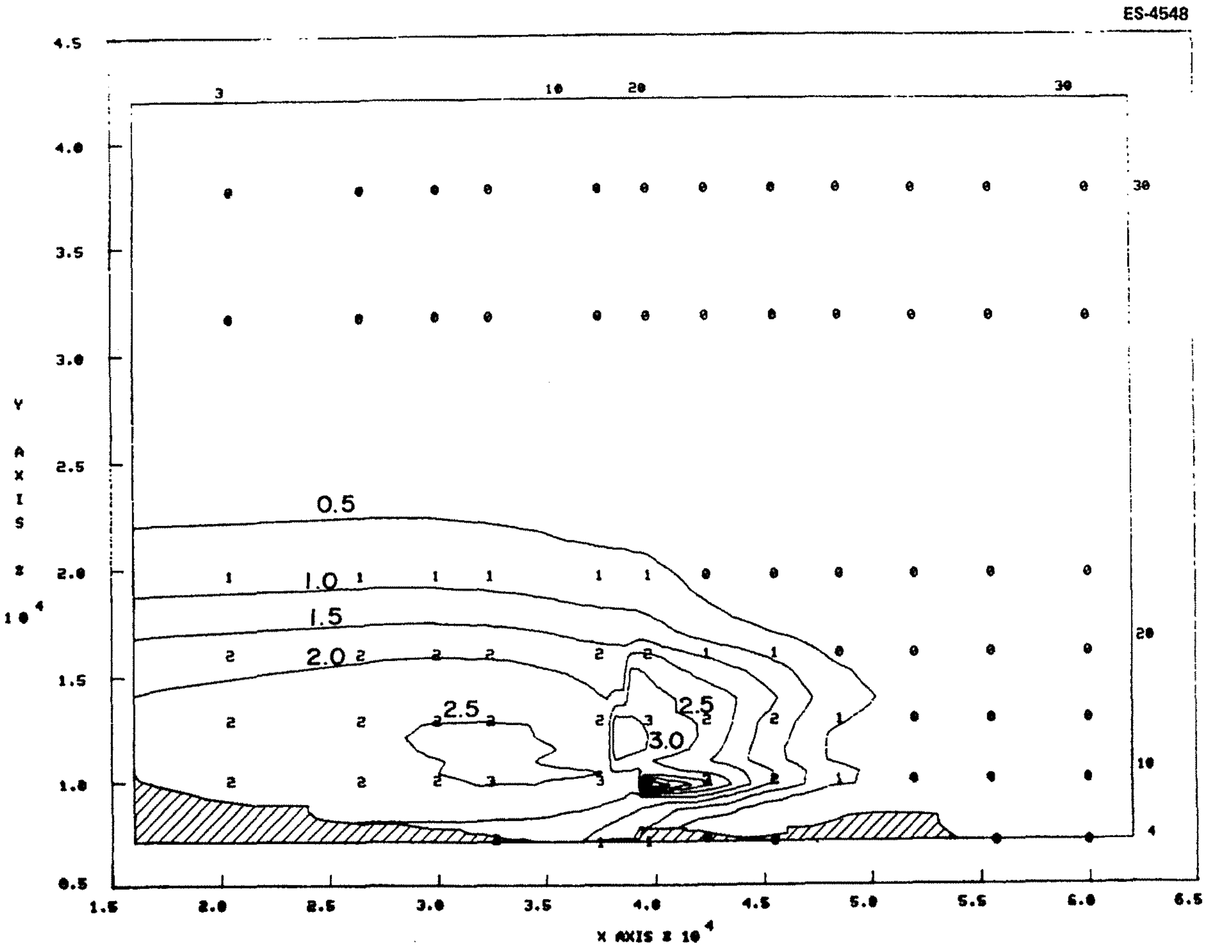


Fig. 5.13 Predicted excess temperatures in the San Onofre region at 2:00 p.m. on the fifth day. Isotherms are plotted in increments of 0.5°F beginning with the 0.5°F isotherm. (To change F° to C°, divide by 1.8.)

roads be kept in good condition by blading (ER, Suppl. 1, Item 21); associated impacts should be minimal. Maximum ground-level field gradients for all transmission lines will not exceed 7.5 kV/m (ER, Suppl. 1, Item 20). Generally, no harmful effects occur from the electrical fields associated with lines operating at 230 kV and below.[9]

5.4.2 Impacts on the aquatic environment

5.4.2.1 Effects of the heat dissipation system

A description of the heat dissipation system to be employed at SONGS 2 and 3 is found in Sect. 3.3 of the FES-CP. Design changes that have occurred since then are discussed in 3.2.2 of this statement. The only changes of potential significance for the assessment of biological effects involve the final specifications for the fish return system, the biocide use program, and the composition of the condenser tubing. Assessments of most major potential impacts also have been reevaluated in light of additional data obtained during technical specifications monitoring programs for SONGS 1 and from construction and preoperation monitoring programs for SONGS 2 and 3 (Section 2.5.2). Except as noted, the reassessments have resulted in the same conclusions that were reached in the FES-CP.

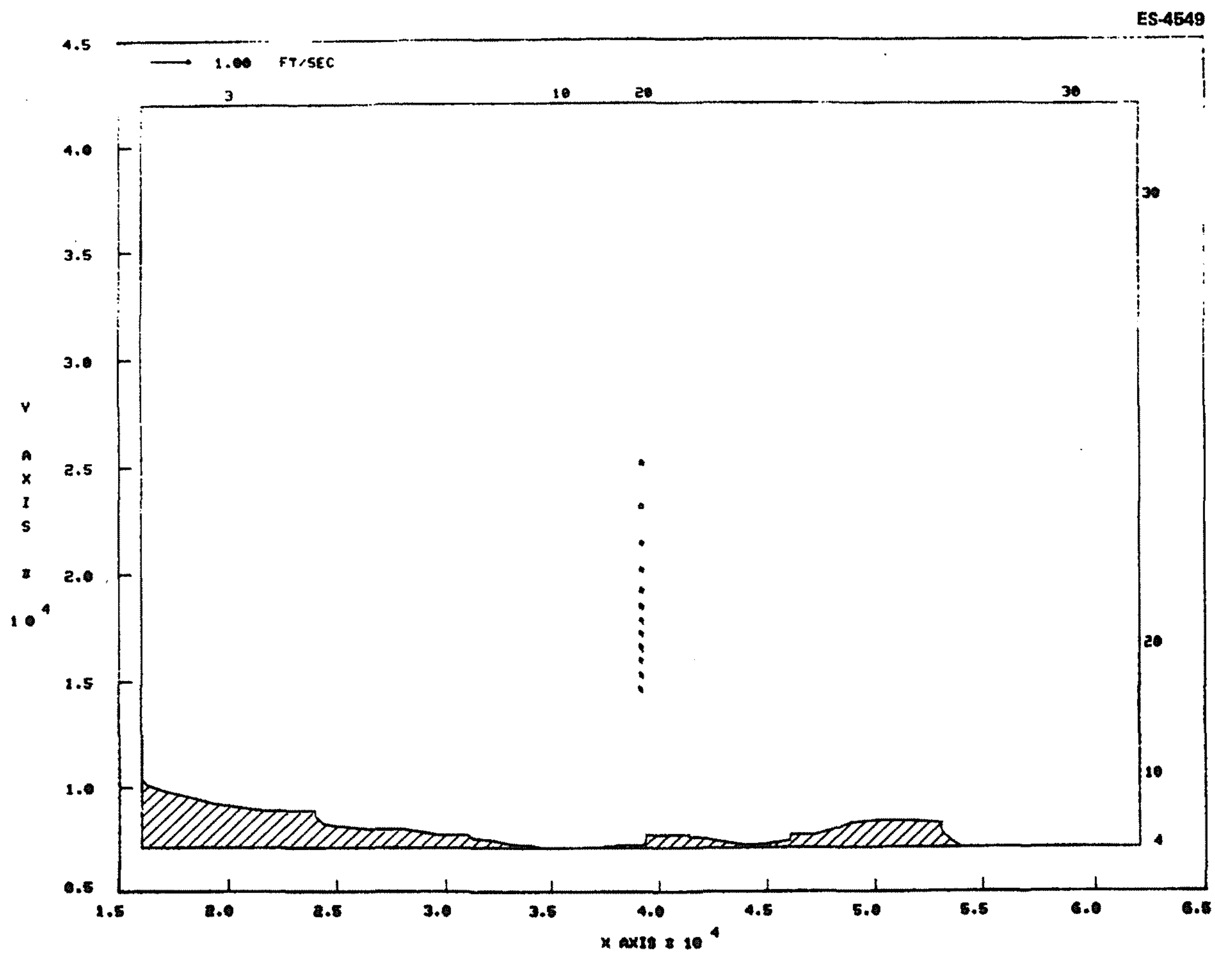


Fig. 5.14. Predicted natural flow field in the San Onofre region at 8:00 pm on the fifth day.

Thermal effects

The discharges from SONGS 2 & 3 must conform to regulations of the California State Water Resources Control Board, the Environmental Protection Agency (with regard to thermal discharges), and the California Regional Water Quality Board, San Diego Region, (under the auspices of the EPA) with regard to NPDES permit considerations (primarily chemical effluent limitations). The regulatory restrictions on thermal discharges are found in Sect. 5.1.1 of the ER; the NPDES permit, as amended, is found in Appendix 12C of the ER.

The results of thermal models used to evaluate temperature increases attributable to SONGS 2 & 3 (and incremental to SONGS 1) are discussed in Sect. 5.3.1. These data indicate that the thermal plume characteristics will be different from those estimated in the FES-CP and in the ER. Since the area to be affected by thermal discharges is now estimated to be greater than previously thought and since areas of substantial biological importance potentially will be affected (e.g., kelp beds), a reassessment is necessary.

Plankton. More planktonic organisms will be affected by thermal discharges than estimated in the FES-CP because the plume will cover greater area. The types of impact will, however, be the same (e.g., species compositon changes, greater respiration rates), and significant changes should be localized. The staff believes that changes which are produced in plankton communities will not threaten the ecological integrity of the near-shore region surrounding the facility (see pp. 5-26 to 5-32 of the FES-CP for a description of the anticipated effects).

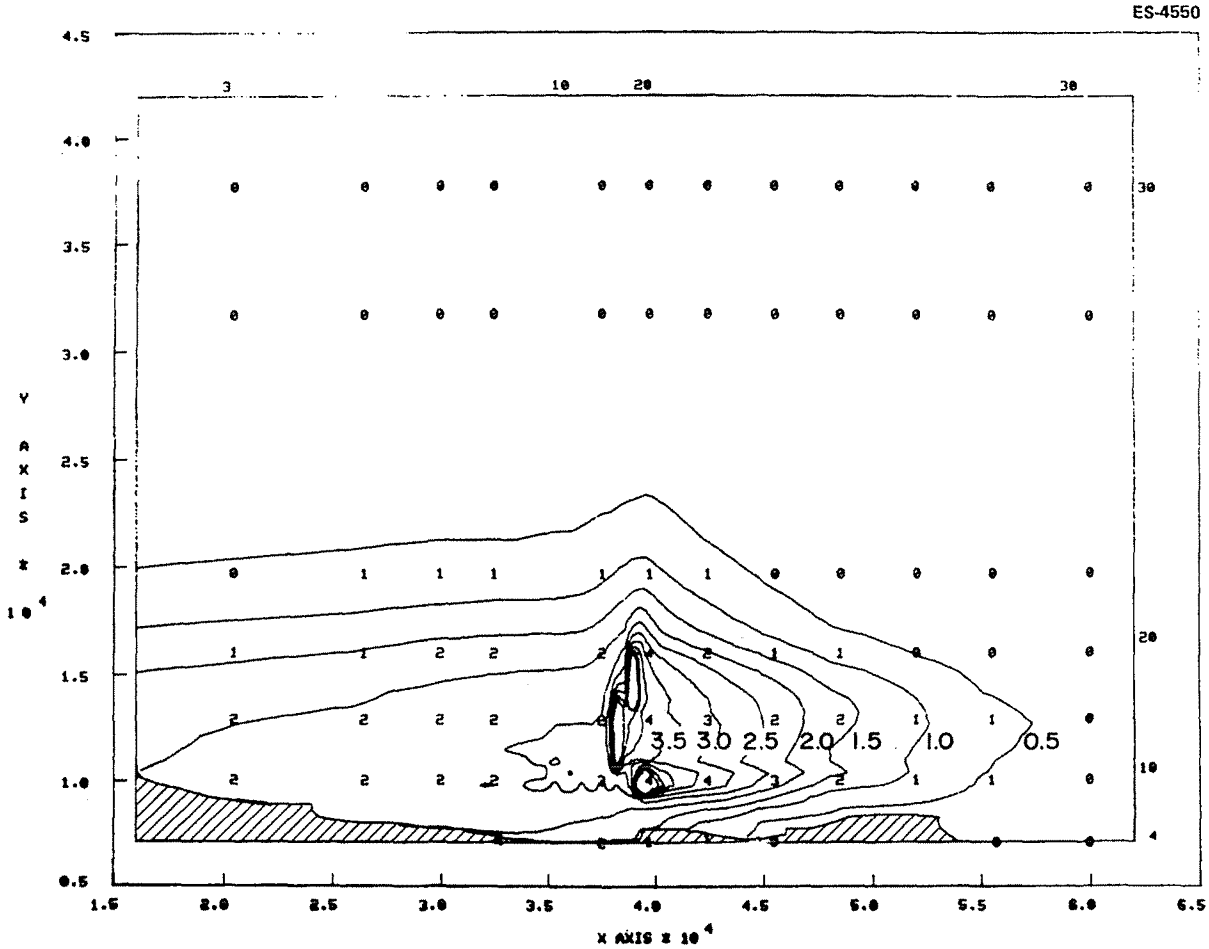


Fig. 5.15. Predicted excess temperatures in the San Onofre region at 8:00 p.m. on the fifth day. Isotherms are plotted in increments of 0.5°F beginning with the 0.5°F isotherm. (To change F° to C°, divide by 1.8)

