Visual Simulation of Offshore Liquefied Natural Gas (LNG) Terminals in a Decision-Making Context[1]

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Abstract: Due to legislation passed in 1977, the Coastal Commission tock part in a study analyzing potential offshore Liquified Natural Gas (LNG) sites and the types of terminals that might occupy those sites. The study had to evaluate the engineering feasibility of siting an LNG receiving terminal offshore in relation to the maximum protection of coastal resource provisions required by the California Coastal Act. The Coastal Act embodies a broad range of policies for the protection of coastal resources, which includes providing for the protection of scenic and visual resources within the coastal zone. This paper analyzes the use of a visual simulation technique for the siting of offshore LNG terminals and describes how the technique was used to implement the scenic and visual protection policies of the California Coastal Act.

INTRODUCTION

California is facing one of the most difficult energy facility siting controversies in the history of the state. The Liquified Natural Gas Terminal Act of 1977[3/] called for various state agencies to participate in the process of siting a liquified natural gas receiving terminal along the coast of California. The California Coastal Commission was asked to do two studies dealing with this siting issue. These included an onshore study to deal strictly with the siting of a conventional LNG terminal at a land based site or sites and an offshore study to determine the most appropriate site(s) and type(s) of LNG terminal combinations that could feasibly be located off the California coast. The onshore study dealt with technical configurations that were relatively easy to visualize (Hibbert 1977) because of the use of conventional looking trestle designs, industrial complexes and storage facilities. The offshore study did not have this luxury due to the many innovative facility designs and possible locations off the California coast. Some of the various offshore terminal concepts studied included island based terminals, deep bottom supported, shallow bottom supported, floating, semi-submersible, and several hybrid land/-sea based concepts.[4/] It became clear that it would be helpful to be able to visu-

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[1/] Submitted to the National Conference on Applied Techniques for Analysis and Management of the Visual Resource, Incline Village, Nevada, April 23-25, 1979.

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[3/] Liquified Natural Gas Act Stats, 1977, Chap. 855, Page 2506 (effective Sept. 17, 1977).

[4/] All line drawing figures are done by John Van Coops, California Coastal Commission Cartographer.

alize what these facilities would look like at the potential sites being studied. The Department of Landscape Architecture work in the field of visual portrayal studies (Sheppard and Smardon 1978) provided a method that the Coastal Commission could use to demonstrate the visual impact of these facilities at potential siting areas. With the aid of water color paints and special air brushing techniques, the artist added various facility types directly onto photographs of the sites at the proper scale. The visual simulations have been useful to the Coastal Commission during policy decision making, report preparation, and for use at various workshops and public presentations. The process provides an effective vehicle for decision makers, as well as members of the public to evaluate the aesthetic impact of future planned development.

DESCRIPTION OF THE PRGJECT

In 1977 Western LNG Associates submitted the current application to import Liquefied Natural Gas (LNG) from Indonesia and Alaska to a receiving terminal along the California coast. Because of the many unknowns regarding the safe transportation and handling of LNG the state legislature passed Senate Bill 1081, the LNG Act of 1977.[5/] The bill established a siting procedure that called for the coordinated effort of three state agencies in determining where the LNG receiving terminal should be located. The Energy Commission was assigned the role of gas demand forecasting, the Coastal Commission the role of site ranking, and the Public Utilities Commission was designated as the ultimate permitting agency. The Coastal Commission was asked to do siting studies evaluating potential onshore and offshore sites along the California coast and to rank the sites under the policies and objectives of the California Coastal Act.[6/]

The objective of the onshore study was to locate and rank sites for land based terminals using existing technology. Figure 1 gives a layout of a typical onshore LNG receiving terminal which includes a trestle for ship berthing and LNG transfer, LNG storage tanks, LNG vaporizers (conversion back to natural gas), and the natural gas

