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Established by THE CALIFORNIA COASTAL ZONE CONSERVATION COMMISSION
to study the effects on the marine environment of the San Onofre Nuclear Generating Station

INTERIM REPORT OF THE MARINE REVIEW COMMITTEE TO THE CALIFORNIA COASTAL COMMISSION

PART I: GENERAL SUMMARY OF THE FINDINGS, PREDICTIONS AND RECOMMENDATIONS CONCERNING THE COOLING SYSTEM OF THE SAN ONOFRE NUCLEAR GENERATING STATION

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March 12, 1979

MRC Document 79-02(I)

INTERIM REPORT OF THE MARINE REVIEW COMMITTEE TO THE CALIFORNIA COASTAL COMMISSION

PART I

INTRODUCTION

This Interim Report is organized into two parts. The first part presents our overall Findings, Predictions and Recommendations plus answers to the questions posed by the Staff of the Coastal Commission in their November 8, 1978 memorandum (Page 4). The second part is the Appendix supplying the detailed evidence upon which the Findings and Predictions are based.

Following this Introduction, we present the findings and predictions in some detail. The predictions are organized into two categories: those in which the MRC has a high degree of confidence and those which the MRC feels should be brought to the attention of the Coastal Commission, even though our information is not yet sufficient to make a firm judgment. Continuing studies are being done to increase the level of reliability of these predictions. Finally, we present the Recommendations, which are based on the findings and predictions. (Throughout we have used the term "Plant" as shorthand to refer to the intake/outfall structures in the ocean, shown schematically in Figure 1 and the Maps.)

I. OVERALL FINDINGS, PREDICTIONS AND RECOMMENDATIONS

FINDINGS ON THE EFFECTS OF UNIT 1

1. Observable effects of Unit 1

Unit 1 causes marked changes in the ecological communities close to the Plant (Map 2). These effects are as follows:

Over an area of about 50 acres extending 200 yards from the Plant, the bottom sediments are altered and this reduces both the number of species and the density of those animals living on or in the sediments. Some of the actual species present also differ from those in areas further away at the same depth. Mysid shrimps are also reduced in density in this zone.

The usual distribution of plankton in the upper, middle and bottom waters is disrupted. This effect can be detected out to 500 yards from the Plant. The concentration of some plankton species in the surface waters is increased by up to 20-fold while the density of a few species in the surface layer is reduced by 100-fold. However, the total abundance in the area is generally not changed.

The queenfish is an abundant fodder-fish which is eaten by a number of sport and commercial fish species. About 75% of the fish entrained by Unit 1 belong to this species. Although there is no detectable difference in the density of this fish species near the Plant and elsewhere, there is a much lower proportion of immature fish within 500 yards of the Plant compared with other areas at the same depth.

The kelp bed has expanded into the zone within 1,900 feet from the proposed diffuser line. Field transplant experiments have shown that young kelp plants survive and grow much more poorly within 60 yards of the discharge of Unit 1 than they do elsewhere at the same depth. This is correlated with the turbidity in the discharge plume, which reduces the light reaching the bottom. Reduction in the growth of mussels and the survival of shrimp placed in the discharge plume has also been observed. Near the Plant, settlement and survival of young stages are greater in some species (barnacles, molluscs) and

lower in other species (shrimps) than they are farther from the Plant. The cause of these effects is not yet known.

There is some evidence that mysid shrimps are more abundant about 200 yards from the Plant than at stations closer to or further from the Plant.

2. Mortality caused by intake entrainment of Unit 1

In an average day of operations, Unit 1 kills billions of planktonic animals, millions of mysid shrimps and about one thousand small fish. Nevertheless, there is no detectable reduction in plankton or fish density around the Plant.

PREDICTIONS OF THE EFFECTS OF UNITS 2 AND 3

1. The following are predictions in which the MRC has a high degree of confidence

(a) The area of soft benthos in the immediate vicinity of all intakes and diffusers in which the sediments are altered will be increased about five times, to about 260 acres. As before, the changes will result in different sets of species which will have lower diversity and abundance (Map 2).

(b) Under certain circumstances (when sediment is stirred up into the water above the bottom), the discharge plumes of all three Units will be more turbid than the surrounding waters. Beneath these plumes, rates of sedimentation will be greater and the amount of light passing downward will be less than elsewhere at the same depths. Since under natural conditions turbidity and sedimentation are less offshore than inshore, the added turbidity from the diffusers will produce a greater environmental change offshore than inshore.