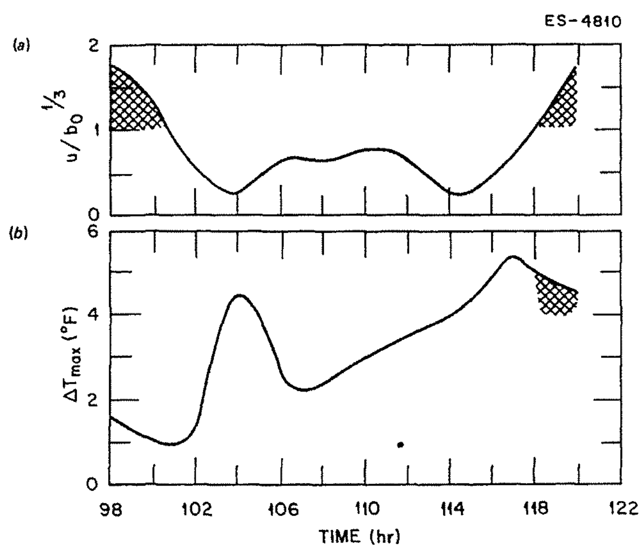


Fig. 5.16. (a) Plot of stability parameter versus time. The shaded area represents periods of vertical mixing. (b) Plot of maximum excess temperature versus time. The shaded area represents the period during which excess bottom temperatures are predicted to be greater than 4°F. (To change F° to C°, divide by 1.8.)

Fish. The types of impact on fish to be expected as the result of thermal discharges are the same as those discussed in the FES-CP. However, with more area to be influenced by the effluent, more fish potentially will be affected. The most observable change is likely to be shifts in the types of species (and their numbers) which inhabit the area; e.g., species which normally exhibit increased standing crops during naturally warm years will be more prevalent. Although the area of potential impact will be greater than estimated before, no fish populations are expected to be adversely impacted in the vicinity of the facility. Species composition changes, however, may affect commercial and recreational fishing within the thermal plume (in some cases adversely, and in others, beneficially; see FES-CP for details). However, because the plume will occupy a relatively small area of the available fishing space nearby, no significant changes in harvest rates for the various species are expected.

As stated in the FES-CP, cold kills of fish are not likely to occur to any large degree. The principal reasons are the relatively high ambient winter temperatures and the fact that all three units are not likely to be inoperative at any given time.

Benthic fauna. The major component of the ecosystem expected to receive the greatest impact from thermal discharges is the benthic community. Unlike free-swimming organisms, benthic individuals cannot easily avoid undesirable temperatures. And unlike planktonic organisms, they do not regenerate quickly to compensate for losses or experience continual, rapid recruitment from surrounding waters. Two major categories of the benthic community exist: animals, such as starfish and molluscs, and attached algae, the most conspicuous of which is kelp (discussed in the following section).

Among the benthic fauna recorded in the vicinity of SONGS during surveys conducted in 1977 in compliance with Environmental Technical Specifications criteria for SONGS Unit 1 were the gastropod molluscs Astraea undosa, Kelletia kelletii, and Roperia poulsoni, the asteroid echinoderm Pisaster giganteus, and the echinoid echinoderm Strongylocentrotus franciscanus.[10]

Although there have been only a limited number of detailed studies concerning the effects of temperature on marine species inhabiting the Pacific Coast, some recent laboratory simulation experiments of 12 to 14 weeks duration have examined the effects of thermal effluent on the survival, growth, and state of health of seven motile invertebrates from shallow rocky habitats along the southern California coast.[11] The treatment conditions simulated temperatures measured at distances of 84 and 335 m (276 and 1098 ft) from the cooling-water discharge structure of the Redondo Generating Station, located approximately 100 km (62 miles) upcoast of SONGS. Several of the species displayed low survival and impaired growth, especially among large adults, in response to the simulated thermal plume conditions at 84 m. Weekly mortality data for S. franciscanus, P. ochraceus, and R. poulsoni showed that individuals of all three species began to die when the temperature fluctuated over a range of 19° to 23°C (66° to 73°F), with a mean for the week of 21.4°C (70.5°F). No deaths had occurred the previous week when the same temperature range prevailed and the mean was slightly higher 22.8°C (73°F). The mortality observed during the second of these two weeks may, however, actually have been a delayed response to the higher average temperature of the previous week.

In the test involving R. poulsoni under a different thermal regime, deaths began occurring when the temperature flunctuated between 18° and 24°C (64° and 75°F) during the week, with a mean of 20.3°C (68.5°F). Although mortality began to appear at a lower mean temperature than in the previous experiment with this organism, the maximum temperature in this second experiment was 1°C (1.8°F) higher (24° vs 23°C) (75°F vs 73°F) and the temperature range was 2°C (3.6°F) wider (6° vs 4°C) (4.28° vs 39.2°F) than in the previous experiment. These results demonstrate the complicated nature of temperature effects; that is, adverse conditions can result from a critical high temperature of short duration, an extreme temperature fluctuation of short duration, or a prolonged period of a high but normally subcritical temperature.

The ambient depth-averaged temperatures predicted for the hottest time of the year (end of July) in the vicinity of SONGS are shown in 5.3.1. This section also contains data on the temperature expected during the operation of all three units. Temperatures potentially as high as 27.8°C (82°F) may occur naturally, and increases of 0.5° to 1.7°C (0.90° to 3.1°F) brought about by the operation of all three units can occur within an area of several square kilometers.

On the basis of the 1976 study,[11] the staff concludes that several components of the benthic fauna in the vicinity of SONGS would probably be adversely affected in areas where weekly mean temperatures of 22°C (71.6°F) prevail for one month or more or where daily temperatures reach or exceed 24°C (75°F). It is not, however, anticipated that temperatures averaging 22°C will occur for more than 2 to 3 weeks or that the area experiencing temperatures of 24°C or greater as a result of SONGS operation will be considerably larger than the area experiencing these temperatures under natural conditions.

The staff concludes that any impacts to the benthic fauna as a result of thermal discharges will be minimal and of an acceptable nature.

Kelp. Kelp beds off California occupy roughly 194 sq km (75 sq mi) of ocean bottom in water depths of 6-18 m (20-60 ft).[12] Although management efforts have possibly halted further severe decline, kelp bed coverage has decreased markedly since about 1920. Although this deterioration may have been partially a result of overharvesting, much of it is probably caused by the increased alteration of the near-shore environment by human activities. In particular, increased temperatures and increased turbidity have been shown to be inimical to kelp survival.[13]

Even without the influence of human perterbations, individual kelp beds experience long-term variations in stand density, productivity, areal extent, etc. Natural factors implicated in causing these variations include storm damage (causing detachment of plants), sand movement (burying holdfasts and causing detachment or prohibiting regeneration), introduction of turbid water masses, high natural temperatures, influx of grazing urchin masses, and fungal and bacterial diseases.[12] Thus, for example, in 1957-59, unusually warm temperatures off southern California caused an estimated loss of 90% of the regions' beds during this period (ER, pp. 2.2-28 and 2.2-29), as judged by surface examinations. Individual beds also commonly display changes in canopy extent during the year. For example, the three beds near the SONGS site showed marked variation in canopy area during 1975 and 1976 (Fig. 2.10). Typically, canopy tissue deteriorates during the warmest time of the year, leaving the basal portion of the plant (which is in cooler water) for regeneration when temperature and light conditions permit.[13] Reduced surface nutrients and higher bottom nutrient mixtures may also contribute to canopy deterioration and basal tissue regeneration respectively.[14]

Kelp beds represent a very important ecological community in California's near-shore waters. It has been estimated that kelp beds are at least three times more productive than the autotrophic components of other near-shore communities. Conservative estimates place the total standing crop of kelp in southern California at 1.8×10^9 kg (2 million tons) and new annual growth potential is on the order of 2-3 times this amount.[13] Kelp beds harbor numerous types of animals and plants, adding greatly to the diversity of an area. Invertebrates commonly found on the plants themselves include ostracods, copepods, amphipods, decapods, polychaetes, nematods, bryozoans, turbellaria and molluscs. Molluscs and echinoderms are kelp grazers prevalent on and around the plants. It is estimated that the larval, juvenile, and adult stages of 25 main sport fish use kelp beds for refuge and food gathering (eating the associated invertebrates, the kelp itself, or other algae), and the average standing crop of fish is estimated to be 300 kg/ha (300 lbs/acre).[13] Kelp not only enter the food chain via grazers, but they contribute large quantities of organic matter to the detritus-based food chains. For example, since several detritus feeders are intermediate in the grazing food chain of many of California's commercial fishes, kelp indirectly influences the populations of these fishes through the production of detritus.[13]

Kelp is an important commercial commodity as well. Although used extensively in the past for such diverse things as fertilizer, cattle feed, and for the production of potassium, acetone, and iodine, most kelp today is processed for the production of algin, a polysaccharide with numerous industrial uses.[12] It is estimated that roughly 15% of the annual kelp production is harvested yearly at a landed value (1964 dollars) of $2 million (market value is roughly 4 times this figure).[13] The kelp beds in the vicinity of SONGS are not now harvested.

Besides the necessity for a favorable physicochemical environment, kelp requires a solid substrate for attachment. Thus, the local distribution of kelp beds in an unperturbed area is largely substrate-dependent. Near the SONGS site, sandy bottoms are prevalent limiting the areas where beds can develop. Natural environmental fluctuations (e.g., higher-than-average temperatures) can virtually denude an area, but, since the casual phenomena are short-lived, kelp beds generally reestablish themselves quickly. However, anthropogenic disturbances frequently completely eliminate kelp beds in their sphere of influence because they generally are of long duration. Even chronic, low-level perturbations which only slightly decrease kelp production often cause the consumption by grazers to outpace new growth.[13]

The temperature tolerance of kelp is probably a reflection of a combination of factors, including physiological responses, susceptibility to disease, and susceptibility to grazing. It has been rather well established that temperatures above 18-20°C (64-68°F) cause deterioration of kelp, and the degree of degradation is directly related to the duration of the exposure to these temperatures. Increased surface temperatures caused by SONGS operation (all three units) would have the effect of extending the period of canopy absence. During the hottest time of the year, data in Section 5.3.1 suggest that the closest kelp bed (San Onofre bed) will experience an average surface temperature increase (over a 24-hr period) of 1.4°C (2.6°F); the range of temperature increase will be 0.6-2.2°C (1-4°F).

Although daily natural temperature variations of 1°C (2°F) are not uncommon in the area (ER, p. 2.2-28), they would not be continuous in nature and thus might not affect the bed as severely as the continuous SONGS discharges would, where the thermal plume may impinge on the bed for a longer time. Prediction of the degree to which canopy disappearance would be prolonged is impossible. Regeneration would be quicker in years with naturally cooler ocean temperatures, assuming the regenerative tissues remained unaffected (see below).

The greatest threat of SONGS to the long-term survival of the San Onofre kelp bed is the possibility of injury to the basal tissues from which the canopy is regenerated each year as the waters cool. Estimates for bottom temperatures within the bed at the end of July (Section 5.3.1) indicate that temperatures could reach 23-25°C (74-76°F), with a 24-hr mean of 24°C (75°F). Such temperatures would represent a 1-1.5°C (2-3°F) increase above ambient conditions encountered during the hottest portion of the year (conditions which are likely to persist for up to approximately a one-week period) (Section 5.3.1). Although the ambient temperatures given above would in and of themselves be detrimental to the kelp, exposure to them for up to a week would not likely cause permanent degradation of the entire bed[13] because the mean exposure temperature does not quite exceed a recognized threshold temperature for rapid degradation (24°C) and deeper portions of the bed would be slightly cooler than the average and would have a greater probability of maintaining a viable population. However, adding 1-1.5°C to these ambient temperatures could place the bottom kelp tissues in a critical temperature environment subjecting the tissues of most of the plants to temperatures greater than their short-term tolerance, and prolonging the period of time in which the plants would experience temperatures greater than 20°C (68°F), which would cause them to be more susceptible to grazing pressure, diseases, etc., leading to their eventual demise.[13] Since ambient bottom temperature in the region from August – early September may typically range up to 19°C (66°F) (Section 5.3.1), a several week period could exist in which temperatures exceed 19°C.

