel which formed numerous terraces along the lower Chehalis River Valley and which currently underlie the Grays Harbor Area.

Recent alluvial deposits in the project area consist of silt and fine sand. These materials are deposited as a result of the combined action of the Chehalis River and its tributaries and marine tides and currents within Grays Harbor. Interbedding of the sediments reflects a relatively frequent transfer between a marine and non-marine depositional environment. Non-marine sand and silt contains no shells or other marine debris and generally contains very little organic matter when deposited directly by rivers. When these deposits accumulate in brackish water or are reworked by marine currents, the resulting deposit is generally finer grained and contains significant organic material and/or shells. During periods of extreme river flooding, not only is more material transported to the Grays Harbor area by the stream system, but softer marine or brackish water sediments are extensively scoured and redeposited in the bay.

DESCRIPTION OF SITES

SLIP NUMBER 1

Slip Number 1 forms part of an existing docking facility situated to the northeast of Rennie Island in Grays Harbor. Pier Number 1 lies east of the slip and contains several warehouses constructed of timber. The pier has a core consisting of fill, rock, crib bulkheads which contain the fill, and timber relieving platforms supported on timber piles. Approximately 800 feet to the southwest of the Slip No. 1 entrance is the dredged navigation channel which passes between Rennie Island and the docking facility. We understand that the outer berth at Slip 1 is maintained to a dredge depth approximately at Elevation -37 MLLW. The existing dimensions of Slip No. 1 are approximately 2000 feet in length by 500 feet in width.

Subsurface Conditions: Our assessment of the subsurface conditions is based on two sets of borings drilled in 1964 and 1974 by Dames & Moore within the vicinity of Slip 2 and Pier 2 located east of Slip 1. In general, three distinct soil units were encountered which should be similar to the soils at Slip 1. The upper layer is a very soft organic silt which has accumulated in the last 10 or so years. The gray organic silt is underlain by interbedded layers of loose to medium dense sand and silt, which extend to a depth of approximately 130 feet. Both the sand and the silt layers have fairly high percentages of organic matter present. Below the sands and silts is a unit of dense to very dense sands and gravels. The sands and gravels extended to the bottom of the borings at approximately Elevation -150.

IDD #1 SITE

The site is located on the northern shore of the Chehalis River, just west of the confluence of the Hoquiam and Chehalis Rivers. In 1976 dikes were constructed along the southern and eastern boundaries of the site and the enclosed area was hydraulically filled using material dredged from the river. The surface of the fill is relatively flat and slopes downward from approximately Elevation 17 at the western end to Elevation 13 at the eastern end of the site.

Subsurface Conditions: The dredged fill decreases in thickness from the western to the eastern end of the site and has an average thickness of about 7 feet. The dredged fill was deposited from discharge pipes situated near the southwestern site boundary. The fill is thus sandier in the western half and grades to a silt in the eastern half of the site.

Below the hydraulic fill is a soft to medium dense sequence of gray sands and silts. This material continues to approximately Elevation -75, at which point the material becomes significantly more dense.

Below approximately Elevations -135 to -140 the site is underlain by very dense sand and gravel.

BOWERMAN FIELD

The Bowerman Field area lies to the south of the Burlington Northern Railroad between Grays Harbor City and Hoquiam; north and adjacent to Bowerman

Airport. The western third of the field is normally tidal, while the eastern third is marshland, containing some recent industrial development. The central third of the site, separated from the marshes to the east by a recently completed two-lane highway oriented north-south, appears to have been used as a dumping ground for some years and has an extremely varied surface. Some of the features are sand fill, drift logs, salt grass, scrub and alders.

Subsurface Conditions: Subsurface conditions at Bowerman Field are extremely heterogeneous above mean sea level, due to the wide variety of materials dumped on the site. These materials range from dredged silts and sands to wood waste. Below sea level the subsurface soil strata consist of alluvium. We have, at this time, reviewed three geotechnical reports on this area from which we have based our summary of the subsurface conditions. The reports cover the road area along the northern boundary of the site (Department of Transportation 1978), the area occupied by a two-lane highway crossing the site (Converse, Davis, Dixon Associates, Inc. 1977) and the sewage treatment plant site to the northeast (Neil H. Twelker and Associates 1977). The entire site is underlain by a sequence of loose sands and silts. The borings, which penetrated to about 100 feet below ground level, encountered a variety of silty, sandy soils ranging from grayish brown silts with silt-stone modules to silty sands and gravels.