(c) Since the measures designed to mitigate fish kills by Units 2 and 3 (new velocity cap and fish return system) will not be completely effective, more fish will be killed by the operation of all

three Units than are killed by Unit 1 alone.

(d) The diffuser plumes of Units 2 and 3 will force masses of inshore water offshore. About half of the time, for periods lasting up to several days, the currents are slow (less than 0.1 knot, 5 cm/sec), and virtually the entire inshore water mass passing the Plant, out to 1.5 miles, will be moved offshore in a stream which, at the offshore end of the diffusers, is 5/8 mile wide and 33 feet deep, moving at 18 feet per minute. The distance travelled by water in this mass will vary, but on the average, it will be moved out to 2.5 miles offshore. Nutrients and phytoplankton will be transported and zooplankton and mysids may be transported offshore in this water. Since the biological effects of such offshore transport have never been studied in nature, it is difficult to predict their consequences with certainty.

2. The following are predictions in which the MRC has a lesser degree of confidence than for those in (1) above

(a) The discharge water sometimes will carry suspended matter at various concentrations to various distances and directions offshore. Since we have not yet been able to predict the pattern of turbidity or the degree to which it will reduce light, we cannot yet be certain of the extent of its effects.

(b) Kelp: At certain times, particularly from winter through early summer, the discharge plume of Units 2 and 3 may add turbidity to the water column to an extent that could interfere with recruitment of young kelp plants in part or all of the San Onofre Kelp bed. Whether such occurrences will completely suppress recruitment in all or part of the San Onofre Kelp bed cannot yet be estimated. The portion most likely to be deleteriously affected is the upcoast offshore quarter of the San Onofre Kelp bed, which represents the major portion that survived the recent die-off in the summer of 1976.

(c) Plankton and Mysids: Mortality will be increased in the group of planktonic species that live largely in a band within 2.5 miles of shore. This will be equivalent to imposing an additional 1 - 10% mortality per day over an area of about 30 square miles during those slower current regimes that occur more than half the year. The estimate of 1% assumes that mortality is caused only by intake entrainment; the 10% figure assumes that all plankton entrained by the diffusers are killed. The maximal rate would be roughly the same as the natural mortality rate and may be great enough to cause a reduction in plankton density around the Plant. A similar effect may occur with mysid shrimps.

We cannot yet predict the area over which this reduction in density may occur, and there will always be uncertainty on this question. However, we believe the effect could be discernible along the coast for one or more miles, but is unlikely to be observable 10 miles from the Plant. Within a similar-sized area, the numbers of planktonic larvae of benthic animals available for settlement will also be reduced to a greater degree than are the other zooplankton which can compensate for losses more rapidly. Whether this will reduce the density of benthic animals, and if so, over how large an area, is something we cannot yet predict.

(d) Hard Benthos: Some species that live on hard substrates will probably be unable to maintain themselves wherever they will be smothered by sedimentation from the turbid plume. Other species, which are more tolerant of sedimentation, will occur on the rocks within this area.

(e) Fish: The degree to which the fish return system will work effectively is not known. The effectiveness of the measures designed to reduce fish kills within the intakes of Units 2 and 3 have either not been tested at all (return conduit), or have not been tested under actual plant operating conditions. If they prove to be ineffective, the amount of juvenile and adult fishes killed will be

almost five times that of Unit 1, which would result in loss equivalent to about 13% of the queenfish living along 27 miles of coastline near SONGS.

Certain species of fish, some of which are important to sportsfishermen, tend to aggregate in kelp beds. Sportfishing is usually intense in the San Onofre Kelp bed. If part or all of the San Onofre Kelp bed is destroyed, the loss of this habitat will probaly reduce the abundance of certain sportfish in the area. Whether this will significantly reduce the yield to the local sportfishery cannot yet be predicted.

The density of fish larvae may be reduced in an area at least as large as the area of reduction of zooplankton.

Although many zooplankton and mysids will be killed and many more may be translocated offshore by Units 2 and 3, most are still available as food for sport and commercial fish. Most of the local fish species extend offshore as far as the plankton will be shifted so that the same fish species will eat them. Of the dead plankton that fall to the bottom, a fraction will be assimilated by invertebrates and bacteria, and some fraction of this energy will reach sport and commercial fish, the rest being diverted en route.