The information above suggests that the thermal discharges from SONGS 1, 2 and 3 may result in the destruction of at least a portion of the San Onofre Kelp Bed during the summer months. Under average conditions, the result may not be detectable or it may be manifested in a noticeably earlier decline of the canopy. However, under extreme worst case conditions (e.g., several days with high ambient temperatures and slack currents, and with all three plants operating continuously), destruction of the basal regenerative tissues might result. Although recolonization of the area from outside sources could occur during the cooler months, the community, if destroyed frequently, could never achieve a stable state characteristic of other kelp beds in the area. Furthermore, constant temperature increases coupled with added turbidity would be inimical to interim reestablishment since these factors tend to increase the effects of grazing.[13] The perennial occurrence of worst case conditions seems highly unlikely (Section 5.3.1) and the staff thus concludes that the long-term thermal impacts from normal station operation are not likely to be severe. However, in view of (1) the potential additive of synergistic effects of turbidity and sediment with thermal discharges, (2) the ecological importance of kelp beds and their already diminished stature, and (3) the fact that the San Onofre bed represents about one-third of this resource along approximately 16 km (10 mi) of shoreline in the vicinity of SONGS, the staff recommends monitoring to ensure the bed's protection.

Heat treatment

In addition to the thermal discharge associated with the normal operation of the facility (see above), the applicant proposes to heat treat portions of the intake and discharge systems to remove biological growth (see Section 5.3.1.2). This antifouling procedure will result in periodic discharge temperatures higher than those normally encountered. As a result, the state required the applicant to perform a demonstration to determine if significant impacts will result from the procedure. This demonstration, in part provided for under part 316(a) of the Federal Water Pollution Control Act of 1972, was used to determine if the proposed process is acceptable to these government agencies. To date, approvals have been obtained from the California State Water Resources Control Board (Resolution No. 80-95 adopted December 18, 1980), thus removing any regulatory obstacles from the state for conducting the antifouling process.

As stated in Section 5.3.1.2, biofouling control will be needed primarily in the winter; ambient summer temperatures will normally be sufficiently high to obviate the need for the procedure at that time. Additionally, the state has imposed a five-week minimum treatment interval for each unit. Hence, the biological effects will be a manifestation of short-term intermittent stress. Localized mortality and chronic debilitation are inevitable, particularly for sessile organisms. However, only one community of organisms is judged to be significantly vulnerable ecologically – the San Onofre Kelp Bed.

The thermal effects of normal operation on kelp are discussed above along with more detailed information on thermal tolerances, etc. Since intake heat treatment should produce smaller far-field ΔT's than that produced by normal operation (Section 5.3.1.2), the effects on kelp will be less than or equal to the effects induced normally. Discharge heat treatment is judged to produce potentially greater far-field thermal effects, however. Without dispersing currents (i.e., during a slack in the tidal cycle), kelp bed temperatures during the summer may increase by ca. 0.4°C (0.72°F) (above normal operations) (Section 5.3.1.2). This negligible increase would not be likely to affect the kelp, particularly since the canopy will be naturally reduced (see kelp discussion above) and the heated water is not likely to be near the bottom.

Discharge heat treatment during the winter may cause a temperature increase in the kelp bed of up to 4°C (7.2°F). The kelp are ordinarily tolerant of the absolute temperatures this would produce, but the rapid heat-up involved (e.g., 0.5 h) could be deleterious since the kelp would not be "hardened" for such a temperature regime. However, it is not possible to tell from the literature the severity of such an event. The plants could be only temporarily taxed physiologically and rebound without sequelae. Conversely, the stress could initiate an increased vulnerability to other, natural stresses such as predation, sloughing, and encrustation. Overt mortality is unlikely. In the absence of definitive data, it would be wise to (1) ensure continuation of the kelp monitoring program and (2) attempt to avoid heat treatment during unfavorable ocean current conditions. As pointed out in Section 5.3.1.2, effects can be mitigated by staggering heat treatment at Units 2 and 3 (thus allowing thermal dispersion from the first treated unit before treating the second) and by conducting the antifouling procedures when current and tidal cycles are known to move the adjacent water mass away from the kelp bed.

Turbidity and sediment transport effects

The FES-CP discusses the types of effects turbidity increases due to SONGS operation will have on the various biological communities, indicating that it is not possible to predict the areal extent of this impact.

The organisms likely to receive the greatest impact from increased turbidity are those which cannot readily avoid adverse conditions or do not regenerate quickly (or experience rapid recruitment from surrounding waters), namely, the benthos. Since the San Onofre Kelp Bed is estimated to be enveloped within the thermal plume, it is likely that it will also experience increased turbidity. The effect on the kelp would potentially be decreased photosynthesis, possibly causing many of the plants to die if the exposure is continuous (a 1% increase in the absorption coefficient has been found to result in a 20% loss in net photysynthesis at 15 m (49.2 ft)[13] and burial of the holdfasts in particles which settle out, inhibiting regeneration and recolonization. Regardless of the magnitude of these effects, their presence would add to the probability that the kelp bed would be adversely affected (see preceding section).

Some of the effects of increased sediment transport on benthic fauna are addressed in the FES-CP. The staff has further addressed the impact of the change in sediment size in areas near the SONGS site which would result from sediment redistribution. A study conducted during SONGS 1 operation, shutdown, and subsequent startup showed a significant reduction in the number of species and the total abundance of individual benthic fauna (primarily molluses and polychaete worms) within 200 m (656 ft) of the intake and discharge structure, probably because of the coarsening of the grain size of the sediments in this area.[15] Sediment coarsening appears to be mainly a result of the discharge of shells and shell fragments of fouling organisms (barnacles, molluscs) sloughed from the insides of the intake and discharge pipes during normal operation and especially during heat treatment.

The sediment-altered area associated with SONGS 1 (following 13 years of operation) is estimated to be approximately 125,600 m^2 (.048 mi^2), on the assumption of a circular pattern of effect with a radius of 200 m (656 ft).[15] Assuming sediment alteration associated with SONGS 2 and 3 forms a rectangular pattern approximately 200 m from the sides and ends of each diffuser, the area affected by SONGS 2 and 3 would be approximately 0.8 km^2 (0.31 mi^2). Adding this to the area affected by SONGS 1 (125,600 m^2 (0.48 mi^2)) plus an estimate of the area affected by heat-treatment backflushing of the SONGS 2 condenser (59,900 m^2 (0.023mi^2)) gives a total area affected by all three units, from both normal operation and heat treatments, of approximately 1.0 km^2 (.386 mi^2).

It is difficult, however, to extrapolate from the effects associated with the point source discharge of SONGS 1 to the 762-m (2500-ft) long dual, staggered diffusers of SONGS 2 and 3. SONGS 2 and 3 jointly are expected to have 5 times the cooling water flow rate, 3.3 times the intake pipe area per intake structure, and 12.5 times the total fouling surface area associated with the two outfall lines that SONGS 1 has.[15] None of these factors has been taken into consideration in calculating the area potentially affected by SONGS 2 and 3. The magnitude of the effect will also increase with duration of operation.

In contrast to the above prediction of benthic impoverishment, the staff concludes that a zone of enhanced species diversity and abundance is to be anticipated beyond the area of sediment modification. This conclusion is also based on results of the Marine Review Committee study,[15] which indicates that within a zone of 200 to 800 m (656 to 2424 ft) from the intake and outfall of SONGS 1, diversity and abundance of benthic fauna show a positive correlation with proximity to these structures. It has been estimated that this area contains 2 times the diversity and 8 times the abundance of benthic fauna as the sediment-altered area within the 200-m (656-ft) radius of the outfall. This phenomenon is believed to be a result of organic enrichment from sinking plankton fragments and/or material continually resuspended by the localized turbulence of the discharged cooling water.[15]

Assuming an eliptical ring pattern for this area of enhancement, starting from a point 200 m (656 ft) on either side of the intake and outfall structures of SONGS 1, to 1200 m (3936 ft) upshore and downshore (the extent of enhancement appears to diminish between 800-1500 m (2624-4920 ft) downcoast) and extending for a distance of 400 m (1312 ft) beyond the 200-m (656-ft) point in the onshore and offshore directions (offshore/onshore effect is much less than longshore), the area of enhancement is estimated to be approximately 2.1 km^2 (0.81 mi^2).

Predicting the magnitude of an enhancement effect associated with SONGS 2 and 3 on the basis of SONGS 1 observations is complicated. The total volume of dead plankton dispersed might be approximately 5 times that of SONGS 1 as a result of the 5-fold increase in cooling water flow rate. However, the volume of discharge for each diffuser port is less than for the single outfall of SONGS 1 so that the distance the entrained plankton are dispersed would be expected to be less. There may also be considerable differences between the shallow current patterns where the SONGS 1 outfall is located and the current patterns in the deeper waters where the SONGS 2 and 3 diffusers will be located.

If it is assumed that the dispersal distances for dead plankton will extend approximately half the distance from the sediment-altered area surrounding the SONGS 2 and 3 diffusers as was found associated with the SONGS 1 discharge, and accounting for overlap, the area of enhancement would be approximately 2.4 km^2 (0.93 mi^2). Adding to this the area affected similarly by SONGS 1 gives a total of 4.5 km^2 (1.74 mi^2). This is an area approximately 5 times that estimated to show a reduction in benthic diversity and abundance. The staff concludes that the impacts likely to occur to the benthic fauna as a result of sediment transport effects are acceptable.

Entrainment

The staff's analysis of entrainment effects in the FES-CP remains valid (FES-CP, p. 5-7 to 5-12). A program on the mortality experienced by entrained ichthyoplankton is being planned currently at SONGS 1 and is expected to be submitted to the NRC staff in 1981. The results of this program should help to determine the significance of any impacts although the analysis presented in the FES-CP indicates that impacts should not be significant. The completion date for this study will be approximately one year after it is initiated.

The circulation of water from near-shore areas to offshore areas will cause some redistribution of species, particularly zooplankton, since species composition is not exactly the same for both areas (Section 2.5.2). Although this may result in long-term species composition changes, the areas affected should be small (FES-CP, Section 5.3.2) relative to the coastal areas as a whole around San Onofre. Because no other power plants or industrial facilities that could exert a similar influence exist within several miles, this impact is judged acceptable.

Impingement

The basic impingement analysis contained in the FES-CP remains valid. Some additional information is available, however, on the design and efficiency of the fish return system. The system is described in detail in Section 3.4 of the ER and in Section 3.2.2 of this document. Basically, the fish return system consists of a mechanism for shunting any fish entrained in the intake to a side holding area by means of an angled conduit design to avoid impinging them on the trash removal mechanisms in front of the final intake. Preliminary experimental results (ER, p. 5.1-20) indicate that perhaps 90% or more of the fish can be returned to the ocean unharmed. However, precise figures on the effectiveness of this system will not be available until the fish return system is in full-scale operation. The FES-CP analysis assumes a worst-case situation in which the fish return system is not at all effective. Under these conditions, 33 to 91 tonnes (36 to 100 tons) of fish per year would be removed from the San Onofre area. These figures are based on extrapolations from data obtained on SONGS 1 operation; new data do not indicate that these figures should be adjusted significantly. The majority of the fish impinged at SONGS 1 are queenfish, and, for reasons given in the FES-CP, losses from all three units should not have a significant impact on the population. Moreover, of the dominant recreational fish impinged at SONGS 1, losses were less than 0.8% of the amount taken by fishermen. Likewise, the primary commercial fish of the area – jack mackerel, Pacific bonito, and white seabass – were seldom entrained at SONGS 1.

Offshore current induction

The analysis of the effects of induced circulation as given in the FES-CP (p. 5-16) remains valid, despite the design changes described in Section 3.2.2.

5.4.2.2 Effects of biocides and other chemical discharges

The FES-CP expressed concern about the potential long-term effects of copper being released into surrounding water by corrosion of the condenser tubing. Design changes have eliminated the plan to use a copper-nickel alloy for condenser tubing; titanium tubing will be used. Therefore, copper- or nickel-induced stresses to the receiving water from condenser tubing would not occur.

The FES-CP conclusion that the effects of chlorine will not be significant remains valid. However, new information is available on this subject. The applicant estimates that the effluent chlorine concentrations will be no greater than 1.5 ppm as total residual before discharge to the ocean (ER, p. 5.3-2). With a 10-to-1 mixing in the immediate vicinity of the diffuser ports (ER, p. 5.3-2), this value would be reduced to 0.15 ppm. The FES-CP required, and the applicant agreed, that the total residual concentration of chlorine and other halogens in the immediate vicinity of the discharge from each unit be limited to less than 0.1 ppm for no more than six 15-min periods each day [FES-CP, p. iv, item 7.a(2)]. Experience at SONGS 1 indicates that total residual chlorine concentrations quickly dissipate to undetectable quantities within a hundred or so meters of the outfall and, for any given 15-min dosing period, are only detectable over the outfall for 2 to 18 min (ER, p. 5.3-2). Even assuming a worst-case condition for SONGS 2 and 3 in which chlorine remains at levels around 0.15 ppm (total residual) in the vicinity of the outfall ports for as long as 30 min, any significant impacts are unlikely.[16] Thus, any chlorine effects are likely to be minimal and of an acceptable nature. Moreover, the difference in effect between discharges of 0.1 and 0.15 ppm are negligible. In view of this and in light of the provisions of the Federal Water Pollution Control Act Amendments of 1972, the staff does not believe that a more stringent limitation on chlorine discharges is necessary.