ENGINEERING PROPERTIES OF SUBSOILS

The subsurface conditions at the three sites considered, that is Slip No. 1, IDD #1 and Bowerman Field, have essentially the same soils present in the substrata. In summary, a gray organic silt layer overlies a wide variety of silty sandy outwash materials which extend to depths of up to approximately 130 feet. This sequence is underlain by a dense sand and gravel layer.

The gray organic silt is very soft, having low strength and high compressibility. Typical dry density and moisture content values for the organic silts are 45 pounds per cubic foot and 100% respectively.

The sands and silts below the organic silt vary in density between loose and dense, corresponding to dry densities of 50 to 80 pounds per cubic foot. This is reflected in the driving resistance during sampling which is indicated to be generally below 10 blows per foot to Elevation -50, and slightly above 10 blows per foot to Elevation -130. In the very dense sand and gravel below Elevation -130, the dry density is on the order of 130 pounds per cubic foot, and the driving resistance during sampling is greater than 100 blows per foot.

Based on this data, we anticipate poor engineering performance from the native soils and also the silty hydraulic fill. Any increase in stress level to the native soils, such as from fill or buildings, will result in significant ground settlements. However, depending on the thickness of the compressible layers and the delay permissible before using the sites, preloading or surcharging the sites to preinduce settlement is feasible.

Due to the high compressibility characteristics of the organic silt, it is generally recommended that this material be removed prior to placing fill over it. However, in some cases where special care is taken in preventing the weak material from spreading or flowing upward into the surfacing, it can be utilized for fill or left in place, providing that provisions are made for subsequent potential settlement.

FEASIBILITY OF LOCATING FACILITIES AT SITES

DRY DOCK AT SLIP NUMBER 1

We have considered two alternatives for transforming the existing slip into a dry dock. The first scheme, based on a standard dock design with heavy gates, is not feasible unless there is substantial strengthening of the soils in the vicinity of the gate structure. Driving piles to support the structure would be only marginally feasible due to the large depth to the bearing layer. The second scheme entails driving sheet piles across the entrance to the slip. The piles would then be pulled to provide access for removing completed structures from the dry dock. The sheet piles could be removed and reinstalled several times.

We understand that final grade of the dry dock would be at approximately Elevation -5 or -7 and that the current level of the bottom of the slip is at approximately Elevation -26. Thus, up to approximately 20 feet of fill would be required to bring the bottom of the dock up to grade. The fill would overlie the soft and highly compressible organic silt material and would undergo substantial settlement. Estimates for the quantities of fill involved would be significantly increased over those calculated from the actual elevations due to compression of the fill and would require further evaluation.

Placement of the fill on top of the soft organic silt is also a problem due to the low strength of the silt. However, techniques are available which avoid the occurrence of the characteristic problems such as heaving and mixing and the formation of mudwaves in the soft material. One such technique involves placing a thick sand blanket in thin layers over the bottom of the slip. The sand blanket acts as a filter and stabilizing layer.

Another design consideration is the utilization of the sheet pile wall as a cut-off and gate for the drydock. The near surface organic silt is unsuitable, both from strength and compressibility standpoints, for supporting the sheet pile wall. As a result, this material should be removed or displaced at the entrance to the slip. The exact depth of removal will require further evaluation. A clean sand backfill material should be used to replace the silt so that the sheet piles may be easily driven and pulled, while also providing the necessary foundation support.

Prior to filling inside the dry dock, an underwater dike should be built up at the entrance to the slip. This dike and the sides of the slip would contain the organic silt which would have a tendency to spread during the filling operations. The thick sand blanket should be laid in thin layers working away from the dike. We expect that all filling operations could be performed more satisfactorily using floating equipment, except possibly for the upper several feet of fill and surfacing in the dry dock floor.

Suitable free-draining fill should then be placed in thin layers above the sand blanket to the required elevation. A network of lateral drains should be planned within the fill leading to collection drains installed around the inside perimeter of the dock. These drains would feed the pumps used to keep the dry dock dewatered. Water levels should be kept as high as possible in the fill during operation of the dock without interferring with its operation, as lower levels would increase the stress levels in the foundation soils leading to unrecoverable settlements.