There will probably be some local gain in fish food because in summer the diffusers will bring mineral nutrients up to the surface which, in turn, will probably cause increases in phytoplankton populations and, subsequently, in zooplankton.

We cannot yet estimate the relative effects on fish yield of the losses of juveniles and adults within the intakes, the loss of kelp bed habitat, the loss due to larval fish kills, the loss of food to bacteria and scavengers on the bottom and the gain from increased phytoplankton productivity. Since some reduction in sport and commercial fish production remains a possibility, we are continuing our analysis of the losses and gains caused by SONGS.

RECOMMENDATIONS

1. Short-term Recommendations

a. Changes in the design of SONGS

Certain changes in the plant would reduce the nearshore ecological effects discussed above, although they might cause new, and as yet unknown, effects. Extending the diffusers farther offshore would remove the kelp bed from risk of damage and ensure that fewer organisms are transported offshore beyond their natural range by discharge entrainment. Altering each diffuser to a single-point discharge offshore beyond the kelp bed would prevent most of this transport offshore. Moving the intakes of Units 2 and 3 offshore would reduce the relative effects on plankton and mysids since the offshore species have wider distributions.

MRC does not feel that these changes should be required at this time, for several reasons:

(1) Those predicted effects in which we are reasonably confident are restricted to within a mile of the Plant. While they do not ensure the protection and the propagation of the local indigenous natural populations, these populations are part of a more extensive contiguous ecosystem. The only parts of the ecosystem which are not extensive in the local region are the kelp beds. San Onofre Kelp bed, although small, represents about 3% of the kelp in the southern half of the Southern California Bight (south of Palos Verdes) and 30% of the kelp area along 27 miles of coastline centered on SONGS (see Map 1). None of the other affected species, to our knowledge, is highly restricted locally and so the ecosystem in the larger general SONGS area will probably be maintained.

(2) We are much less certain of more extensive possible effects, for example the destruction of the San Onofre Kelp bed, or the extent of reduction of benthic, planktonic, mysid, and inshore fish densities. In the face of this uncertainty, two facts lead us to recommend no change in design at this time. First, we believe the

ecological effects would be reversible if SONGS were altered later. Second, we recognize that the Permit of February 28, 1974, states on Page 2, Item 6, that modifications may be required by the Coastal Commission should the MRC study at any time indicate that, "substantial adverse effects on the marine environment are likely to occur or are occurring through the operation of Units 1, 2 and 3." Thus, the design may still be altered after the new Units are operating.

Because we believe that alternatives such as single-point discharges further offshore would probably reduce the deleterious ecological effects, we recommend that the Coastal Commission examine the engineering feasibilities, economic costs and legal aspects of such alternatives. At the same time, if directed, the MRC will investigate and predict the ecological gains and losses of the alternatives.

b. Establishing predictions

It is essential to solidify and sharpen the predictions before Units 2 and 3 begin operation. The crucial studies to carry out this aim are now in progress or in the planning stage.

2. Long-term Recommendations

a. The importance of the present study

MRC believes the present SONGS study is of critical importance for the future management of the coastal region. This is the first attempt to see if we can successfully predict the extent and nature of the environmental effects of a large facility on the ocean shore. Such a test is essential for planning the design and siting of future facilities. It is therefore essential that proper monitoring is done after Units 2 and 3 begin operation, both to test the predictions and to tie down the extent of the effects. For example, future decisions about siting depend very much on whether effects extend one mile or 10 miles from the Plant, and it is in this region that our uncertainty lies.

b. Regulatory criteria

We believe that the regulatory emphasis on thermal effects is misplaced for situations at a relatively open coastal site like SONGS. Thermal effects of SONGS apparently will be less important than its dispersal of turbidity, large volumes of water pumped, and the massive transport of water offshore. It is likely that the requirement of reduction to 4° F within 1,000 feet of the discharge, which led to the present diffuser design, will result in greater damage than would have occurred with a single-point discharge which would exceed the present State Thermal standards. In other situations, of course, such a requirement might be appropriate.

We recommend that the Coastal Commission undertake a review of thermal requirements with a view to developing more appropriate and ecologically sound State guidelines.

SUMMARIES

Summary of Findings

SONGS Unit 1 clearly has a measurable effect on the local ecological community. However, ecologically marked changes occur over a relatively small area. This is partly because the local community is but a relatively small part of a large, well-mixed nearshore ecosystem. No Plant effects on the distribution and abundance of organisms are detectable beyond half a mile.