Miscellaneous chemicals will be discharged through the circulating water outfall system and will include laboratory wastes, ion exchange regeneration chemicals, and pH adjusters (Section 3.2.4 of this document and Section 3.5 of the FES-CP). The FES-CP analysis of the impact of these chemicals remains valid; that is, because of the small quantities involved, the great dilution factors present, and the relatively innocuous nature of most of these chemicals, impacts will not be detectable.

5.4.2.3 Effects of sanitary waste discharge

The effects of sanitary waste discharge are not discussed specifically in the FES-CP. However, any effects will be insignificant for the following reasons.

1. On the average, only about 26 m^3/day (7000 gpd) of secondary treated sewage will be discharged.

2. The discharge will be made into the circulatory water system at the rate of 0.02 m^3/min (5 gpm). The cooling water flow is about 1200 m^3/min (320,000 gpm). Thus, a 6400 dilution factor will result.

3. The resulting concentrations of suspended solids, BOD, N, P, coliform bacteria, and chlorine will not result in detectable incremental increases above ambient levels even before discharge into the ocean.

5.5 RADIOLOGICAL IMPACTS

5.5.1 Radiological impact on man

The impact on man associated with the routine release of radioactive effluents from SONGS 2 and 3 has been estimated. The quantities of radioactive material that may be released annually from the plant are estimated based on the description of the radwaste systems given in the applicant's ER and PSAR and using the calculational model and parameters described in NUREG-0017.[17] Using these quantities and site environs information, the dose commitments to individuals are estimated using models and considerations discussed in detail in Regulatory Guide 1.109. Additional assumptions and models described in Appendix B of this environmental statement were used to estimate integrated population doses.

5.5.1.1 Exposure pathways

The environmental pathways that were considered in calculating the radiological impact are shown in Fig. 5.17. Calculations of radiation doses to man at and beyond the site boundary were based on the radioactive material quantities shown in Tables 3.2 and 3.3, on site meteorological and hydrological considerations, and on exposure pathways at SONGS 2 & 3.

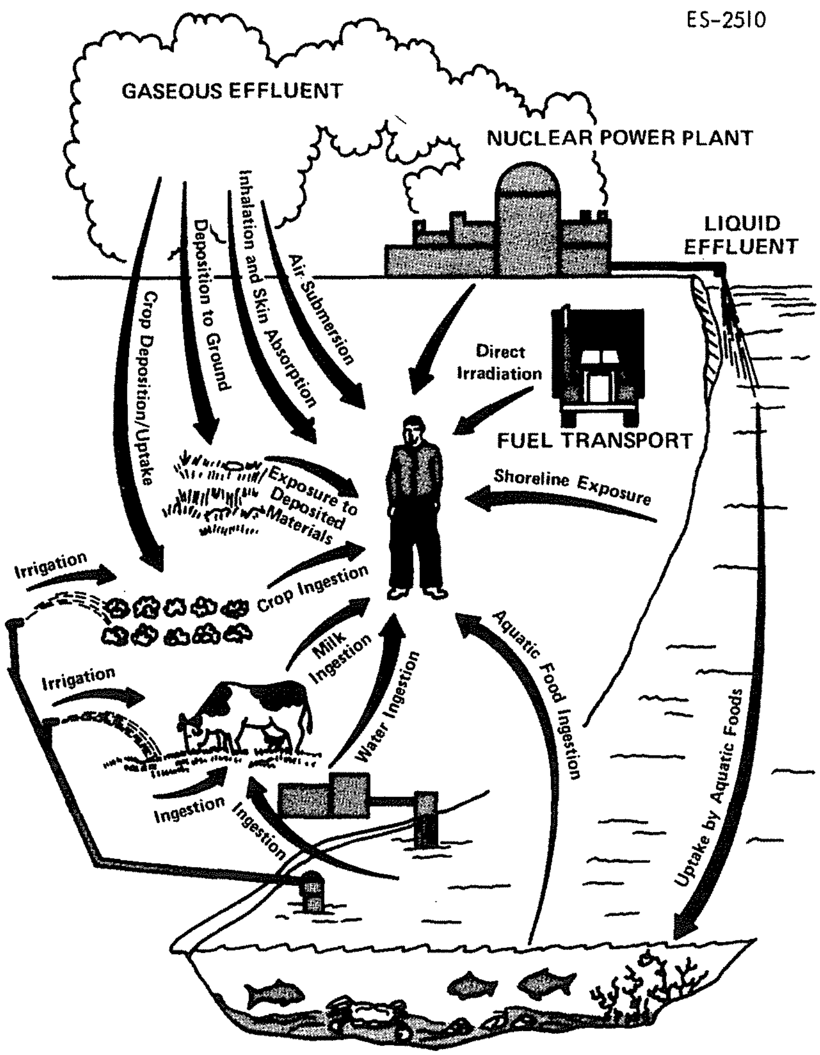


Fig. 5.17. Exposure pathways to man.

In the analysis of all effluent radionuclides released from the plant, tritium, carbon-14, radiocesium and radiocobalt inhaled with air and ingested with food and water were found to account for essentially all total-body dose commitments to individuals and the population within 80 km (50 miles) of the plant.

5.5.1.2 Dose commitments from radioactive releases to the atmosphere

Radioactive effluents released to the atmosphere from SONGS 2 & 3 will result in small radiation doses to the public. NRC staff estimates of the expected gaseous and particulate releases listed in Table 3.3 and the site meteorological considerations discussed in Sect. 2.4 of this statement and summarized in Table 5.1 were used to estimate radiation doses to individuals and populations.

Table 5.1. Summary of atmospheric dispersion factors and deposition values for selected locations near SONGS 2 & 3[a]

Location	Source[b]	X/Q (sec/m^3)	Relative deposition (m^{-2})
Nearest site land boundary (0.36 mile NNW)[c]			
	A	5.4 E–5	2.1 E–7
	B	2.4 E–5	9.3 E–8
Nearest residence and garden (1.3 mile NNW)[c]			
	A	4.8 E–6	2.0 E–8
	B	1.7 E–6	6.9 E–9

[a]The doses presented in the following tables are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

[b]Source A is gas decay tank, 48 purges per year, 12 hr per purge; source B is continuous release.

[c]"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

[d]Here E-x is used to indicate the factor 10^{-x}; i.e., 5.4 E–5 = 5.4×10^{-5}

(To change mi to km, multiply by 1.609.)

Dose commitments to individuals and the population can be estimated using different methodologies. The staff's assessment of dose is based on a 50-year commitment and is described in Regulatory Guide 1.109. The results of the calculations are discussed below.

Radiation dose commitments to individuals

The predicted dose commitments to the "maximum" individual from radioiodine and particulate releases are listed in Tables 5.2 and 5.3. The maximum individual has been estimated to receive the highest dose commitment from SONGS 2 & 3 and is assumed to consume well above average quantities of the foods considered (see Table A-2 in Regulatory Guide 1.109). The maximum annual air, total body, and skin doses from noble gas releases are presented in Tables 5.3 and 5.4.

Table 5.2. Maximum annual dose commitments to an individual near the SONGS 2 & 3 plant caused by particulate and liquid effluents

Location	Pathway	Dose (millirems per year per unit)		
		Total body	Thyroid	Other organs (if greater than 10% of dose)
	Iodine and particulate doses			
Nearest residence and garden (1.3 NNW)[a]	Ground deposit	0.66	0.66	NA
	Inhalation	0.07	0.48	
	Vegetation	0.40	2.5	
Totals		1.1	3.7	
	Liquid effluent doses			
Nearest fish	Fish ingestion	0.019	0.018	0.0016
	Invertebrate ingestion	0.0058	0.025	0.104
	Shoreline use	0.039	0.039	0.039
Totals		0.064	0.082	0.15

[a]"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

(To change mi to km, multiply by 1.609.)

Table 5.3. Maximum calculated dose commitments to an individual and the population from SONGS 2 & 3[a]

	Appendix I Design objectives	Calculated doses
	(Annual dose per reactor unit)	
Maximum individual doses		
Liquid effluents		
Dose to total body from all pathways, millirems	3	0.064
Dose to any organ from all pathways, millirems	10	0.15
Noble gas effluents (at site boundary)		
Gamma dose in air, millirads	10	4.6
Beta dose in air, millirads	20	14
Dose to total body of an individual, millirems	5	2.8
Dose to skin of an individual, millirems	15	8.5
Radioiodines and particulates[b]		
Dose to any organ from all pathways, millirems	15	3.7

Population doses within 80 km (50 miles)

	Total body (man-rems)	Thyroid (man-rems)
Natural radiation background[c]	700,000	
Liquid effluents	0.17	0.14
Gaseous effluents	21	46

[a]Appendix I design objectives from Sects. II.A, II.B, II.C, and II.D of Appendix I, 10 CFR 50; considers maximum doses to individuals and population per reactor unit. Source: *Federal Regist.* 40, 19442, May 5, 1975.

[b]Carbon-14 and tritium have been added to this category.

[c]"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1 (June 1972); using the average State of California background dose of 97 millirems per year and year 2000 projected population of 262 million.

Table 5.4. Annual total-body, skin, and air doses at the nearest site boundary of SONGS 2 & 3 caused by gaseous radioactive effluents[a]

Location	Dose (millirem per year per unit)			
	Total body	Skin	Gamma air dose	Beta air dose
Nearest site boundary (0.36 mile WNW)[a]	2.5	8.3	4.2	14

[a]"Nearest" refers to that site boundary location where the highest radiation doses caused by gaseous effluents have been estimated to occur.

(To convert mi to km, multiply by 1.6.)

Radiation dose commitments to populations

The calculated annual radiation dose commitments to the population within 80 km (50 mi) of SONGS 2 and 3 from gaseous and particulate releases are presented in Table 5.3. Estimated dose commitments to the U.S. population are presented in Table 5.5. Background radiation doses are provided for comparison.

Within 80 km of the plant site, specific meteorological, populational, and agricultural data for each of 16 compass sectors around the plant were used to evaluate the doses. Beyond 80 km, meteorological models were extrapolated by assuming uniform dispersion of noble gases and continued deposition of radioiodines and particulates until no suspended radionuclides remained. Doses were evaluated using average population densities and food production values discussed in Appendix B. The doses from atmospheric releases during normal operation represent an extremely small increase in the normal population dose from background radiation sources.

Table 5.5. Annual total-body population dose commitments in the year 2000

Category	U.S. population dose commitment for the site
Natural background radiation, man-rems per year[a]	27,000,000
SONGS 2 & 3 operation, man-rems per year per site	
Plant workers	2600
General public	
Gas and particulates	160
Liquid effluents	<1
Transportation of fuel and waste	14

[a]Using the average U.S. background dose of 102 man-rems per year and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541 (February 1975).

5.5.1.3 Dose commitments from radioactive liquid releases to the hydrosphere

Radioactive effluents released to the hydrosphere from SONGS 2 & 3 during normal operation will result in small radiation doses to individuals and populations. The staff estimates of the expected liquid releases listed in Table 3.2 and the site hydrological considerations discussed in Sect. 2.3 of this statement and summarized in Table 5.6 were used to estimate radiation dose commitments to individuals and populations. The results of the calculations are discussed below.

Table 5.6. Summary of hydrologic transport and dispersion for liquid releases from SONGS 2 & 3[a]

Location	Transit time (hr)	Dilution factor
Nearest sport fishing location (plant outfall)[b]	0.1	1
Nearest shoreline (plant boundary)	0.1	1

[a]See Regulatory Guide 1.112, "Analytical Models for Estimating Radioisotope Concentrations in Different Water Bodies," (1976).

[b]Assumed for purposes of an upper-limit estimate; detailed information not available.

Radiation dose commitments to individuals

The estimated dose commitments to individuals at selected offsite locations where exposures are expected to be largest are listed in Tables 5.2 and 5.3. The standard NRC models given in Regulatory Guide 1.109 were used for these analyses.

Radiation dose commitments to populations

The estimated population radiation dose commitments to 80 km for SONGS 2 & 3 from liquid releases, based on the use of water and biota from the Pacific Ocean, are shown in Table 5.3. Dose commitments beyond 80 km were based on the assumptions discussed in Appendix B.

Background radiation doses are provided for comparison. The dose commitments from liquid releases from SONGS 2 & 3 represent small increases in the population dose from background radiation sources.

5.5.1.4 Direct radiation

Radiation from the facility

Radiation fields are produced in nuclear plant environs as a result of radioactivity contained within the reactor and its associated components. Doses from sources within the plant are primarily due to nitrogen-16, a radionuclide produced in the reactor core. Since the primary coolant of pressurized water reactors is contained in a heavily shielded area of the plant, dose rates in the vicinity of PWRs are generally undetectable (less than 5 millirems per year). Low-level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 millirem per year at the site boundary.