An alternative design option would be to place some or all of the fill in the dry. Disadvantages would be possible slope failures in the existing material around the perimeter at Slip 1 as the ground stresses are increased during dewatering, and construction of the gate structure to retain a higher water level differential than is necessary during operation of the dry dock. The possible slope failure problem should also be taken into consideration during normal operation of the dry dock. The overall stability of the underwater slopes should be evaluated for rapid drawdown conditions during dewatering of the dry dock. Slope flattening and/or a filter blanket may be needed to stabilize the slopes.

Preloading or surcharging the floor of the dry dock may be desirable if settlement during operations is unacceptable. This could be important if structures under construction are to rest uniformly on the bottom of the dock.

The effects of the filling operations within the slip will be to induce downdrag on the piles supporting Pier 1, leading to large settlements. There is also the possibility that lateral movement of the softer underlying materials will develop as the horizontal ground stresses increase. An investigation and evaluation should be made to determine the significance of these movements.

CARGO DOCK AT IDD #1 SITE

Typical cargo docks in Grays Harbor have a dock at Elevation 16 or 17 and an adjacent mudline dredged to Elevation -40 to -45. The resulting height is therefore on the order of 58 feet. Three dock designs are feasible for constructing a dock of these dimensions. The first one is a high bulkhead involving sheet pile cells or a standard bulkhead supported by tie-backs. Due to the height of the bulkhead, this design would require that several rows of tie-backs be installed below the water level if the structural components of the bulkhead are to remain at reasonable sizes. While not totally infeasible, this operation probably would not be economical. Also, because of the relatively weak foundation soils and the height of the structure a cellular wall would also be uneconomical.

The second design consists of a deck supported by piles above an underwater slope, referred to as a relieving platform. This design would transfer the dock loads to levels below the upper soft layers of the slope. For a reasonably narrow deck, a fairly steep slope or a combined short bulkhead and slope is required.

The present underwater slopes are fairly flat and significantly steeper slopes are not feasible unless the low strength soils are replaced or the strengths increased by consolidation. The flat slopes would mean a wide deck if the full width of deck was to be maintained from the shoreline to the dock. This leads to a third design which is a modification of the second, consisting of a deck supported by piles offshore from the existing shoreline. Access to the deck would be by trestles, also supported on piles. This design would allow the deck to be narrower while still maintaining the required draught beside the dock.

BARGE LOAD-OUT

The barge load-out facility consists of a dock next to an underwater loading pad. The bulkhead height is on the order of 20 to 25 feet. The load-out operation is accomplished by docking the barge and then flooding the tanks so that the barge rests on the pad during loading and unloading operations. At the IDD #1 site, the facility would be constructed near the existing containment dike.

The mudline currently slopes away from the dike at an inclination of approximately 4:1 (horizontal to vertical). As discussed earlier in this report, the subsurface soils are soft and the existing slope is probably close to its natural angle of repose. Excessive bending stresses on the barge substructure can be avoided by insuring that settlement of the loading pad is kept to within tolerable levels.

Given these criteria, we have considered two design alternatives. The first involves constructing a sheet pile bulkhead along the existing dike, excavating the seaward side of the dike and placing fill on the existing slope to develop the pad. The second involves excavating on the landward side of the dike and placing a sheet pile bulkhead at a distance of approximately one barge length behind the dike. While the first alternative involves less excavation than the second, some strengthening of the existing underwater slopes will be required if they are to support the additional fill comprising the loading pad. An underwater fill is feasible, but will require relatively flat side slopes. Also, due to the varying thickness of the fill and underlying soils, periodic maintenance to keep the loading pad level should be anticipated.

The second alternative involves a considerable cut behind the dike. However, the excavation would produce clean fill which would be suitable as backfill in other areas. The side slopes in the cut area would be stable and settlement of the loading pad would be minimal because of previous surcharging from the hydraulic fill. No engineering disadvantages, from the standpoint of soil conditions, appear to be associated with this option.

Construction of the sheet pile bulkhead is feasible.

SITE DEVELOPMENT OF BOWERMAN FIELD

Filling of the tidal marshes at Bowerman Field may be accomplished using either hydraulic or land-based fill. Placement of the fill should be carefully controlled to avoid local failures within the weaker subsurface materials. The filling may be facilitated by subdividing the fill area into smaller sections by dikes and filling each section separately.

Settlement of the fill surface, due to consolidation of the subsurface materials, will be significant and the filled area should not be built on for a year or so. Various techniques, such as surcharging or the installation of sand drains, are available to expediate the consolidation, should it be necessary. Also, if fine grained dredge fill is used for filling, it could require several years to consolidate and compact, depending on the thickness.