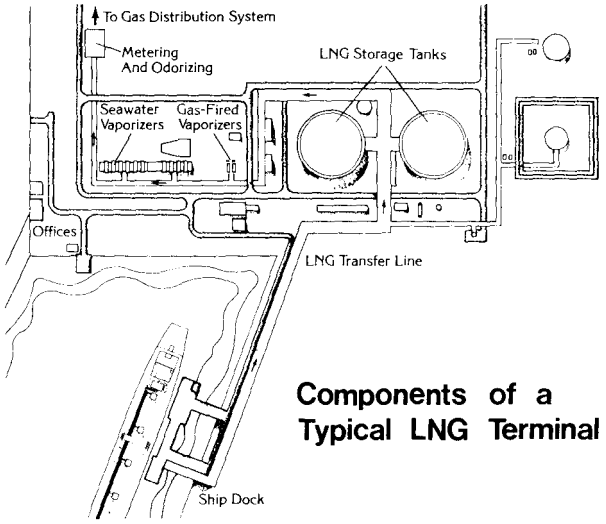

Figure 1--Components of a Typical LNG Terminal

pipeline distribution system. The objective of the offshore study on the other hand was to rank offshore sites and determine what type of terminal should be located at those sites. The various offshore terminal types, whether floating, deep bottom supported, shallow bottom supported, or a hybrid configuration, had to be able to accommodate all the component systems mentioned above for land based terminals (Hibberd 1977). For the offshore study the commission had the role of site selection, terminal feasibility, and protection of coastal resources under the Coastal Act. Senate Bill 1081 specifically states:

> Not later than 12 months after the effective date of this chapter, the coastal commission shall complete a final study of potential offshore sites and types of terminals for such sites. Such study shall indicate the most appropriate offshore terminal site or sites, in the coastal commission's judgement, together with the most appropriate type or types of terminals for each site.

The results of such study shall be transmitted to the commission, the energy commission, to the Governor, and to each house of the legislature."[7/]

The legislature asked the Coastal Commis-

[5/] Liquified Natural Gas Act Stats, 1977, Chap. 855, Page 2506 (effective Sept. 17, 1977).

[6/] California Resources Code, Div. 20, Art. 6 (1976).

[7/] Liquified Natural Gas Act Stats, 1977, Chap. 855, Page 2506 (effective Sept. 19, 1977).

sion to conduct this study under the policies and objectives of the California Coastal Act so that the resources along the California coast could be protected to the maximum extent, while at the same time determining offshore LNG site/terminal combinations that would be feasible, safe, and would provide for the reliable importation of LNG. Scenic and visible resources are protected by the Coastal Act and therefore were taken into consideration in the site and facility selection for this study. Section 30251 of the California Coastal Act states in part:

> The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designated to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas.[8/]

Implementation of the visual and scenic policies contained in the act posed a problem because of the high degree of subjectivity involved in assessment of this type of resource. Application of traditional planning techniques for scenic resource protection in a study of conceptual offshore LNG terminals proved to be a difficult task. What the California Coastal Commission staff needed to know from this study was what these facilities would look like at the sites being studied. The visual simulation technique provided an excellent tool for determining how these facilities might impact visual resources along the coast.

STUDY APPROACH

The Commission contracted with three designer-builder engineering firms to develop conceptual designs for one floating and two sea bottom-supported offshore LNG terminals at specific sites off California's coast. These designs permitted credible conceptual engineering and environmental evaluations of specific terminal types on potential offshore sites. At the same time, staff and consultants screened the entire California offshore area for zones where it might be feasible to site a terminal because of favorable winds, waves, water depths, and other factors. Seven zones off Southern California survived this initial screening; however, four were eventually recommended as acceptable (fig. 2). The zones have been evaluated with respect to terminal engineering problems, operational reliability in delivering gas to California, public safety, and adverse impacts on marine and coastal resources. Additional screening factors included conflicts with existing recreational, military and other uses of offshore areas, as well as terminal system cost, problems obtaining approvals, and starting terminal operation.