Occupational radiation exposure

The dose to nuclear plant workers varies from reactor to reactor and can be projected for environmental impact purposes by using the experience to date with modern pressurized water reactors (PWRs). Most of the dose to nuclear plant workers is due to external exposure to radiation from radioactive materials outside of the body rather than from internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000 MWe PWRs are designed and operated in a manner consistent with the new (post-1975) regulatory requirements and guidelines. These new requirements and guidelines place increased emphasis on maintaining occupational exposure at nuclear power plants as low as is reasonably achievable (ALARA), and are outlined in 10 CFR Part 20, Standard Review Plan Chapter 12, and Regulatory Guide 8.8. The applicant's proposed implementation of these requirements and guidelines are reviewed by the NRC staff at the construction permit licensing stage, the operating license licensing stage, and during actual operation. Approval of the proposed implementation of these requirements and guidelines is granted only after the review indicates that an ALARA program can actually be implemented. As a result of our review the staff has determined that the applicant is committed to design features and operating practices that will assure that individual occupational radiation doses can be maintained within the limits of 10 CFR Part 20 and that individual and population doses will be as low as is reasonably achievable.

On the basis of actual operating experience, it has been observed that this occupational dose has varied considerably from plant to plant, and from year to year. Average individual and collective dose information is available from over 190 reactor-years of operation between 1974 and 1979. These data indicate that the average reactor annual dose at PWRs has been about 410 man-rem, with particular plants experiencing an average annual dose as high as 1300 man-rem. These dose averages are based on widely varying yearly doses at PWRs. For example, annual collective doses for PWRs have ranged from 18 to 5262 man-rem per reactor. The average annual dose per nuclear plant worker has been about 0.8 rem.

The wide range of annual doses (18 to 5262 man-rems) experienced by U.S. PWRs is dependent on a number of factors, such as the amount of required routine and special maintenance, and the degree of reactor operations and inplant surveillance. Since these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. It is necessary to recognize that high doses may occur, even at plants with radiation protection programs that have been developed to assure that occupational radiation doses will be kept at levels that are ALARA. Consequently, the NRC staff's occupational dose estimates for environmental impact purposes for SONGS 2 and 3 are based on the conservation assumption that the station may have an higher than average level of special maintenance work. On the basis of the staff's review of the applicant's Safety Analysis Report, as well as occupational dose data from over 190 PWR reactor operating years, the NRC staff projects that the occupational doses at SONGS 2 and 3 could average as much as 1300 man-rem/yr when averaged over the life of the plant. However, actual year to year doses may differ greatly from this average, depending on actual plant operating conditions.

Transportation of radioactive material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants" [10 CFR 51.20(g)]. The estimated population dose commitments associated with transportation of fuels and wastes are listed in Tables 5.5 and 5.7.

5.5.1.5 Comparison of dose assessment models

The applicant's site and environmental data provided in the ER and in subsequent answers to staff questions were used extensively in the dose calculations. Any additional data received which could significantly affect the conclusions reached in this draft statement will be used in preparing the final statement.

Table 5.7. Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor[a,b]

Exposed population	Estimated *number of* persons	Range of doses to exposed *individuals* (millirems per reactor year)[c]	Cumulative dose to exposed population (man-rems per reactor year)[d]
Transportation workers	200	0.01 to 300	4
General public			
Onlookers	1,100	0.003 to 1.3	
Along Route	600,000	0.001 to 0.06	3
Accidents in transport			
Radiological effects		Small[e]	
Common (nonradiological) causes		1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year	

[a]*Data supporting this table are given in the Commission's Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,* WASH-1238, December 1972, and Suppl. I, NUREG-75/038, April 1975.

[b]Normal conditions of transport: heat (per irradiated fuel cask in transit), 250,000 Btu/hr; weight (governed by Federal or State restrictions), 73,000 lb per truck; 100 tons per cask per rail car; traffic density, <1 per day; rail <3 per month.

[c]The Federal Radiation Council has recommended that radiation doses from all sources of radiation other than natural background and medical exposures should be limited to *5000 milirems per year for individuals as a result of occupational exposure and should be* limited to 500 millirems per year for individuals in the general population. The dose to individuals as a result of average natural background radiation is about 102 millirems per year.

[d]Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirems) each, the total man-rem in each case would be 1 man-rem.

[e]Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

(To convert lb to kg, multiply by 0.45; to convert tons to tonnes, multiply by 0.907.)

5.5.1.6 Evaluation of radiological impact

The actual radiological impact associated with the operation of SONGS 2 & 3 will depend, in part, on the manner in which the radioactive waste treatment system is operated. The staff concludes on the basis of their evaluation of the potential performance of the radwaste system that the system as proposed is capable of meeting the dose design objectives of 10 CFR Part 50, Appendix I. Table 5.3 compares the calculated maximum individual doses to the dose design objectives. However, because the facility's operation will be governed by operating license technical specifications and because the technical specifications will be based on the dose design objectives of 10 CFR Part 50, Appendix I, as shown in the first column of Table 5.3, the actual radiological impact of plant operation may result in doses close to the dose design objectives. Even if this situation exists, however, the individual doses will still be very small when compared to natural background doses (∿100 millirems per year) or of the dose limits specified in 10 CFR Part 20. As a result the staff concludes that there will be no measurable radiological impact on man from routine operation of SONGS 2 & 3.

5.5.2 Radiological impacts to biota other than man

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than man receives. Although guidelines have not been established for acceptable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. Although the existence of extremely sensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding SONGS 2 & 3. Furthermore, in all the plants for which an analysis of radiation exposure to biota other than man has been made, there have been no cases of exposures that can be considered significant in terms of harm to the species, or that approach the exposure limits to members of the public permitted by 10 CFR Part 20.[19] Since the BEIR Report[20] concluded that the evidence to date indicates that no other living organisms are very much more radiosensitive than man, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this plant.

5.5.3 Environmental effects of the uranium fuel cycle

On March 14, 1977, the Commission presented in the *Federal Register* (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It was effective (by Amendment of September 12, 1978) through March 14, 1979 and revised Table S-3 of Paragraph (e) of 10 CFR Part 51.20.* In a subsequent announcement on April 14, 1978, (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to clarify that the table does not cover health effects. On July 27, 1979, the Commission approved a final rule setting out revised environmental impact values for the uranium fuel cycle to be included in environmental reports and environmental statements for reactors (44 FR 45362). The final rule reflects new and updated information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*,[21] and NUREG-0216,[22] which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low-and high-level wastes. These are described in the AEC report WASH-1248, *Environmental Survey of the Uranium Fuel Cycle*.[23]

Specific categories of natural resource use are included in Table S-3 of the final rule, which is reproduced in this statement as Table 5.8.† These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table 5.8 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of SONGS 2 & 3 is based on the values given in Table 5.8 and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000 MWe LWR operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff conclusions would not be altered if the analysis were to be based on the net electrical power output of SONGS 2 & 3.

The total annual land requirement for the fuel cycle supporting a model 1000 MWe LWR is about 46 ha (114 acres). Approximately 5 ha (13 acres) per year are permanently committed land, and 40 ha (100 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, e.g., mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 40 ha per year of temporarily committed land, 32 ha (79 acres) are undisturbed and 9 ha (22 acres) are disturbed. Considering common classes of land use in the U.S.,‡ fuel-cycle land-use requirements to support the model 1000 MWe LWR do not represent a significant impact.

The principal water-use requirement for the fuel cycle supporting a model 1000 MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3 ($11{,}000 \times 10^6$ gal), about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 0.6×10^6 m^3 per year and water discharged to ground (e.g., mine drainage) of about 0.5×10^6 m^3 per year.

---

*A notice of final rulemaking proceedings was given in the *Federal Register* of May 26, 1977 (42 FR 26987) that calls for additional public comment before adoption or final modification of the interim rule.

†A narrative explanation of Table 5.8 (Table S-3) was published in the *Federal Register* (46 FR 15154-75) on March 4, 1981.

‡A coal-fired power plant of 1000 MWe capacity using strip-mined coal requires the disturbance of about 81 ha (200 acres) per year for fuel alone.

Table 5.8. Summary of environmental considerations for uranium fuel cycle[a]

Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)

Natural resource use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1000-MWe LWR
Land, acres		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to 110-MWe coal-fired power plant
Permanently committed	7.1	
Overburden moved, millions of metric tons	2.8	Equivalent to 95-MWe coal-fired power plant
Water, millions of gallons		
Discharged to air	160	Equals 2% of model 1000-MWe LWR with cooling tower
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4% of model 1000-MWe LWR with once-through cooling
Fossil fuel		
Electrical energy, thousands of megawatt hours	321	Less than 5% of model 1000-MWe LWR output
Equivalent coal, thousands of metric tons	117	Equivalent to the consumption of a 45-MWe coal-fired power plant
Natural gas, millions of standard cubic feet	135	Less than 0.3% of model 1000-MWe energy output
Effluents – chemical, metric tons		
Gases (including entrainment)[c]		
SO_x	4,400	
NO_x[d]	1,190	Equivalent to emissions from 45-MWe coal-fired power plant for a year
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards – below level that has effects on human health
HCl	0.014	
Liquids		
SO_4^{2-}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^-	25.8	NH_3 – 600 cfs
Fluoride	12.9	NO_3 – 20 cfs
Ca^{2+}	5.4	Fluoride – 70 cfs
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions, thousands of metric tons	240	From mills only – no significant effluents to environment
Solids	91,000	Principally from mills – no significant effluents to environment
Effluents – radiological, curies		
Gases (including entrainment)		
Rn-222		Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium, thousands	18.1	
C-14	24	
Kr-85, thousands	400	
Ru-106	0.14	Principally from fuel reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99	0.203	Presently under consideration by the Commission
Fission products and transuranics		
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment
Ra-226	0.0034	From UF_6 production
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10% of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR
Fission and activation products	5.9×10^{-6}	
Solids (buried on site)		
Other than high level (shallow)	11,300	9100 Ci come from low-level reactor wastes and 1500 Ci come from reactor decontamination and decommissioning – buried at land burial facilities. Mills produce 600 Ci – included in tailings returned to ground; about 60 Ci come from conversion and spent-fuel storage. No significant effluent to the environment
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents – thermal, billions of British thermal units	4,063	Less than 4% of model 1000-MWe LWR
Transportation, person-rems	2.5	
Exposure of workers and general public		
Occupational exposure, person-rems	22.6	From reprocessing and waste management

[a]In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, this table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at al in this table. Table S-3 of WASH-1248 does not include health effects from the effluents described in this table or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by this table may be the subject of litigation in individual licensing proceedings. Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle*, WASH-1248, April 1974; the *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0116 (Suppl. 1 to WASH-1248); and the *Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0216 (Suppl. 2 to WASH-1248). The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no-recyle). The contribution from transportation excludes transportation of coal fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of Sect. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A – E of Table S-3A of WASH-1248.

[b]The contributions to temporarily committed land from reprocessing are not prorated over 30 years, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

[c]Estimated effluents based on combustion of equivalent coal for power generation.

[d]1.2% from natural gas use and process.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000 MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3 per year is about 2% of that of the model 1000 MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of that of the model 1000 MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000 MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from a 1000 MWe plant. The staff finds that the direct and indirect consumption of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

The quantities of chemical, gaseous, and particulate effluents with fuel-cycle processes are given in Table 5.8. The principal species are SO_x, NO_x, and particulates. The staff finds, on the basis of data in a Council on Environmental Quality report,[24] that these emissions constitute an extremely small additional atmospheric loading in comparison with these emissions from the stationary fuel-combustion and transportation sectors in the U.S., i.e., about 0.02% of the annual national releases for each of these species. The staff believes such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in such dilute concentrations that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 5.8 specifies the flow of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in an NPDES permit issued by an appropriate state or Federal regulatory agency.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

Radioactive effluents estimated to be released to the environment from reprocessing and waste management activities and certain other phases of the fuel-cycle process are set forth in Table 5.8. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population. These calculations estimate that the overall involuntary total body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be approximately 400 man-rems per year of operation of the model 1000 MWe LWR. The additional involuntary total body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation, estimated on the basis of the values given in Table 5.8, would be approximately 100 man-rems per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 500 man-rems (whole body) per year of operation of the model 1000 MWe LWR.

At this time Table 5.8 does not address the radiological impacts associated with radon-222 releases. Principal radon releases occur during mining and milling operations and, following completion of mining and milling, as emissions from stabilized mill tailings and from unreclaimed open-pit mines. The staff has determined that releases from these operations for each year of operation of the model 1000 MWe LWR are as follows:

*The environmental dose commitment (EDC) is the integrated population dose for 100 years; i.e., it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

Mining: (during active mining)[25]	4060 Ci
Mining: (unreclaimed open-pit mines)[26]	30 to 40 Ci/year
Milling and Tailings:[27] (during active milling)	780 Ci
Inactive Tailings:[27] (prior to stabilization)	350 Ci
Stabilized Tailings:[27] (several hundred years)	1 to 10 Ci/year
Stabilized Tailings:[27] (after several hundred years)	110 Ci/year

The staff has calculated population dose commitments for these sources of radon-222 using the RABGAD computer code described in Section IV.J of Appendix A of NUREG-0002.[28] The results of these calculations for mining and milling activities prior to tailings stabilization are shown in Table 5.9.