MARINE RAILWAYS

The marine railways should generally be supported on piles due to the highly compressible nature of the soils in the area. They can also be supported on several feet of granular fill or ballast, providing that problems related to settlement and slope stability are planned for in the design. However, care should be taken to avoid using piles in areas of recently placed fill because of downdrag loads on the piles.

SURFACE LOAD SUPPORT

The presence of relatively thick layers of soft compressible soils can result in considerable settlement due to permanent or long term surface loads. Support of structures on piles or surcharging can be utilized to control the amount of post construction settlement. The amount of surcharge required depends on the available time it can remain in place and the weight of future surface loads. We expect that surcharge periods as short as 2 to 3 months are feasible for most areas.

Many areas are presently capable of supporting significant surface loads; other areas can be upgraded by filling or compacting the upper soils to produce a strong crust for support of surface loads. The required thickness of the crust depends on the size and magnitude of the load and the strength of underlying soils. Bearing pressures ranging up to 3000 psf for shallow spread footings and support of large wheel loads such as from a log loader (50 ton wheel load or 100 ton axle load) are feasible.

We appreciate the opportunity of working with you on this project. Should you have any questions or need additional information, please call.

Yours very truly,
ROGER LOWE ASSOCIATES INC.

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SECTION 4

4.0 SCHEMATICS OF POSSIBLE SITE DEVELOPMENT

4.1 GENERAL DISCUSSION

Figure 1.2 shows the locations of the three alternative sites. Table 2.8 summarizes OCS construction requirements. This section shows how each of the three sites might be developed. In general, changes to existing shoreline are minimal. Piers are of the teehead, pile-supported type, without bulkheads. Except for the entrance to the possible drydock, maintenance dredging in the future is expected to be minimal. Fill is required only in Slip 1 and behind Bowerman Field.

The site developments shown in this section are intended to be consistent with the uses contemplated in the Grays Harbor Estuary Management Plan. Consequently, it is expected that specific site development permits, if not already in hand, could be obtained within a predictable schedule, and that an OCS constructor would therefore be able to plan and execute an economical, on-schedule operation.

4.2 SPECIFIC POSSIBLE DEVELOPMENT

4.2.1 Bowerman Field Area

The existing local airport, Bowerman Field, lies on the northern side of the main channel, to the west of the City of Hoquiam. The airport proper covers 142 acres. The airport is used extensively for commercial and private aviation.

The present location of the airport precludes use of the site for OCS construction, as the runway separates the deep-water channel from the large potential yard area which lies between the runway and US 12. A study is currently in progress to evaluate relocation of the airport. If a feasible alternative site can be found, the current airport site could be used for OCS activities.

Behind the airport, toward the land, lies a potential yard area of nearly 500 acres of grassy marshland, created by spoils from past maintenance dredging. This area is owned by the Port, and is designated for upland industrial development.

The eastern half of the marshland has only minor restrictions to filling. The remainder may be considered for filling after other available industrial acreage along the harbor is in use.

Figure 4.1 shows the potential use for the Bowerman Field area. Because relocation or realignment of the airport is under study, no attempt to indicate its future possible location has been made. This site is suitable for all probable OCS construction uses. It is also potentially suitable for graving dock construction, as the existing preconsolidated soils offer geotechnical advantages over Slip 1. This would make the site suitable for uses similar to the proposed Brown & Root OCS yard at Astoria.

4.2.2 Industrial Development District #1

Figure 4.2 is taken from the Environmental Impact Statement prepared by the U.S. Corps of Engineers before filling of the site. The site is currently filled, but is not surfaced. Permits in hand allow development of marine launchways and a barge load-out terminal. The site area of 45 acres precludes its use for the largest module projects. This site is currently under option to Kaiser Steel for use as a jacket construction site.

4.2.3 Port Industrial Area, Terminal 1, Slip 1 and Adjacent Area

Figure 4.3 shows this site. It consists of the existing Slip 1 (used intermittently by cargo ships), Terminal 1, Slip 2 (not used, to be filled by 1980-1981) and the land north of Slip 1 up to and including the warehouse shown there. Total site area is about 70 acres.

The existing Slip 1 is a natural location for a graving dock, or construction basin. The floor elevation for the construction basin is dependent upon the draft required at high tide for towout of the constructed jacket or gravity base. There are strong capital and operating cost pressures for making the floor elevation as high as possible. A reasonable range of elevation would be -7 to +2 feet MLLW. Width and length are also set by the size of the structure to be built in the basin. The lowest cost construction would be steel sheetpile walls and cutoff (closure) wall, with a quarry-spall surfaced floor. Permanent dewatering would be by a well-point system. This type of graving dock is shown in Figure 2.6.