The evaluation of visual and scenic resources was broken up into three study elements which included 1) the number of people exposed to a particular scene, 2) the percentage of time the activity was visible due to atmospheric conditions, and 3) the compatibility of the activity with the surrounding viewshed. For estimating the number of people viewing the activity several methods were used. Cal Trans provided the staff with highway use figures for the coastal routes where some of the sites would be visible. In addition, the density of residential development in coastal areas was taken into account in determining the num-

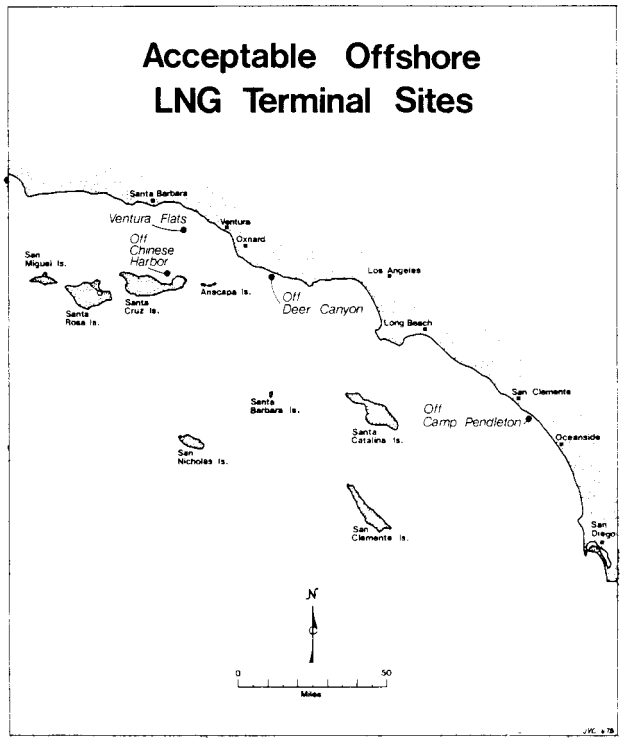

Figure 2--Acceptable Offshore LNG Terminal Sites

[8/] California Resources Code, Div. 20, Art. 6, S. 30251 (1976).

bers of people viewing a particular site. For the more remote sites such as the Channel Island related sites, figures were much more difficult to determine. The National Park Service provided some use figures for the Anacapa Island national monument, but very little information was available on visitation to Santa Cruz Island or Santa Rosa Island. In this instance we assumed that the number of people viewing the potential island related sites would be drastically less than the number viewing the sites visible from the mainland coast.

The second evaluation category dealt with the degree of visibility of the potential site zones from the areas where they might be viewed. Data on visibility were provided by J. J. McMullen Associates, Inc. (1978) who were maritime consultants to the Commission on the study. They provided the staff with figures on the percentage of time that the sites off the mainland coast would not be visible due to offshore atmospheric conditions such as fog and coastal haze.

Lastly, the overall visual compatibility of a facility with the surrounding area was an important factor in our analysis. For example, the Ventura Flats site (fig. 3) is located in an area that has 10 oil development platforms inshore of it, whereas the island related sites (fig. 4) are in an area with no existing industrial development. The data compiled in these three study elements provided the basis for the decisions

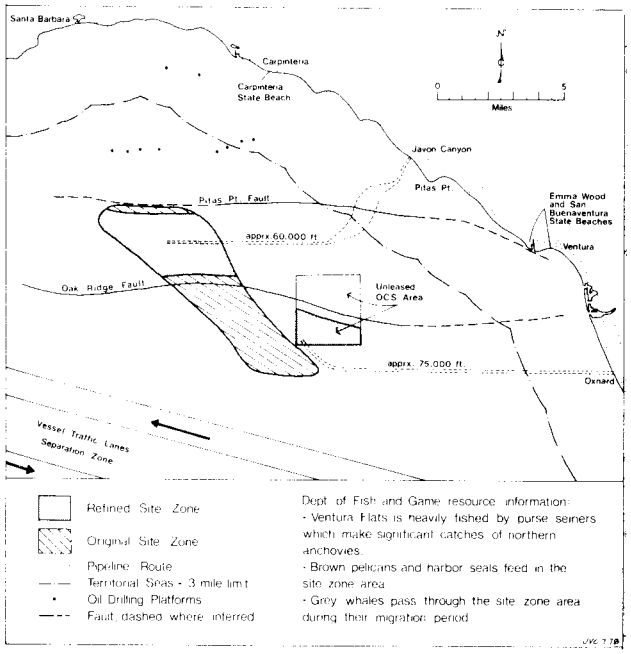

Figure 3--Ventura Flats

made regarding visual resource values of the sites.