Summary of Predictions

1. The effects of Units 1, 2 and 3 will undoubtedly be more widespread than those of Unit 1 (see Maps 1 and 2). We expect to detect alterations in the ecological communities in an area roughly one square mile around the Plant.

2. Some effects on plankton, mysids and fish may extend and be observable one or more miles distant from the Plant. We do not expect to observe effects 10 miles distant from the Plant. The diffusers of Units 2 and 3 will redistribute turbidity, and if the turbidity plume drifts over the San Onofre Kelp bed, the bed may be partly destroyed. We think it unlikely it will be wholly destroyed.

Summary of Recommendations

Short-term Recommendations

1. Certain changes in the design of SONGS Units 2 and 3 would reduce the effects on the local ecological communities. MRC does not

recommend that these changes be required at this time. However, the results of studies now being carried out by the MRC may later lead to recommendations for changes.

2. It is essential to continue present efforts to establish predictions of the effects of SONGS Unit 1, 2 and 3.
3. Since alternative cooling designs might reduce ecological effects, it is recommended that the engineering feasibilities, economic costs and legal aspects of alternatives be examined at this time. If directed, the MRC will investigate the ecological gains and losses of such alternatives.

Long-term Recommendations

1. It is essential for the proper future management of the coastal environment that the intensity and extent of ecological effects of Units 1, 2 and 3 are measured once these Units are operating.
2. Our findings and predictions indicate that a thorough review, and possible revision, of State thermal requirements are required.

II. ANSWERS TO QUESTIONS POSED BY THE STAFF OF THE COASTAL COMMISSION

Question 1:

"Because of the large volumes of water being entrained by Unit 1, very large numbers of plankton are being killed. How many plankton are being killed by Unit 1, and how many will be killed by the operation of Units 2 and 3? Are these losses significant enough to warrant relocation of the intake and discharge pipelines?"

Answer:

Unit 1 kills about 100 - 160 billion microzooplankton, 2.5 - 4 billion macrozooplankton and 3.5 - 6 million ichthyoplankton organisms per day, equivalent to about 100 - 200 tons wet weight per year. Units 1, 2 and 3 will kill about 600 - 6,000 billion microzooplankton, 14 - 150 billion macrozooplankton and 20 - 340 million ichthyoplankton individuals per day or about 700 - 7,500 tons wet weight per year. Sometimes, when currents are slow (about half of the year), the maximum estimated rate will increase the death rate by an amount equal to the natural death rate and the density will prbably be reduced an observable amount up to one or more miles away from the Plant.

Given the large, well-mixed ecosystem of which this area is but a small part, these losses are not likely to alter the local community in a substantial way. Therefore, we do not recommend, at this time, the relocation of the pipelines. However, we do recommend that studies be continued to discover if the predicted reductions in density occur and, if so, over how large an area. Such information, unknown as of now for any marine ecosystem, is crucial for the siting of future facilities (power plants, LNG terminals, etc.) along the coast.

Question 2:

"Are all the requirements of Section 316(a) of the Clean Water Act being complied with?"

Answer:

Section 316(a) addresses the question of whether the discharge will or will not: "assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the body of water into which the discharge is to be made." To evaluate this question, one must define the population being addressed. If, for example, the population is defined as those benthic invertebrate animals that would have lived within 200 yards of Unit 1 discharge if it were not there, then they are not being protected since they are now different in many ways. The original indigenous population was indeed changed in an area of about 50 acres around both the intake and discharge of Unit 1.

If the population is defined as including those living in a much larger area up- and downcoast, then the population as a whole may be judged to be protected and to be propagating even though a certain fraction (that within 50 acres near SONGS) is not propagating. All natural populations are continually being damaged or destroyed over some variable fraction of their habitable range. They have evolved compensatory mechanisms that confer some resilience so that they usually recover from such partial destruction.

The construction and operation of Units 1, 2 and 3 will, over a certain fraction of the habitable range and for the life of the power plant, prevent the propagation of the indigenous populations. However, the Plant probably will not cause any species to disappear from a larger region of the coast. In other words, one must define the size of the area affected before one can decide whether Section 316(a) is being complied with. Over a small local area, 316(a) is not being complied with; over a larger area, it is.

Question 3:

"Are all possible impacts of SONGS Units 1, 2 and 3 being adequately measured by current study programs?"