Slip 2 is scheduled to be filled by 1980-1981. The cargo pier at Terminal 2 is scheduled for simultaneous construction. A barge load-out terminal (or marine way) is shown at Slip 2. Alternative site arrangement or utilization could put these types of facility downstream of Slip 1, or in line with the old Terminal 1 pier. In this event, the Slip 2 area could be considered either as part of the OCS construction site or as a part of the adjacent timber products export facility.

This site is suitable for all probable types of OCS construction. It is unique in that it offers a ready site for construction of a graving dock or construction basin.

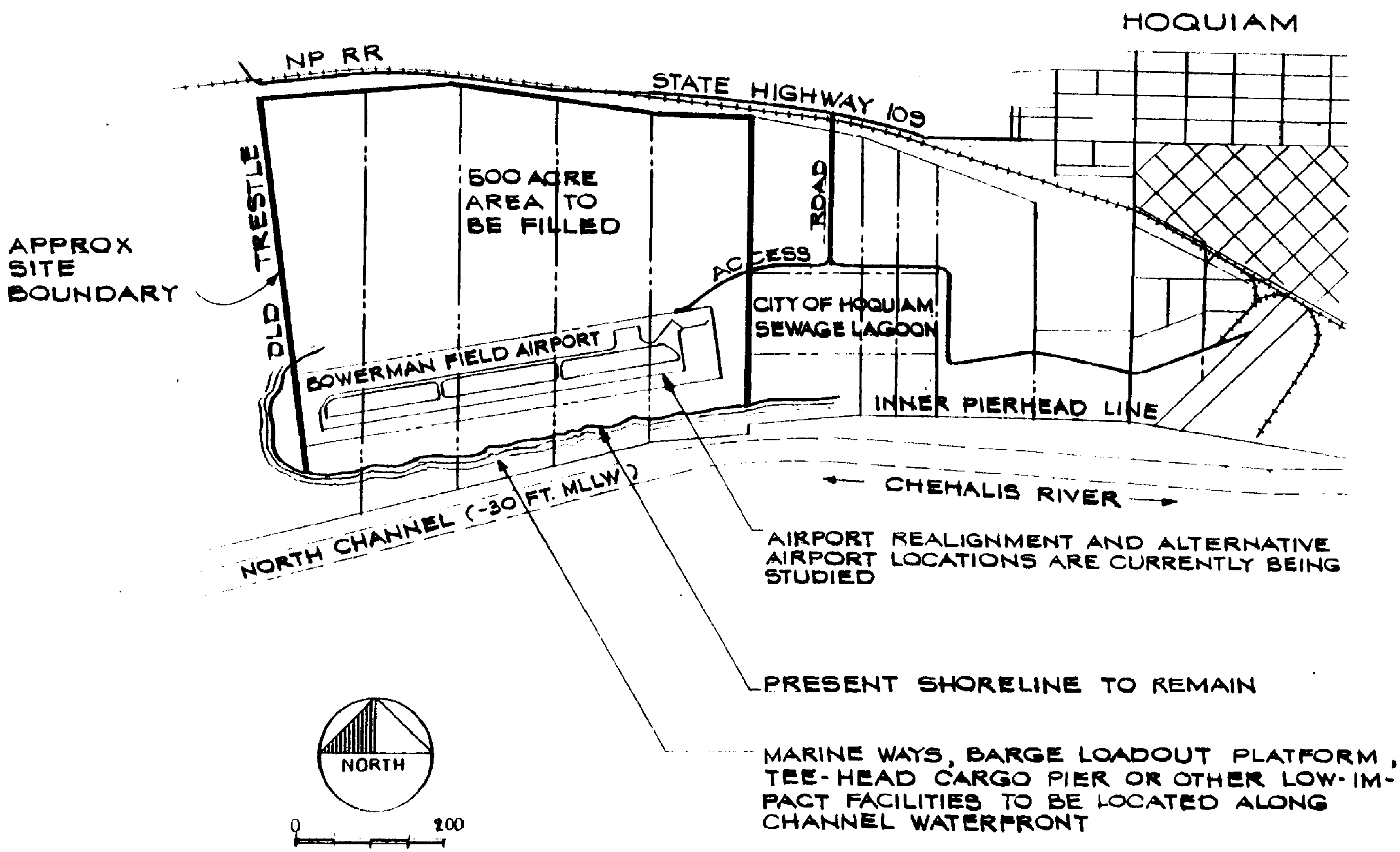

FIGURE 4.1 BOWERMAN FIELD AREA

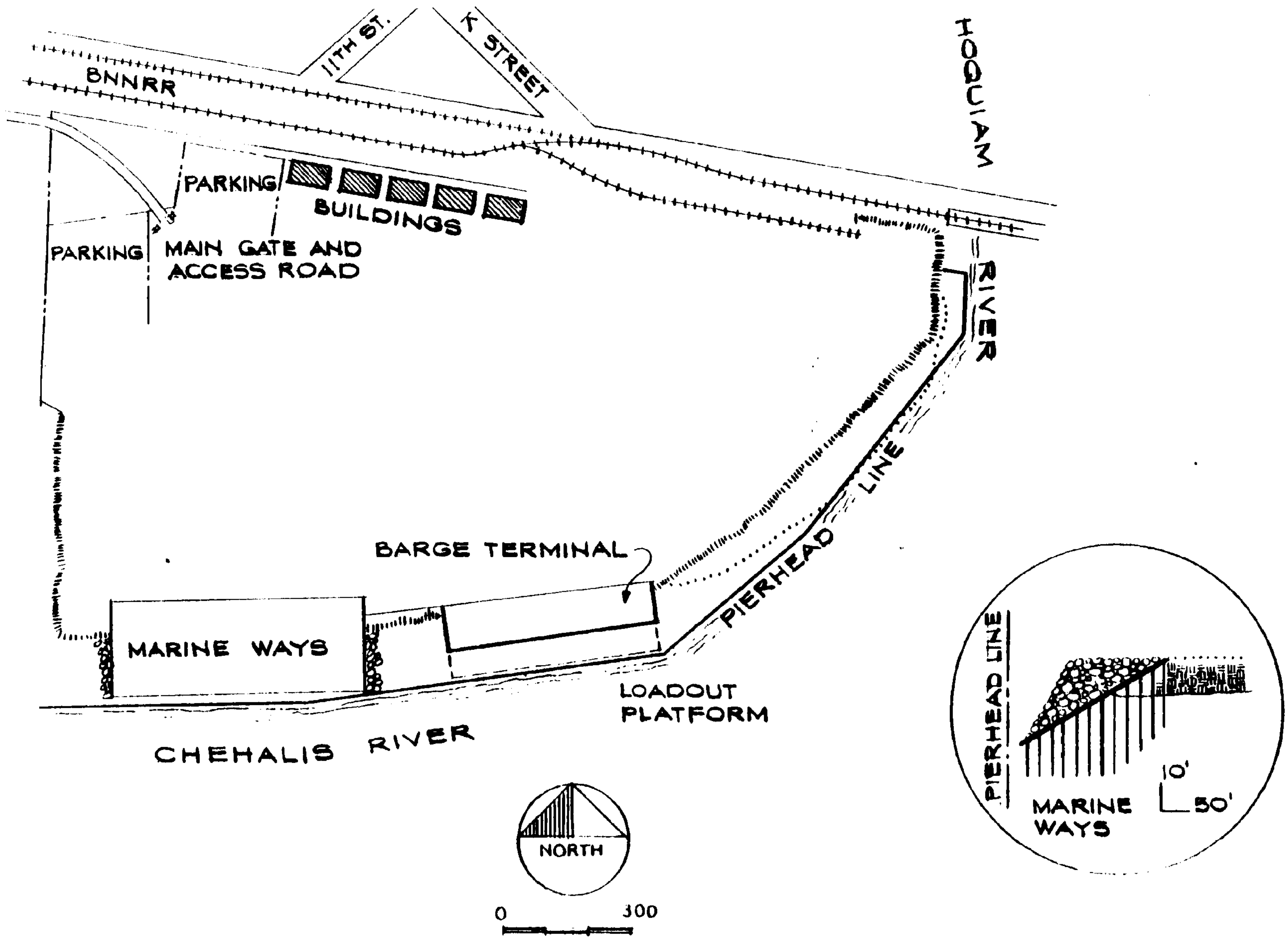

FIGURE 4.2 INDUSTRIAL DEVELOPMENT DISTRICT #1

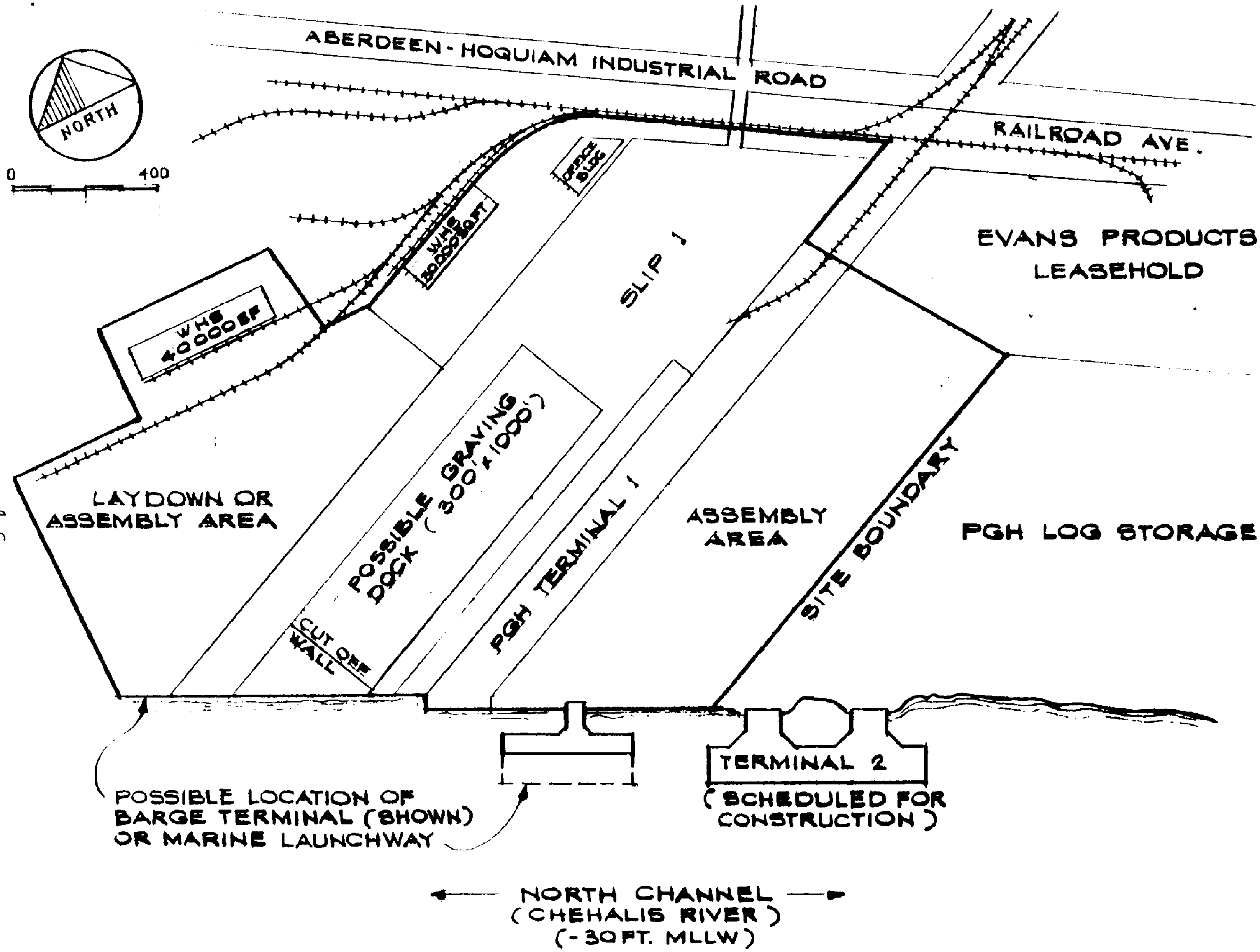

FIGURE 4.3 PORT INDUSTRIAL AREA, TERMINAL 1, SLIP 1 AND ADJACENT AREA

SECTION 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 Summary of Requirements for OCS Construction

Projects suitable for construction in the Grays Harbor area include module and jacket assembly. The relative likelihood of such projects being built in Grays Harbor is dependent upon market factors outside the control of Grays Harbor, the energy industry, or the constructors. There is potentially a large market for OCS construction sites. These factors include the uncertainties of offshore oil discovery and the legislative/regulatory difficulties related to LNG terminal siting, gas pipeline routing, and offshore oil production structures.