Even though the California Coastal Commission was collecting information mentioned above, some staff members felt that more was needed to evaluate fully the visual impact of the facilities at the site zones being studied. The design drawings of the facilities provided the information needed for the technical studies, but it was still difficult to imagine the visual impact of a terminal located at the proposed sites. A staff member contacted the Forest Service Pacific Southwest Forest and Range Experiment Station regarding the work that they were doing in coordination with the Department of Landscape Architecture at the University of California, Berkeley in the field of visual portrayal studies. We discussed the possibility of actually drawing the facility directly on the photographs at the proper scale, so that the visual impact of the facilities could be fully understood. The authors all agreed that this would be a useful and unique study in which to apply this concept.

In order to represent the facility at the proper scale at the proposed sites, the artist had to be provided with specific information regarding the location and angle from which the photographs were taken, location and dimensions of objects within the photographs, and dimensions of the facilities being represented on the photographs. Some of the photographs used for the renderings were not taken for this study and it was often difficult to determine exactly where the photographer was when the pictures were taken. Because of this, some of the locations had to be extrapolated from landforms located within the field of vision covered by the photograph. Original photographs should have been taken for all the renderings, but unfortunately the visibility in the Santa Barbara Channel was quite poor during this portion of the study, so photographs of that area could not be taken. Original photographs were used, however, for the Camp Pendleton offshore site rendering. The photographer took 36 pictures for the Camp Pendleton site, numbered them, and plotted their locations on a map of the area. This careful logging was extremely helpful for facility location purposes and scaling. In addition, certain objects in the photographs such as oil platforms, oil platform workboats, and offshore islands were used for scaling by the artist. The artist was provided with navigation maps showing the exact location of the sites being studied so he could represent the loca-