Table 5.9. *Estimated 100-year environmental dose commitment per year of operation of the model 1000 MWe LWR*

Radon-222 releases		Dose commitments (man-rems)		
Source	Amount (Ci)	Total body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total		140	3600	2900

When added to the 500 man-rem total body dose commitment for the balance of the fuel cycle, the overall estimated total body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000 MWe LWR is approximately 600 man-rems. Over this period of time, this dose is equivalent to 0.00002% of the natural background dose of about 3,000,000,000 man-rems to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling, and active tailings and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. After completion of active mining, the staff has assumed that underground mines will be sealed, with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci/year of operation of the model 1000 MWe LWR. However, since the distribution of uranium ore reserves available by conventional mining methods is 66.8% underground and 33.2% open pit,[29] the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.332 x 110 or 37 Ci/year of operation of the model LWR.

On the basis of these assumptions, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods can be calculated to be about 3700 Ci and 37000 Ci/year of operation of the model reactor, respectively. The total dose commitments for a 100-1000-year period would be as follows:

*Based on an annual average natural background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

Time span	Total release	Population dose commitments (man-rems)		
		Total body	Bone	Lung (brochial epithelium)
100 years	3,700	96	2,500	2,000
500 years	19,000	480	13,000	11,000
1,000 years	37,000	960	25,000	20,000

The above dose commitments represent a worst-case situation since no mitigation circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for uranium open-pit mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles, the staff has assumed that these tailings would emit, per year of operation of the model 1000 MWe LWR, 1 Ci/year for 100 years, 10 Ci/year for the next 400 years, and 100 Ci/year for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized tailings piles per operating year of the model reactor will be 100 Ci in 100 years, 4,090 Ci in 500 years, and 53,800 Ci in 1000 years[30]. The total body, bone, and bronchial epithelium dose commitments for these periods are as follows:

Time span	Total release	Population dose commitments (man-rems)		
		Total body	Bone	Lung (brochial epithelium)
100 years	100	2.6	68	56
500 years	4,090	110	2,800	2,300
1,000 years	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9, and 22.2 cancer deaths per million man-rems for total body, bone, and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling, and active tailings emissions of radon-222 would be about 0.11 cancer fatalities per operating year of the model 1000 MWe LWR. When the risk due to radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities is estimated over a 1000-year release period per operating year of the model 1000 MWe LWR. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon induced cancer fatalities per operating year of the model 1000 MWe LWR would range as follows:

0.11-0.19 fatalities for a 100-year period

0.19-0.57 fatalities for a 500-year period

1.2-2.0 fatalities for a 1000-year period

To illustrate: A single model 1000 MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection[31], the average radon 222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung dose commitment of 135 million man-rems per year. Using the same risk estimator of 22.2 lung cancer fatalities per million man-lung-rems used to predict cancer fatalities for the model 1000 MWe LWR, estimated lung cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year or 300,000 to 3,000,000 lung cancer deaths over periods of 100 and 1,000 years respectively.

Other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures in addition to the radon-related potential health effects from the fuel cycle. It is estimated that 0.08 to 0.12 additional cancer deaths may occur per operating year of the model 1000 MWe LWR (assuming that no cure or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

These latter exposures can also be compared with those from naturally-occurring terrestrial and cosmic-ray sources, which average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million man-rems per year, or 3 billion man-rems and 30 billion man-rems for periods of 100 and 1000 years respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis, the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources.

5.6 SOCIOECONOMIC IMPACTS

5.6.1 Introduction

A 96-km (60-mile) radius of the San Onofre site circumscribes most of the metropolitan areas of Los Angeles and San Diego, the third and fourteenth largest cities, respectively, in the United States. Between 1970 and 1980, San Diego County had a 37.1% increase in population, reaching a total of 1,861,846 in 1980 and a density of about $170/km^2$ ($438/m^2$).

Continued growth within 96 km (60 miles) of the San Onofre site is expected for the next three decades. The central portion of Orange County and the city of San Diego and its immediate environs are projected to be the major growth areas (ER, Sect. 2.1.3.2.2). The population growth rates within 16 km (10 miles) of the site are expected to fluctuate over the operating life of SONGS 2 and 3. The annual growth rate between 1976 and 1980 is expected to be 4.2%, decreasing to 0.3% between 1990 and 2000, and rising to 1.1% between 2010 and 2020 (ER, Sect. 2.1.3.1.1).

5.6.2 Impact of the construction labor force

A peak labor force of about 3000 workers was employed at SONGS 2 and 3 in late 1979. Of this number, the applicant has estimated that about 600 workers (20% of the peak labor force) have relocated to the southern California area (Sect. 2.2.3). Although the staff could not determine the exact location of these workers, current growth projections for the area indicate that the addition of 600 workers represents an insignificant impact. Between 1976 and 1980 the population in the area that is 16 to 80 km (10 to 50 miles) from the site was projected to increase 2.2% (ER, Sect. 2.1.3.2.1). The addition of 600 workers accounts for less than 0.1% of the growth expected during that time period.

Staff interviews with local and regional officials indicated that construction of SONGS 2 and 3 has had no impact on cities within 24 km (15 mi) of the site. Representatives of Southern California Association of Governments stated that it was doubtful that any significant impact attributable to plant construction could be identified in Orange County. The facts that (1) the majority of the work force commuted to site, (2) there was widespread busing to and from Orange County, Oceanside, Vista, Escondido, and San Diego, and (3) the region is currently experiencing rapid population growth support the staff's judgment that no significant social impact has occurred or is likely to occur due to in-migration of construction workers.

Cessation of large construction projects can result in varying degrees of economic dislocation to an area, especially if a previously underdeveloped commercial and service structure is expanded to meet the requirements of a large, short-term population influx. The southern California area has a well-developed infrastructure; thus, ending the construction phase of SONGS 2 and 3 is not expected to produce significant economic dislocation.

5.6.3 Impact of the operating labor force

The operation of SONGS 2 and 3 will employ about 200 workers. Table 5.10 provides an estimate for typical operating personnel requirements and types of employment positions at a two-unit pressurized-water reactor (PWR). The operations positions will be filled first by current members of I.B.E.W. Local No. 246. Positions unfilled will be offered to all Southern California Edison (SCE) employees, and if the position remains unfilled, SCE will advertise in local and regional newspapers (ER, p. S.2-175). Because of the diversified labor markets of Los Angeles and San Diego, the staff believes that at least 75% of these workers can be hired from within a 96-km (60-mile) radius of the site.

The applicant conducted surveys in March 1976 to determine the residential location of SONGS 1 workers. Seventy-five percent of these workers lived within 40 km (25 miles) of the San Onofre site, and 65% resided in Orange County, 30% in San Diego County, and 5% in Los Angeles and Riverside counties (ER, Appendix 8A, p. 10). The surveys further indicated that the cities of Carlsbad, Oceanside, San Clemente, San Juan Capistrano, and Vista were the major

Table 5.10. Operating personnel for a two-unit PWR

1	Plant superintendent
1	Assistant plant superintendent
2	Safety engineers
	Quality assurance staff
1	Superintendent
4	Engineers
6	Engineering aides
	Administrative services
1	Superintendent
1	Assistant superintendent
3	Payroll clerks
9	Stenographers and file clerks
7	Janitors
1	Industrial engineer
1	Nurse
	Health physics staff
1	Superintendent
2	Technicians
1	Clerk
	Security staff
1	Superintendent
1	Assistant superintendent
9	Security officers
	Operations
	Control room staff
1	Superintendent
1	Assistant superintendent
1	Training coordinator
5	Clerks
6	Shift engineers
10	Assistant shift engineers
15	Unit operators
18	Assistant unit operators
	Communications engineering staff
2	Engineers
3	Engineering aides
	Warehouse staff
1	Superintendent
1	Assistant superintendent
5	Clerks
1	Truck driver
	Engineering section
1	Superintendent
3	Instrument engineers
3	Instrument engineering aides
2	Senior instrument mechanic foremen
20	Mechanics
2	Mechanical engineers
3	Mechanical engineering aides
1	Reactor engineer
1	Reactor engineering aide
2	Nuclear engineers
1	Chemical engineer
9	Chemical engineering aides
	Maintenance staff
1	Superintendent
1	Assistant superintendent (electrical)
1	Assistant superintendent (mechanical)
2	Mechanical maintenance engineers
1	Electrical maintenance engineer
3	Engineering aides
	Trades and labor staff
1	Machinist foreman
11	Machinists
1	Boiler-maker foreman
5	Boiler makers
1	Steam-fitter foreman
12	Steam fitters
1	Electrician foreman
10	Electricians
1	Labor foreman
10	Laborers
2	Truck drivers
2	Carpenters
2	Sheet metal workers
2	Painters
2	Insulators
1	Structural iron worker

Source: Tennessee Valley Authority, Department of Planning, Chattanooga, Tenn., 1977.

communities of worker residence. The staff estimates that approximately the same pattern of location will occur with SONGS 2 and 3 workers as occurred with SONGS 1 workers.

Between 1973 and 1980, northern San Diego County was expected to have a population increase of about 22,000. From 1975 to 1980 southern Orange County was projected to grow by about 21,000 persons. Assuming that all operations workers relocated to the area, the staff concludes that the addition of 200 workers and their households represents a negligible effect.

The staff cannot determine precisely the number of workers who will (1) relocate from outside the area or (2) choose to move from within the 96-km (60-mile) radius to a residence closer to the plant. In order to predict the maximum possible impact on housing in the area, the staff assumes that all of the workers will relocate and thus require housing. A relocating operations force will likely demand permanent housing. From Table 5.11, it appears that housing availability in Orange and San Diego counties is sufficient to provide diversity in location for all operations workers' households. The table further indicates that, based on the number of vacant units in 1976, a surplus of housing exists in each of the communities expected to house workers.

Estimates on the location of SONGS 1 worker indicate SONGS 2 and 3 households will likely contribute to increased enrollments in the school districts of Carlsbad, Capistrano, Oceanside, Saddleback Valley, and Vista. The total additional enrollment at all five school districts

Table 5.11. Housing availability in Orange and San Diego counties

Communities	Residential distribution of households SONGS 2 & 3	Number of existing dwelling units as of Jan. 1, 1976	Number of vacant units as indicated by number of idle electric meters for Jan. 1, 1976
Orange County *total*	127	592,932	10,080
San Clemente	32	10,636	170
San Juan Capistrano	41	4,561	73
Saddleback (Irvine)	22	11,102	178
Other unincorporated areas	32	76,260	1,220
San Diego County total	61	547,708	8,763
Carlsbad	11	9,111	200
Oceanside	25	20,835	458
Vista	20	12,539	276
Other unincorporated areas	5	108,841	2,395

Source: ER, Suppl. 2, Table 89-A, p. S.2-178.

will be about 105 students (ER, Appendix A, p. 20). The community college districts of Oceanside-Carlsbad, Palomar, and Saddleback will likely increase their enrollments by approximately 20 to 25 students (ER, Appendix 8A, p. 20). The staff concludes that this estimated increased enrollment represents a negligible impact on the school districts.

Operations employment at SONGS 2 and 3 will be relatively high-paying, stable work. About 87% of the total work force will have gross incomes in excess of $15,000 per year (ER, Appendix 8A, p. 15). The annual average income in 1976 dollars for a SONGS 2 and 3 household will be about $20,800. This compares to a median family income in 1980 for San Diego and Orange counties of $21,500 and $26,200 respectively. SONGS 2 and 3 households are expected to contribute to the economic activity of the area. Total taxable retail expenditures by households of operations employees are estimated to be about $855,000 per year (ER, p. S.2-176). In addition, those workers who build homes will contribute further to the economic activity of the area.

5.6.4 Economic impacts

The staff believes that the major economic impact associated with the operation of SONGS 2 and 3 will be a result of tax revenues generated by the plant. These taxes include property tax, state income tax, utility users tax, franchise tax payments, and sales and use taxes. The analysis presented here differs from that presented earlier in the DES by taking into account the impacts of the Jarvis-Gann Amendment (Proposition 13). The following discussion is based on two important assumptions. (1) The method of determining the value of state-regulated utility systems, currently before the State Court of Appeals, will be decided in accordance with the decision of the State Board of Equalization. Accordingly, SONGS 2 and 3 will be assessed on current market value, based on historical methods of valuation rather than on the 1975-76 base year as prescribed in Proposition 13. (2) The allocation of tax revenues among the various funds and districts within the county will remain roughly the same as at present.[32] Changes in either of the above conditions in the future may result in significant variation from the situation described here.