Answer:

No. However, we feel that most of the important impacts are being adequately measured. There remain some impacts that we have not yet measured and that we may begin to measure if we or the Coastal Commission feel it is essential. These are:

(a) Effects on organisms of various substances in the discharge.

Our results have shown a reduction in growth of sea mussels within 100 - 400 yards of the Unit 1 discharge, during periods of pumping with or without heat.

In the unheated effluent of Unit 1, there are traces of chlorine, heavy metals, radionuclides and other wastes, as well as sediments, organic and inorganic, entrained outside the discharge. Any or all of these might produce deleterious effects (reduced growth, etc.). We have begun an analysis of the effects of turbidity and sedimentation and plan to do a study of chlorine and heavy metal effects.

(b) In the Permit No. 183-73 of February 28, 1974, Section III B, Page 5, it states that, "The Commission, in reaching its decision on this application, has been advised by its legal counsel, the Attorney General, that the Federal Government appears to have exclusive authority to regulate and control radiation hazards posed by nuclear power plants. Accordingly, the Commission expresses no opinion and makes no finding with regard to nuclear safety, and declares that questions of nuclear safety have played no part in its decision."

The MRC requests the opinion of the Coastal Commission as to whether a study of the effect of discharges of

radioactive materials on the reproduction, recruitment, growth and mortality of marine organisms falls under the term "nuclear safety" referred to above. If so, the MRC will not study it; if not, the MRC may decide to do so.

(c) Some species are being studied more intensively than others and some species are not being studied at all. It is standard practice to focus more effort on certain indicator species that are either common or that play a key role in the functioning of the ecosystem. Kelp is a good example of such a species. We feel that the species we have chosen to concentrate on are key species and that we have probably not ignored any key species.

(d) The effects of kills of plankton and fish by the Plant on the shunting of energy and materials between trophic levels has not yet been studied in detail; we make some estimates in this report.

Question 4:

"What is the amount and significance of fish mortality from Unit 1?"

Answer:

About 500,000 fish weighing 20 tons are estimated to be killed by a full year's operation of Unit 1. This is lost to the system because these fish are all removed and buried on land. Ninety-five percent of the fish killed are small fodder-fish representing 75% of the weight or 15 tons. This is enough to support about 1.5 tons of fish of the size caught by sport and commercial fishermen. Almost all of the remaining five tons of fishes killed are species that are economically unimportant.

Question 5(a):

"What species and how many individuals of those species will be affected if the San Onofre Kelp bed is wholly or partially destroyed?"

Answer:

This question cannot be answered precisely. Although over 760 species of animals and over 120 species of plants have been recorded from kelp beds in Southern California, the numbers of these in one kelp bed about 120 acres in area must be fewer. Also, not all are restricted to kelp beds, so that even if the whole of the San Onofre Kelp bed were destroyed, not all would disappear locally. Our present estimate is that the San Onofre Kelp bed has at least 164 species of animals and at least 16 species of plants. In all the local kelp beds (Map 1), we have recorded a total of 384 animal species and 36 plant species. If the size of the San Onofre Kelp bed were greatly reduced, some species now living in the San Onofre Kelp bed would be lost locally and the abundances of most species now there would be greatly lowered.

Question 5(b) (Kelp Beds):

"Are there any other recommendations for mitigation in addition to those presented in the Interim Report?"

Answer:

The mitigation recommendations in the February, 1978, Interim Report were confined to enlarging existing kelp beds or establishing new ones beyond the influence of Units 2 and 3. Other possible recommendations include extending the discharge conduits and substituting single-port discharges for diffusers. This would prevent the discharge from affecting the San Onofre Kelp bed for most of the time.

The original recommendations have not yet been shown to be feasible on a scale sufficient to make up for the total loss of the San Onofre Kelp bed. If so directed, the MRC will investigate the feasibility of establishing a new kelp bed in a place beyond the influence of SONGS.

Question 6:

"Of the alternatives presented in the Interim Report to mitigate the effect of the temperatures in excess of State Thermal Plan standards, which would result in the least damage to the marine environment offshore of the San Onofre plant complex?"

Answer:

In the Interim Report of February, 1978, the MRC showed that discharge temperatures would exceed the State Thermal Plan standards during part of the year. The decision, Order 76-21 of the Regional Water Resources Control Board, San Diego Region, permits this excess temperature by defining the "receiving waters" as those taken into the Plant. Order 76-21 was neither supported nor struck down in a recent tie vote of the State Water Resources Control Board.