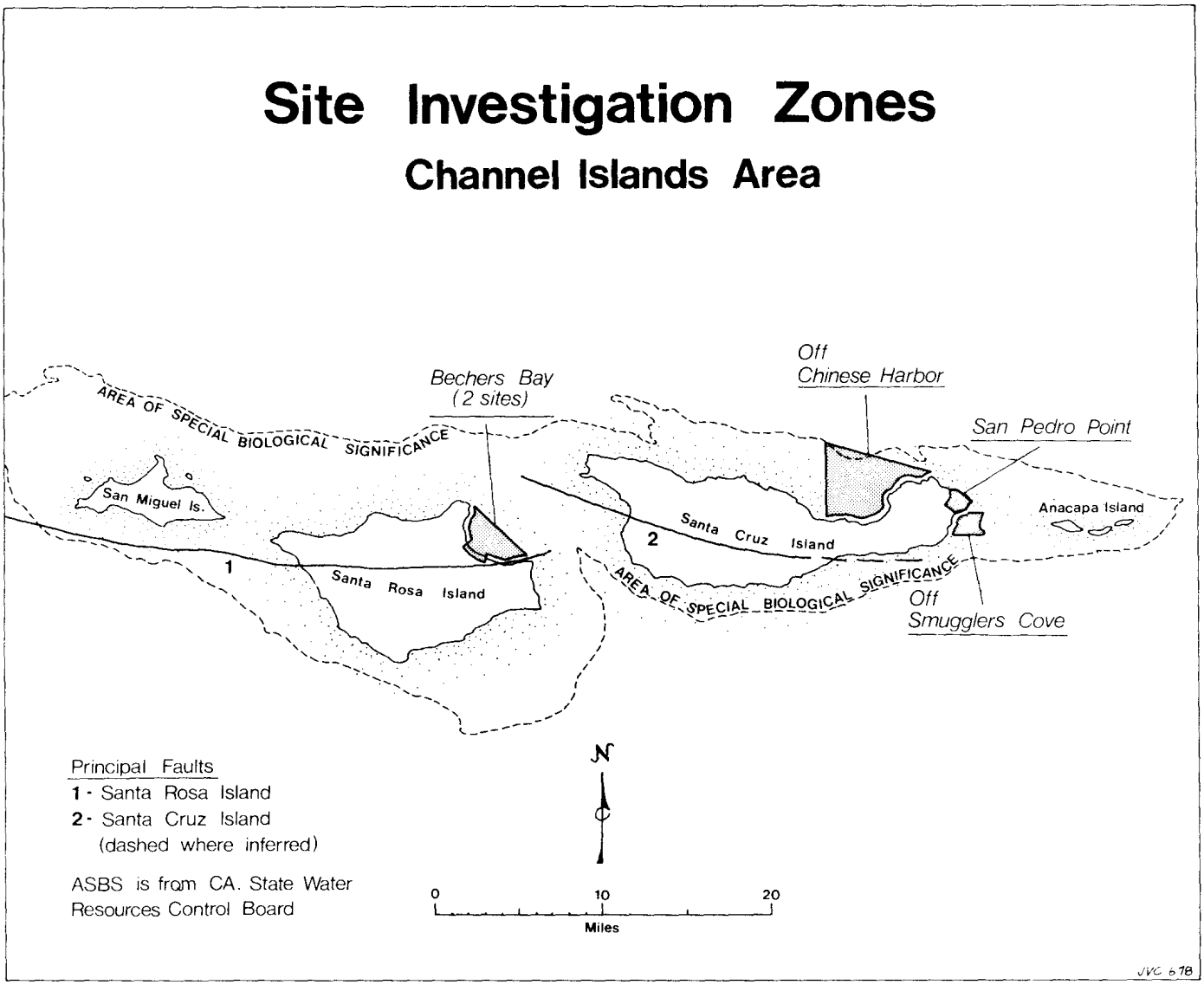

Figure 4--Site Investigation Zone.: Channel Islands Area

tion of the facility as accurately as possible on the photograph. Only after the artist was given all the above information and materials could he portray a terminal in a manner that would accurately represent the size and position it would assume at the potential sites being considered.

Application and Use of the Visual Portrayals

Proposed activities were rendered onto photographs of existing unaltered sites. Data on proposed dimensions, materials, colors, etc. were obtained from plans, elevations, and photographs of models. The form and outline of the proposed activity were drawn on a mylar overlay of a 7" x 10" print by conventional perspective drawing techniques (Martin 1968). These require that the observation point used in the photograph, and the site of the proposed activity be located on a topographic map or plan of the area. The eye-level or horizon line of the photograph must also be known or deduced from objects in the photograph. Detailed field notes on these and other elements, obtained at the time the photograph was taken, would obviate the need for corroborative field trips or guesswork where recognizable or measurable objects are absent from the field of view. For this reason, views containing features which can be readily located on the map or are of known dimensions are most helpful in checking that the scale and position of the activity in

the scene are correct.

The completed outline of the activity was transferred from the overlay to the print by tracing or through the use of paper frisket as a stencil. Retouch colors and opaque water-colors were then applied to simulate the colors and textures of the proposed activity. At this stage, decisions need to be made on such things as light conditions and shadow patterns. Any associated visual effects, such as water disturbance, smoke plumes, aerial perspective, or other man-made developments, must also be predicted, even though the design data are invariably too general to provide such information. Once completed, the altered print and its unaltered counterpart were rephotographed.

The technical feasibility studies performed by each terminal design contractor for the Coastal Commission were tailored to an illustrative site, to demonstrate in a site specific instance that that terminal feasibility could be achieved. Information obtained regarding strengths and weaknesses of the designs was then applied to the other site areas being analyzed by Commission staff and consultants. The floating LNG terminal feasibility study was done for the Smugglers Cove site off Santa Cruz Island (fig. 4, 5), the deep bottom supported facility at Ventura Flats off Ventura County (fig. 3, 6) and the shallow bottom supported facility at the site offshore Camp Pendleton (fig. 7, 8). To parallel the studies being done by the design contractors, renderings of the facilities were done for each of the illustrative sites (figure 9*). Unfortunately, time problems encountered by both the Coastal Commission staff and the Department of Landscape Architecture study staff precluded doing a rendering for the shallow bottom supported facility. However, this facility did not turn out to be one of the favored facility designs anyway, so a rendering was not essential. The floating facility was the preferred design of the three, so the staff felt that renderings of this terminal should be done for as many of the sites as possible.