A "composite" OCS construction site comprises a level, well-drained site of 25-100 acres, adjacent to a deep-water channel to open ocean and to rail and highway transportation. Waterfront facilities would include a barge loadout terminal, and possibly a marine launchway or a graving dock. The usual industrial utilities are necessary.

The principal requirement with the greatest potential impact on Grays Harbor is people. Employment levels could range from 200 (small piping module, or jacket assembly) to 3,000 (largest module projects), most of whom would be skilled crafts. Existing large construction projects in the Grays Harbor area are expected to require up to 3,500 skilled craft employees. It is quite possible that phasing and manpower demands of the more probable OCS projects will be such that little or no additional labor supplies will be required.

5.1.2 Evaluation and Potential Development of Alternative Sites

The three sites studies with respect to their potential development for OCS support facilties are individually suited to specific project types and sizes. The important considerations are land area available, access to existing cargo piers, and potential for location of a graving dock. The three sites are most likely to be considered individually by several constructors or by a single constructor for distinct operations. The sites can be ranked in order of their probable availability:

1. Industrial Development District #1: Permits in hand for docks and marine ways; site preparation in final stages of construction.

2. Port Industrial Area, Terminal 1, Slip #1 and Adjacent Area: Level area including warehouse space, site for graving dock and dedicated industrial area.

3. Bowerman Field Area: Necessary relocation or realignment of airport; adjacent tidal lands approved for development only after other waterfront sites are committed to industrial use.

Adherence to the guidelines set forth in the Grays Harbor Estuary Management Plan should facilitate receipt of necessary permits on a predictable basis.

Each of the three sites is accessible by the deep-water channel and a surface capable of supporting the anticipated loads is obtainable. The land varies considerably and, if a graving dock is required, the Port Industrial Area would probably be preferred with the Bowerman Field Area also a possibility. The Bowerman Field Area would be available only if a suitable alternative airport site can be found and after the other sites are committed to industrial use.

5.1.3 Consequences to the Community

The three activities discussed in Section 4.2 would produce nearly identical changes of a socio-economic or environmental nature.

The greatest change would be socio-economic, resulting from relatively sudden increases in population. Increased employment would obviously raise industrial productivity and would help alleviate the regions' chronic unemployment problem and help stabilize the local economy.

There are obvious benefits associated with ongoing construction of nuclear powerplants at nearby Elma. The project has attracted large numbers of laborers skilled in the same trades required for OCS support activities. The socio-economic impact due to the influx of these people into the area has already been experienced and substantially dealt with.

Additional new residents would, however, place further demands on an already short housing supply and, depending on location and numbers, could strain particular schools' capabilities. However, schools in the Aberdeen-Hoquiam area have experienced declining enrollment during the past decade, with the result that additional capacity is currently available.

Environmental impacts directly attributable to OCS activity siting are largely short term, and are associated with initial construction activities. Long-term impacts, associated with operations on a particular site, are easily minimized by good housekeeping, use of readily available pollution control equipment and routine maintenance of such equipment.

Development of a graving dock at Site 3 does present some unique environmental impacts associated with the reduction of aquatic habitat. Undoubtedly, some fish, and perhaps mammals and birds, utilize the present slip for varying periods during their life cycles. Heavy industrial use of the area for over 50 years, however, has presumably placed severe limits on biological productivity in this area. Specific impacts associated with the loss of aquatic habitat in the slip are currently being evaluated by the Army Corps of Engineers in an Environmental Impact Statement on Maintenance Dredging in Grays Harbor. This EIS is scheduled to be published by 1979.

5.2 RECOMMENDATIONS

5.2.1 General

It is recommended that continuing contact be maintained with the oil industry to keep market, siting and facilities requirement data current. In this way, Grays Harbor can continue to plan coherently for its own destiny, as it is now doing with the Grays Harbor Estuary Management Plan. The following "Items of Planning Consequence", comprise the Consultants' specific recommendations to the Planning Commission.

5.2.2 Items of Planning Consequence

a. Continue to press for early completion of the Grays Harbor Estuary Management Plan, and provide a continuing high level of staff support to aid in its implementation.

b. Develop strategies for encouraging an increased level of new housing starts.

c. Continue to monitor activities at the Satsop Nuclear Power Plant construction project in order to be able to capitalize on surplus labor force.

d. Complete the development of a City of Ocean Shores Comprehensive Plan.

e. On an annual basis, survey major firms engaged in OCS energy development and production, in order to maintain a current assessment of the probability of such large, high technology construction projects on Grays Harbor.