Under Proposition 13, neither the assessed value of the SONGS 2 and 3 units nor their annual tax liability differs greatly from the figures presented in the DES. Earlier projections were for an assessed valuation of $348 million in 1976 dollars (ER, Appendix 8-A, p. 4) and an annual property tax payment of $13.1 million (DES, Sect. 5.6.4). Current calculations show an eventual assessed value of $326 million in 1979 dollars and an annual tax of approximately $13 million (Table 5.12). At present, current construction at SONGS 2 and 3 is already assessed at roughly $100 million and is generating $4 million yearly in property tax revenues. The remaining $9 million in property taxes will be added as construction is completed.[32]

While the total tax burden is not significantly different under the terms of Proposition 13, the distribution of the resulting revenues is. Previously, it was projected that nearly all of the $13 million in property taxes generated by SONGS 2 and 3 would go to the County General Fund, the County Library Fund, and three local school districts in the immediate vicinity of the plant - Fallbrook Union Elementary, Fallbrook Union High, and Palomar Community College (DES,

Table 5.12. Projected impacts of SONGS 2 & 3 on San Diego County property tax revenues

	San Diego County	SONGS 2 & 3	Total: County plus SONGS 2 & 3	SONGS 2 & 3 as % of total
Assessed value	\$7,775.5 million[1]	\$326 million[3]	\$8,101.5 million	4.0%
Annual taxes	\$311 million[2]	\$13 million[3]	\$324 million	4.0%

[1]For FY 1978–79, not counting \$100 million of SONGS 2 & 3 construction currently on tax rolls.
[2]For FY 1978–79, not counting \$4 million currently received for SONGS 2 & 3 construction.
[3]As of project completion, in 1979 dollars.
Source: Letter from J. H. Drake, Southern California Edison Co., to W. H. Regan, Jr., U.S. NRC, dated April 17, 1979.

Sect. 5.6.4). Now, however, the new revenues will be distributed throughout the county on the basis of the historical property tax revenue relationships between all the various funds and districts. Accordingly, the five entities named above will receive roughly one-fourth of the plant-induced taxes, or \$3.4 million, because this is the proportion of all county funds they have traditionally received. The remaining \$9.6 million will go to other recipients county-wide. Because of this widespread distribution, the property taxes paid by SONGS 2 and 3 will not bring a large windfall to any single district but, rather, a modest 4.0% increase to all county funds and districts over pre-construction receipts (2.9% over the present situation where \$100 million of plant construction is already on the tax rolls). The debt service rate of the three previously named school districts will be reduced as a result of plant induced revenues but this represents a very small part of the total property tax.[32]

Sales and use taxes payable to the State of California are levied at 6% of the retail or use value of fixtures, equipment, machinery, and materials purchased either in or outside of the State of California and placed in use within the state. For every 6 cents collected, 1.25 cents is allocated to counties and cities. The state tax on nuclear fuel for SONGS 2 and 3 is expected to be about \$2.5 million per year. In addition, \$415,000 in sales tax for materials will be paid in 1981, the first year of operation (ER, Appendix 8A, p. 8).

Over the operating life of SONGS 2 & 3, about \$66 million in California state corporate income taxes will be paid by the applicant. California also has a City Utility Users Tax that, although it is difficult to determine the proportion for which SONGS 2 & 3 are directly responsible, is estimated to increase by \$1.6 million per year (ER, Appendix 8A, p. 8). This tax varies for each city, and the revenues are not earmarked for any particular purposes.

The California Energy Resources Surcharge is included in the retail customer's bill and is collected by the utility. The current surcharge is \$0.00015 per kilowatt-hour. The revenues collected are placed in the State Energy Resources Conservation and Development Special Account in the General Fund in the State Treasury by the State Board of Equalization. All funds in the account are to be expended for the purpose of carrying out the provisions of the Warren-Alquist State Energy Resources Conservation and Development Act.

5.6.5 Impact on recreational resources

In the early 1960s the applicant secured a leasehold from the U.S. Marine Corps at Camp Pendleton. During construction of SONGS 1, the Marine Corps released about 5.6 km (3.5 miles) of beach front to the State of California to be maintained as San Onofre State Beach. When this park opened in 1971, an additional 2440 m (8000 ft) of beach front had gained public access. Of this, 1370 m (4500 ft) are on the applicant's leasehold and the remaining 1070 m (3500 ft) are immediately north of the plant site, comprising another section of the state beach.

In order to comply with NRC regulations regarding the siting of nuclear power plants set forth in 10 CFR Part 100, the applicant proposes to control recreational activities on the beach for a distance of about 1.4 km (0.85 mile) adjacent to the station (ER, Sect. 2.1.2). Access to this area will be permitted for the purpose of viewing the barrancas and bluffs south of the station and for pedestrian passage between the public beach areas north and south of the station. Recreational activities, such as sunbathing or picnicking, will not be permitted within the landward portion of this restricted area. To facilitate passage between the beaches, a walkway will be constructed through the restricted area adjacent to the seawall. This walkway will be 4.6 m (15 ft) wide, will be bounded by a 2.4-m (8-ft) chain link fence, and will be used only for passage through the restricted area. It is the judgment of the staff that the fence proposed by the applicant is inappropriate in light of the scenic nature of the area and that a less aesthetically objectionable way should be sought to restrict access to the beach. Therefore, it is recommended that the applicant consider alternate methods of beach enclosure that will safely restrict access in a manner compatible with the scenic nature of this area.

In the Final Environmental Statement required for the construction permit of SONGS 2 and 3, the staff stated, "Use of the beach will not be restricted after construction is complete" (FES-CP, p. 2-11). The current plan to restrict use of approximately 1.4 km (0.85 mile) of the beach front for the 30-year operating life of the plant is a significant loss of valuable recreational and scenic space and represents a substantial change in action between issuance of the FES-CP and application for an operating license. The staff further stated, "The beach in the vicinity of the Station (5639 m (18,500 ft) south and 1036 m (3400 ft) north) is considered to be a unique and scarce recreational resource," (FES-CP, p. 2-11) and "Closure for even a brief period is objectionable" (FES-CP, p. 8-1). The loss of this resource precludes recreational benefits to significant numbers of beach users in the vicinity of San Onofre Beach. The staff reiterates those judgments and concludes that the current plan to restrict the public's use of this beach is a significant cost of the project, unanticipated at issuance of the construction permit. This impact is not sufficiently adverse, however, to warrant denying an operating license.

While all state beaches in the Pendleton coast area experienced increased usage in recent years, the attendance at San Onofre State Beach has risen significantly faster than at the other facilities. Between 1972 and 1978, the annual number of visits to the San Onofre State Beach rose by 98% while San Clemente and Doheny State Beaches showed increases of 46% and 25%, respectively (ER, Appendix 8A, Table 24, and Reference 32). As demand on available recreational resources increases, the significance of removing the beach in front of SONGS 2 & 3 from unrestricted public use will increase.

5.6.6 Emergency planning impacts

The applicants are currently revising the Emergency Plan, San Onofre Nuclear Generating Station Units 2 and 3 in accordance with 10 CFR Part 50, as amended July 23, 1980, as well as the recommended criteria contained in NUREG-0654. The staff believes the only noteworthy potential source of impact on the public from emergency planning would be associated with the siren alert system. The system will be designed to provide a minimum 10db dissonant differential from the ambient noise levels. The maximum sound level received by any member of the public should be lower than 123db. A complete cycle test will be required annually. The test requirements and alarm noise levels are consistant with those used for existing alert systems; therefore the staff concludes that the noise impacts associated with the siren alert system will be infrequent and insignificant.

5.6.7 Summary and conclusion

The staff concludes that, with the significant exception of restricting public use of 1.4 km (0.85 mi) of the San Onofre beach, the social and economic impact of operating SONGS 2 & 3 will be moderate. The large population within 96 km (60 miles) of the site and the projected population growth in the area is such that the addition of all 200 workers and their families would represent negligible impact to the area. Under the terms of Proposition 13, the property tax revenues received by the various funds and districts in San Diego County will be relatively small in proportion to existing revenues.

REFERENCES

Escept as specifically noted, documents cited can be obtained through the listed publisher or public technical libraries.

1. B. M. Kilgore, U.S. Department of the Interior, National Park Service, letter dated May 13, 1977, to Division of Site Safety and Environmental Analysis, Nuclear Regulatory Commission.*

2. R. C. Y. Koh, N. H. Brooks, E. J. List, and E. J. Wolanski, "Hydraulic Modeling of Thermal Outfall Diffusers for the San Onofre Nuclear Power Plant," W. M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Report KH-R-30, January 1974.*

3. "Energy Division Annual Progress Report," Report ORNL-5364, Oak Ridge National Laboratory, Oak Ridge, Tenn., April 1978.

4. Intersea Research Corporation, "Current Meter Observations and Statistics Off San Onofre Nuclear Generating Station, Jan. 5-Nov. 22, 1972," January 1973.*

5. C. D. Winant, R. E. Davis, and R. W. Severance, "A Study of Physical Parameters in Coastal Waters Off San Onofre, California, Final Report 1977," Scripps Institution of Oceanography, University of California, SIO Reference 77-11, June 31, 1977.

6. "Current Meter Observations and Statistics Off San Onofre Nuclear Generating Station, 5 January - 22 November 1972," Intersea Research Corporation, January 1973.*

7. R. C. Y. Koh, "Estimation of Drift Flow at San Onofre," memo to Southern California Edison Company, June 12, 1978.*

8. C. W. Almquist and K. D. Stolzenbach, "Staged Diffusers in Shallow Water," Report No. 213, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Cambridge, Mass., 1976 (also C. W. Almquist, personal communication, February 22, 1979).

9. G. F. Schiefelbein, "Alternative Electrical Transmission Systems and Their Environmental Impact," Report NUREG-0316, U.S. Nuclear Regulatory Commission, Washington, D.C., August 1977.**

10. Lockheed Center for Marine Research, "San Onofre Nuclear Generating Station Unit 1, Environmental Technical Specifications, Annual Operating Report, Vol. II, Biological Data - 1977," March 1978.*

11. R. F. Ford and others, "Effects of Thermal Effluents on Marine Organisms, Annual Report for Phase II," Southern California Edison Co., Research and Development Series No. 76-RD-90, 1976.*

12. E. Y. Dawson, Marine Botany, Holt, Rinehart and Winston, Inc., New York, 1966.

13. R. C. Phillips, "Kelp Beds," in Coastal Ecological Systems of the United States, Vol. II, H. T. Odum, B. J. Copeland, and E. A. McMahan, eds., The Conservation Foundation, Washington, D.C., 1974, pp. 442-87.

14. G. A. Jackson, "Nutrients and Production of Giant Kelp, Macrocystis pyrifera, off Southern California," Limnol. Oceanogr. 22: 979-995, 1977.

15. California Coastal Commission Marine Review Committee, "Annual Report to the California Coastal Commission, August 1976-August 1977, Summary of Estimated Effects on Marine Life of Unit 1 San Onofre Nuclear Generating Station," MRC Document 77-09 no. 1, September 1977.*

16. J. S. Mattice and H. E. Zittel, "Site-specific Evaluation of Power Plant Chlorination," J. Water Pollut. Control Fed. 48: 2284-2308, 1976.

17. U.S. Nuclear Regulatory Commission, "Calculations of Release of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," USNRC Report NUREG-0017, April 1976.**

18. U.S. Nuclear Regulatory Commission, "Occupational Radiation Exposure to Light Water Cooled Reactors 1969-1974," USNRC Report NUREG 75/032, June 1975.**

19. B. G. Blaylock and J. P. Witherspoon, "Radiation Doses and Effects Estimated for Aquatic Biota Exposed to Radioactive Releases from LWR Fuel-Cycle Facilities," Nucl. Safety 17: 351, 1976).

20. "The Effects on Population of Exposure to Low Levels of Ionizing Radiation (BEIR Report)," National Academy of Science/National Research Council, 1972.*

21. U.S. Nuclear Regulatory Commission, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," USNRC Report NUREG-0116 (Supplement 1 to WASH-1248), October 1976.**

22. U.S. Nuclear Regulatory Commission, "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," Report NUREG-0216 (Supplement 2 to WASH-1248), March 1977.**

23. U.S. Atomic Energy Commission, "Environmental Survey of the Uranium Fuel Cycle," Report WASH-1248, Washington, D.C., April 1974.***

24. Council on Environmental Quality, "Seventh Annual Report," September 1976, Figs. 11-27, 11-28, pp. 238-239.***

25. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of R. Wilde, filed April 17, 1978.*

26. U.S. Nuclear Regulatory Commission, In the Matter of Long Island Lighting Company (Jamesport Nuclear Power Station), Docket No. 50-516, Deposition of Leonard Hamilton, Reginald Gotchy, Ralph Wilde, and Arthur R. Tamplin, July 27, 1978, p. 9274.*

27. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of P. Magno, filed April 17, 1978.*

28. U.S. Nuclear Regulatory Commission, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors," USNRC Report NUREG-0002, Washington, D.C., August 1976.**

29. U.S. Department of Energy, "Statistical Data of the Uranium Industry," Report GJO-100(78), January 1, 1978.***

30. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of R. Gotchy, filed April 17, 1978.*

31. National Council on Radiation Protection and Measurements, Publication 45, 1975.

32. Letter from J. H. Drake, Southern California Edison Co., to W. H. Regan, Jr., U.S. NRC, dated April 17, 1979.*

* Available for inspection and copying for a fee in the NRC Public Document Room, 1717 H St., NW., Washington, DC 20555.
** Available from the NRC/GPO Sales Program, Washington, DC 20555, or the National Technical Information Service, Springfield, VA 22161.
***Available from NTIS only.