Slides were made of the rendered and original prints, showing the sites with and without the facilities for comparison purposes. These slides served three main functions for the Commission during and after the study. They aided the staff in policy decisionmaking; they were used in presenta-

*See color illustration on page 398.

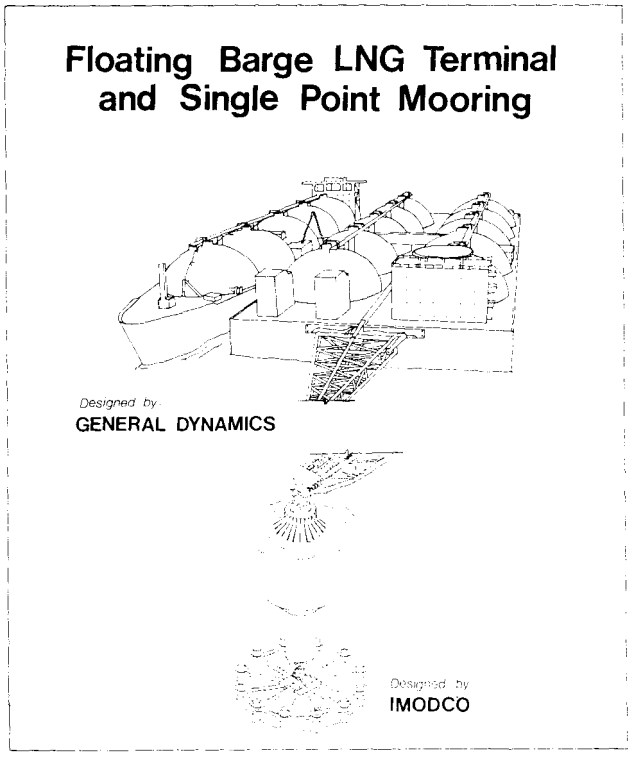

Figure 5--Floating Barge LNG Terminal and Single Point Mooring

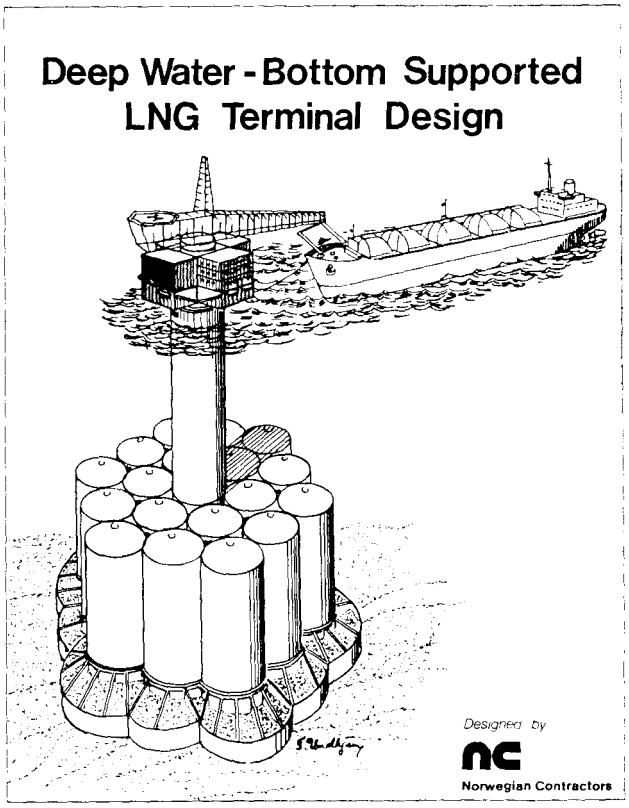

Figure 6--Deep Water-Bottom Supported LNG Terminal Design

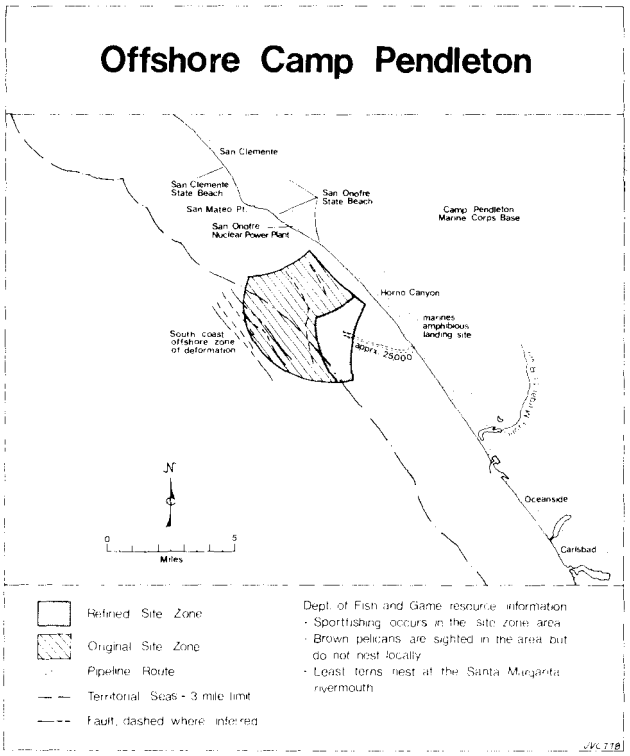

Figure 7--Offshore Camp Pendleton

tions to the Coastal Commissioners to explain the differences in site/facility relationships and they were used to inform the public at workshops held in the affected counties. Showing the renderings of the facilities at the sites being studied greatly enhanced familiarity with contemplated LNG activity for those attending the presentations mentioned above, as well as demonstrating the magnitude of the terminals and their overall compatibility with their surroundings.

This method of demonstration was extremely useful in attempting to carry out the visual and scenic policies of the California Coastal Act. Speaking from a regulatory standpoint, protection of visual and scenic resources is difficult because of the subjectivity involved. Unfortunately, protection of these resources often receives little weight in regulatory actions, environmental assessments, or facility siting studies. The renderings helped Commission staff to compare the sites located off the mainland coast with the island related sites, and to emphasize what was already known about the visual impact of locating a terminal at the proposed sites. Commission staff knew the visual disruption of a facility near the islands would be the most severe, however, the staff also knew that very few people would be exposed to this view. On the other