Of the alternatives presented in the MRC Interim Report of February, 1978, our original statement on Page 5 still applies: "The least ecological impact would probably result from the first, reducing the amount of heat produced at appropriate times. However, the fourth alternative, raising the thermal limit to 25° F, might also have little additional ecological impact, since the temperatures of the discharge water will very quickly diminish owing to the rapid mixing within a short distance of the discharge ports."

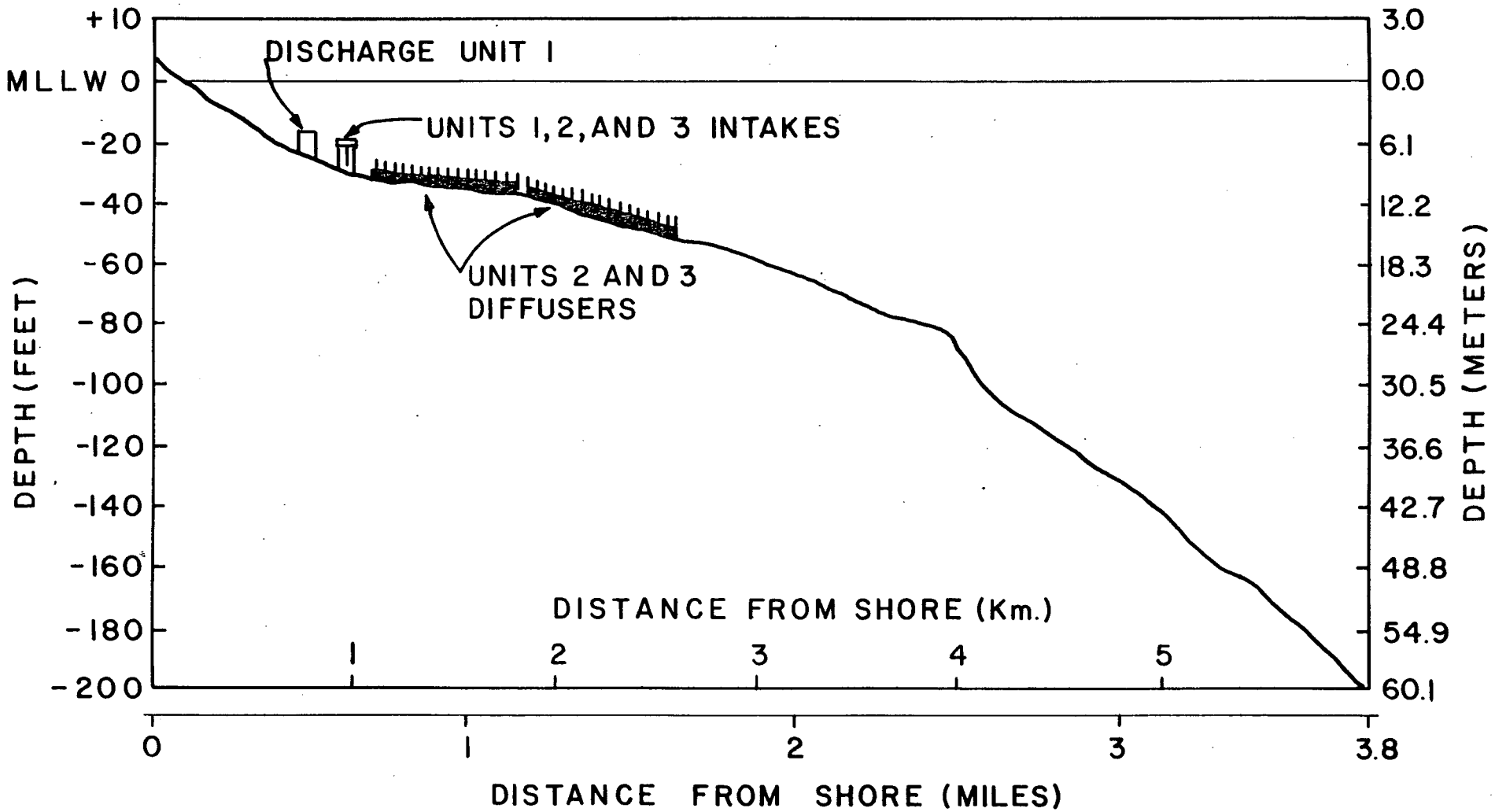
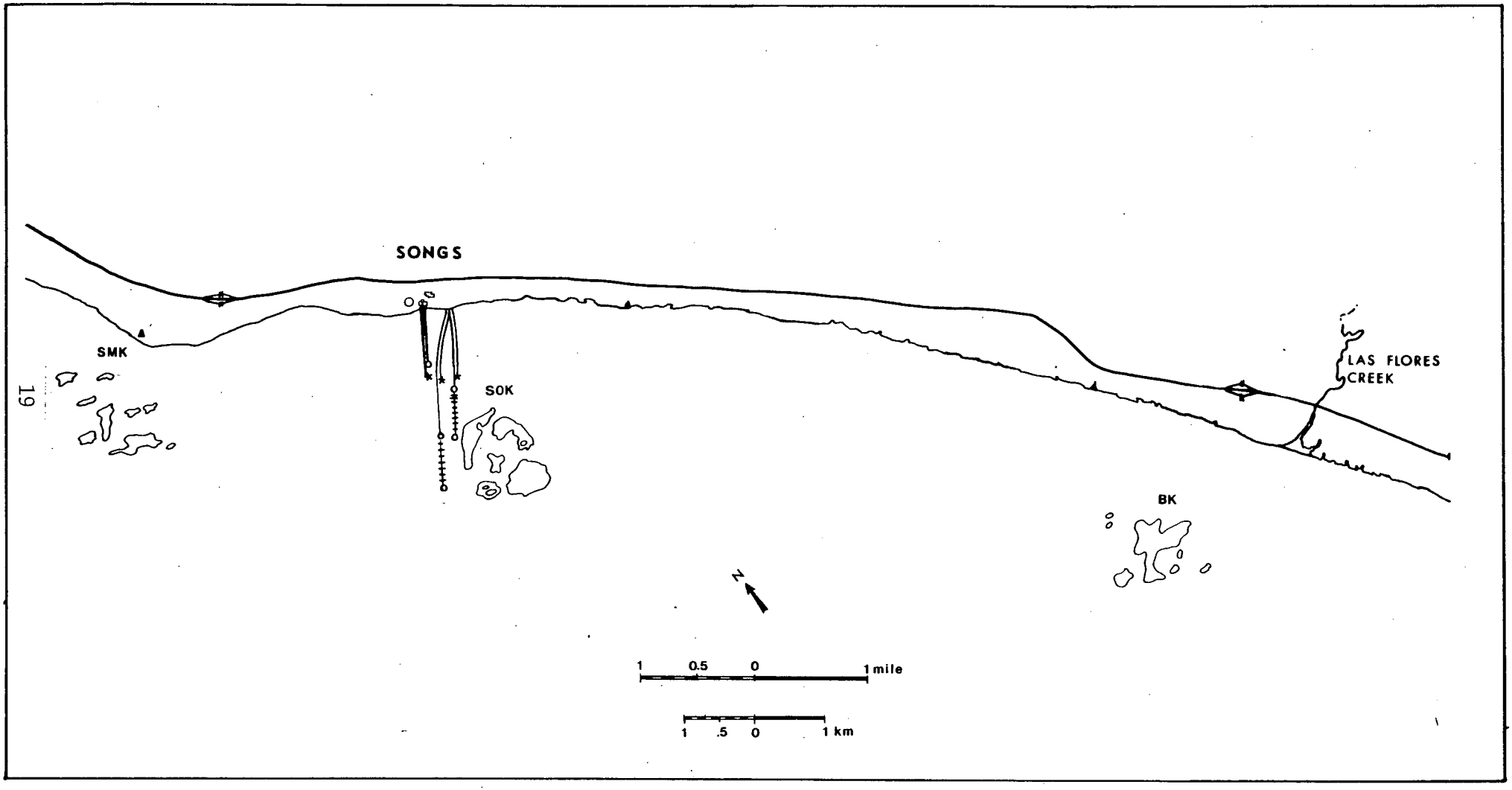
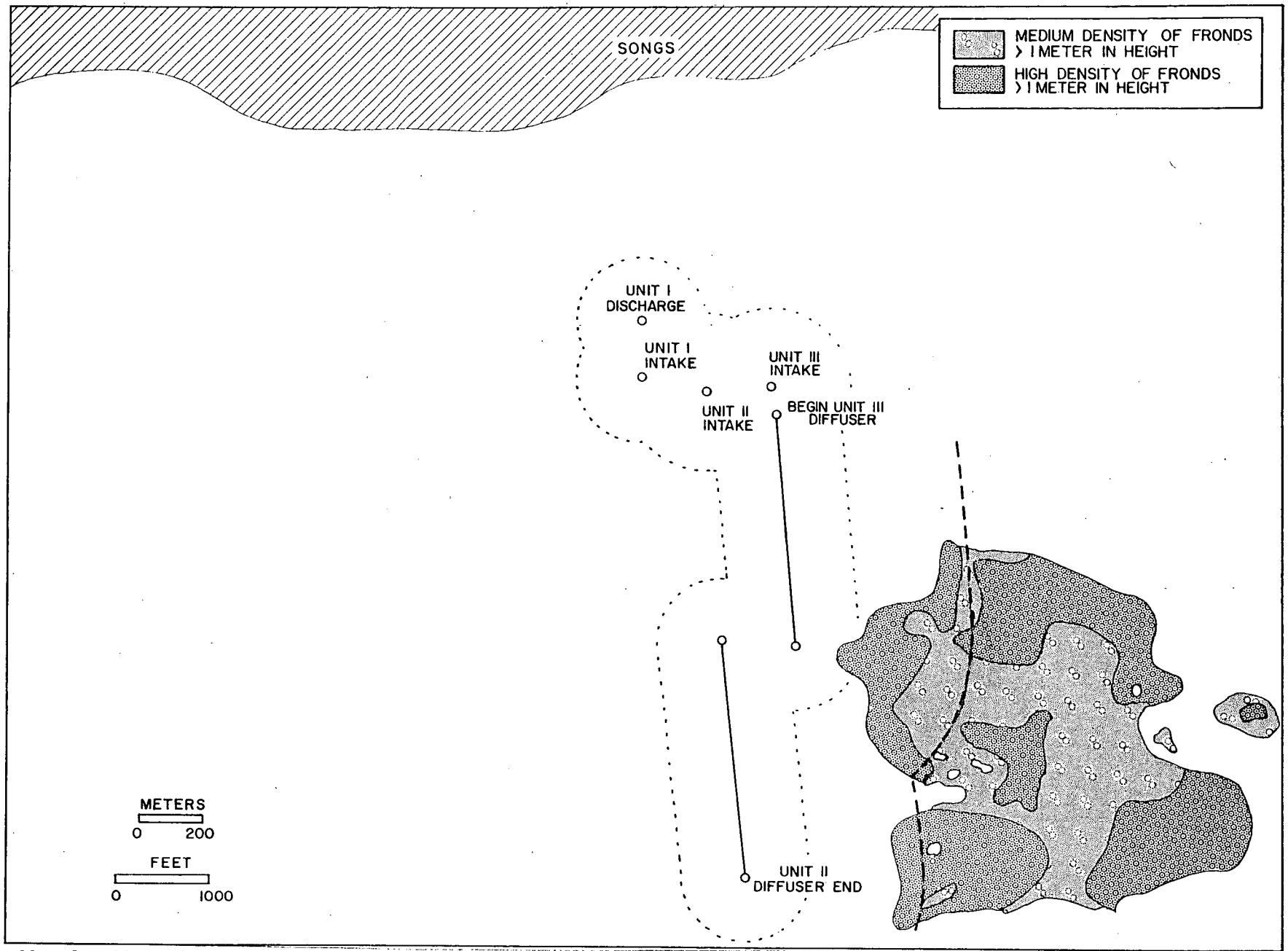


Figure 1. Offshore profile of the cooling system of SONGS Units 1, 2 and 3. (Modified from Figure II-3, Southern California Edison, San Diego Gas and Electric Company, Thermal Effect Study, San Onofre Nuclear Generating Station Units 2 and 3, Vol. 2, September, 1973.)



Map 1. Map of the region near SONGS. The kelp beds shown are the high density portions of San Mateo (SMK), San Onofre (SOK), and Barn (BK) kelp beds, as measured in December, 1978.



Map 2. Map of the coast near San Onofre showing the cooling systems of SONGS Units 1, 2 and 3 and the medium to high density areas of kelp measured in December, 1978, within the San Onofre Kelp (SOK) bed. The boundaries of the areas where the sediments are modified are indicated by dashed lines. The dotted line delimits the area within 1,900 feet of the diffusers as specified in the Coastal Commission Permit of February 28, 1974, Page 3, Item C.

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