6. ENVIRONMENTAL MONITORING

6.1 SUMMARY

The applicant has expanded its San Onofre Unit 1 environmental monitoring program (biological, chemical, physical, and thermal) to determine environmental effects which may occur as a result of site preparation and construction of Units 2 and 3 and to establish an adequate preoperational baseline by which the operational effects of Units 2 and 3 may be judged.

The aquatic preoperational environmental monitoring program for SONGS 2 and 3 was approved by NRC and implemented by the applicant in April 1978. The NRC-approved program terminated in September 1980. However, all NPDES permit monitoring program requirements will continue to be met until an approved operational monitoring program is implemented. Results of the preoperational monitoring program will be used in formulating the operational monitoring program, which the applicant will submit for approval by the California Regional Water Quality Control Board to be incorporated in the NPDES permit monitoring program.

The environmental monitoring programs presented here differ somewhat from the description in the FES-CP. More detailed information is given here than in the FES-CP. Two state agencies, the California Regional Water Quality Control Board and the California Coastal Commission, have imposed environmental monitoring requirements in the vicinity of the San Onofre Station. NRC has discussed the results of its environmental review with the State agencies and has provided the State with recommendations for monitoring. The sections which follow include NRC staff recommendations based on its environmental review. However, requirements for non-radiological monitoring of the aquatic environment will be the responsibility of the State.

6.2 PREOPERATIONAL ENVIRONMENTAL PROGRAMS

The results from the preoperational monitoring program for Units 2 and 3 will be submitted with the Annual Operating Report for Unit 1.

6.2.1 Aquatic biological monitoring program

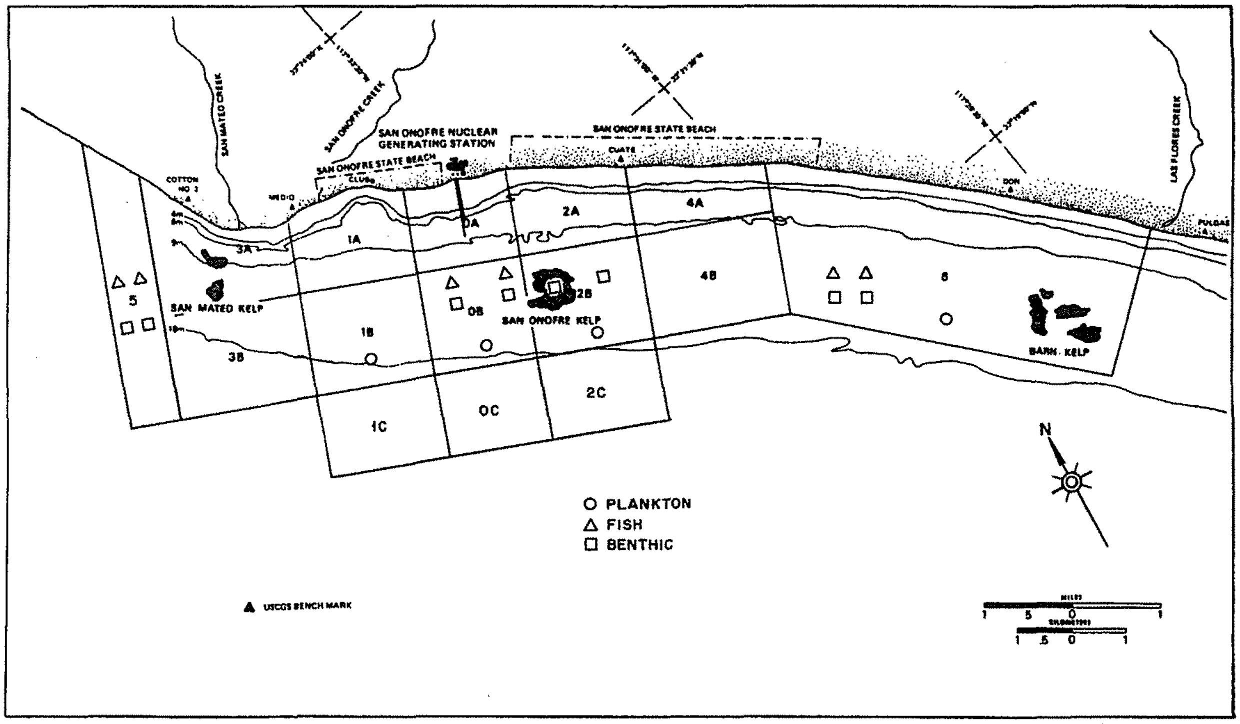
The applicant's preoperational aquatic biological monitoring program was designed to determine the species composition, abundance, and the temporal and spatial distribution of phytoplankton, zooplankton, ichthyoplankton, nekton, benthos, kelp beds, and intertidal organisms. The data obtained will be used to provide a basis for comparison with future operational monitoring data to determine if plant operation has caused observable perturbations in the ecosystem.

The possible operational impacts identified in this document and the FES-CP include: changes in local plankton populations due to entrainment; changes in the abundance of fish eggs, larvae, juveniles, and adults due to entrainment; adult fish population shifts due to fish impingement; alterations in some of the benthic and fish communities from thermal discharges; and changes in benthic and planktonic communities from increased turbidity. Thus, results from the preoperational and operational monitoring programs will be used to determine the extent to which the above effects occur.

6.2.1.1 Phytoplankton and zooplankton

Phytoplankton and zooplankton were sampled bimonthly. Samples were collected from at least four fixed stations, one each in zones 0B, 1B, 2B and 6 (Figure 6.1). A pump system is used to sample the water column and a 202 μm mesh-size screen is used to collect the zooplankton. Zooplankton biomass is determined and predominant species are enumerated. Chlorophyll analyses are performed on whole-water samples. Collections are coordinated, as much as possible, with the collection of pertinent physical data such as temperature, transparency, and current velocity and direction.

ES-4559



ES-4560

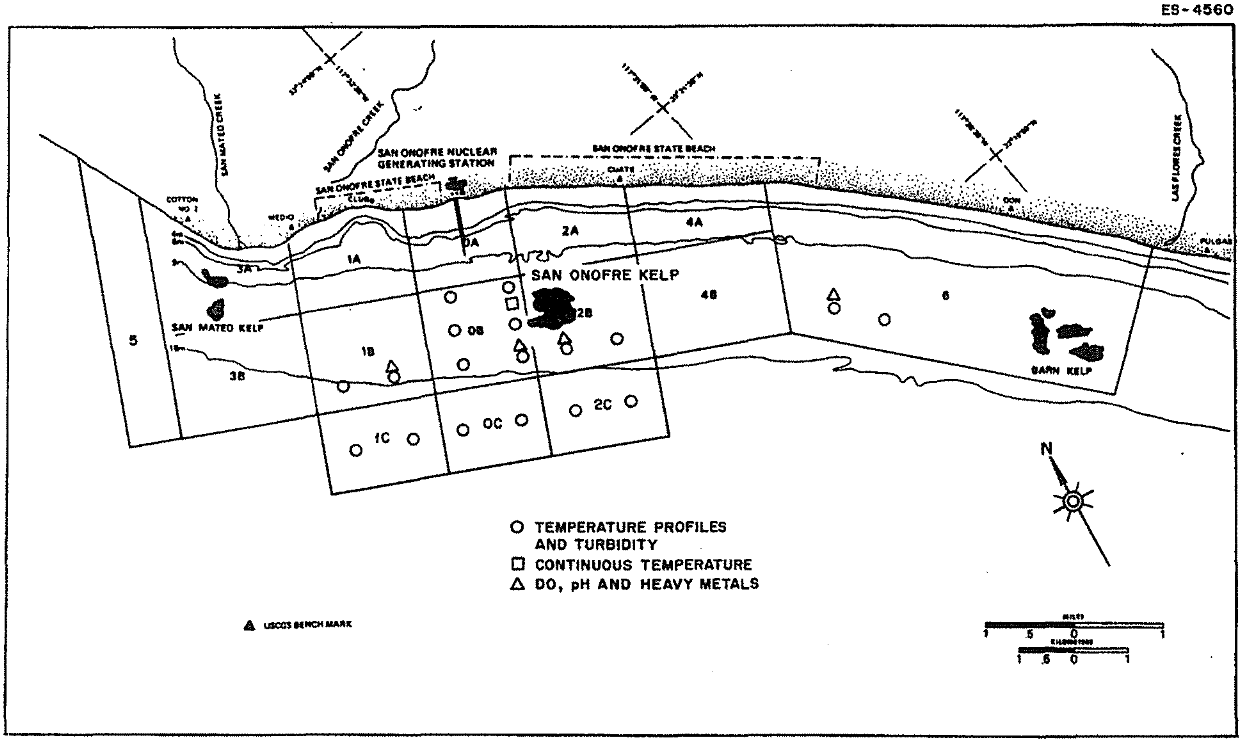


Fig. 6.1. Environmental monitoring stations for SONGS 2 and 3 preoperational monitoring program. Source: ER, Apendix 6A, Figs. 1 and 2.

The staff recommends that predominant phytoplankton genera also be enumerated to provide baseline conditions for this group. This would enable, for example, the determination of whether operation of the facility promotes red tide development (see Sect. 5.3.2, FES-CP).

6.2.1.2 Ichthyoplankton

Ichthyoplankton will be collected monthly at two stations in the Units 2 and 3 discharge area, zone OB, and at two stations in the reference area, either zone 5 or 6. Additionally, the Unit 1 intake area will be sampled. The study began approximately two years prior to initial operation of Unit 2 and lasted one year. Sampling was conducted during the day, at night, at dawn, and at dusk at the intake; night sampling was employed at the other locations. The water surface, water column, and epibenthos was sampled at each station. Fish larvae were identified to the lowest taxon possible and enumerated. Fish eggs were sorted and enumerated.

A study by the Marine Review Committee (MRC) was initiated in July 1976 (see Section 6.4.2) to assess the distribution, abundance, and entrainment of ichthyoplankton at SONGS 1. It is expected that data acquired from this work will also help characterize the SONGS 2 and 3 environment.

6.2.1.3 Nekton

Replicate fish samples were collected on a quarterly basis from at least two stations in zone OB, two in zone 5, two in the control zone, zone 6 (Figure 6.1). The gill nets used were 2- by 46-m (6- by 150-ft) full size, containing six 7.5-m (25-ft) panels of 19.05-, 25.4-, 31.75-, 38.1-, 44.5-, and 63.5-mm (3/4-, 1-, 1-1/4-, 1-1/2-, 1-3/4-, and 2-1/2-in.) bar mesh. The fish were measured, their state of health was assessed, and sexual maturation was determined on subsamples. Synoptic measurements of temperature and transmissivity were taken at each station.

6.2.1.4 Benthos

Benthic samples were collected quarterly at at least two stations within each of zones OB, 2B, 6 and 5 (or zones 3A and/or 3B) (Fig. 6.1). Permanent sampling stations exist in which a 6-m^2 (64.56-ft^2) sampling area has been established. Each sampling area contains 300 evenly spaced contact points which are used to estimate the distribution and relative abundance of sessile invertebrates, large motile invertebrates and macrophytes. Species enumeration and substrate type are recorded for each contact point. Additionally, four 0.125 m^2 (1.35-ft^2) quadrants are randomly placed within the sampling area to evaluate the distribution and abundance of small, clumped, or patchily distributed organisms. General observations to be recorded during sampling include: quantity and composition of drift algae, conspicuous or sparsely distributed biota not sampled with the point contact method, and substrate alteration (e.g., increased sedimentation). Selected species which are enumerated will be measured, and their general condition recorded. Procurement of some of the physical data, such as temperature and turbidity, will be coordinated with the benthic sampling program.

6.2.1.5 Intertidal organisms

Although not a required component of the preoperational monitoring program, quarterly observations were made along cobble intertidal transects at four monitoring stations and one control station. Predominant macroscopic species and substrate composition were identified and enumerated within three permanent 0.25-m^2 (2.69-ft^2) quadrats along a line perpendicular to the beach. Photographs were also taken of each quadrat for a permanent record of any possible ecological changes.

The staff believes that it is unnecessary to begin the intertidal sampling program until the time of removal of the construction apron from SONGS 2 and 3 (See FES-CP, Sect. 4.3.2, p. 4-9). At that time the intertidal monitoring program should be reinstated to assess the effect of the added sand movement in the intertidal zone. Provided the data show no significant effects, this program may be terminated after all translocation of sand has occurred or after two years. Until the time of apron removal, visual inspection of the intertidal zone will be sufficient, with biological sampling and laboratory analysis initiated only if needed. Deletion of the intertidal program may be reasonable during operational monitoring because of the extensive impact sustained by the intertidal area from activities unassociated with SONGS (Sect. 2.5.2.4) and because of the unlikely potential for any significant impact resulting from SONGS operation.