hand Commission staff were amazed at the relative visual compatibility the facilities had with the surrounding viewshed at the Ventura site (See figure 9*). This was due primarily to the existing oil development platforms in the vicinity of the site. The Ventura Flats rendering provided an important input in the recommendation of that site as the most appropriate offshore LNG terminal location. It provided a visual demonstration of Coastal Act policies calling for consolidation of development. Section 30250 of the California Coastal Act states in part:

> New development, except as otherwise provided in this division, shall be located within, contiguous with, or in close proximity to, existing developed areas able to accommodate it ...[9/]

Additional support can be found in the following sections of the Act. Section 30260 states in part:

> Coastal Dependent industrial facilities shall be encouraged to locate or expand within existing sites and shall be permitted reasonable long term growth where consistent with this provision ...[10/]

Section 30262 (b) gives additional support in the context of oil and gas development. It states:

> Oil and gas development shall be permitted in accordance with Section 30260, if the following conditions are met:
>
> (b) New or expanded facilities related to such development are consolidated, to the maximum extent feasible and legally permissible, unless consolidation will have adverse environmental consequences and will not significantly reduce the number of producing wells, support facilities, or sites required to produce the reservoir economically and with minimal environmental impacts.[11/]

OBSERVATIONS

The primary reaction of most people viewing the renderings was surprise at the

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[9/] Ibid., S. 30250 (1976).

[10/] Ibid., S. 30260 (1976).

[11/] Ibid., S. 30262 (1976).

*See color illustration on page 398.

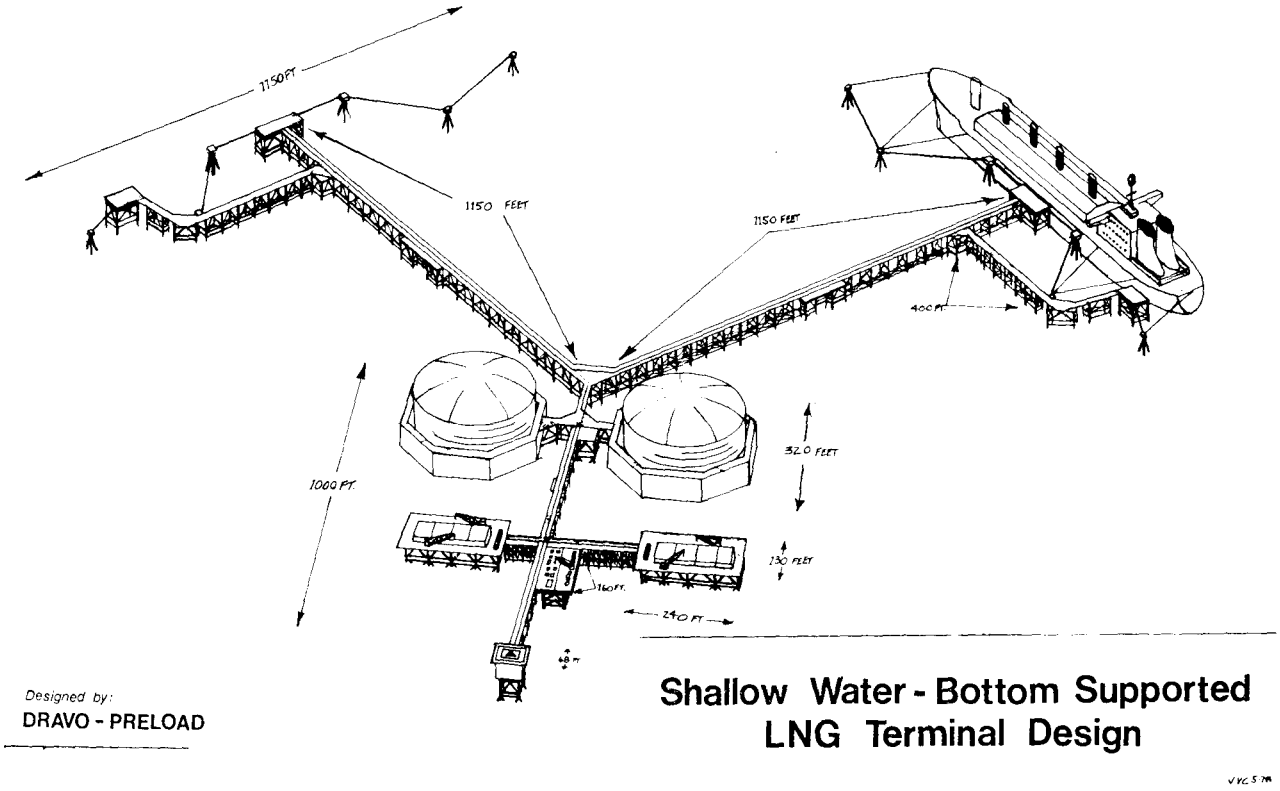

Figure 8--Shallow Water-Bottom Supported LNG Terminal Design

magnitude of the terminals. This was especially true at the Smugglers Cove site where the floating facility was represented in a more confined setting within a protected island cove. However, in a relative sense the terminals represented at Ventura Flats generated less of a reaction in terms of the size and intrusion of the facilities on the scene. Oil development platforms are located between the facility and the viewer at this site. Because of this, the facility seems more compatible with the surrounding viewshed. The relative compatibility of the Ventura Flats site/facility combinations as demonstrated by the rendering, provided one of the factors in choosing this as the preferred site. Not only was it compatible from a planning standpoint of consolidation of industrial development, but it definitely appeared to be less visually disrupting than the other site/facility combinations studied.

CONCLUSIONS

This technique provided the Coastal Commission with an excellent aid to combine evaluation of visual and scenic resources with the coastal protection policies of the California Coastal Act. The Act contains strong policies protecting visual resources, but these policies are useless if the resource cannot be assessed in some manner (Smardon and Hoke-Nunez 1976). The renderings helped Commission staff to refine further concepts about the visual acceptability of the facilities at the sites under consideration. In addition they provided an excellent device for demonstration of proposed staff findings which recommended a floating facility at the Ventura Flats as the most appropriate site/facility combination. The use of the visual portrayal technique should provide a valuable tool to energy facility siting studies being conducted in the future.

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