ATTACHMENT 3

NEAR-SHORE SALINE EFFECTS DUE TO REDUCED FLOW RATE SCENARIOS DURING STAND-ALONE OPERATIONS OF THE CARLSBAD DESALINATION PROJECT AT ENCINA GEENRATING STATION

Near-shore Hyper-Saline Effects due to Reduced Flow Rate Scenarios during Stand-Alone Operations of the Carlsbad Desalination Project at Encina Generating Station

Submitted by:
Scott A. Jenkins, Ph. D. and Joseph Wasyl
Dr. Scott A. Jenkins Consulting
14765 Kalapana Street, Poway, CA 92064

Submitted to:
Poseidon Resources
501 West Broadway
San Diego, CA 92101

12 January 2007

TABLE OF CONTENTS:

ABSTRACT:

This study evaluates the dispersion and dilution of concentrated sea water (brine) associated with reduced flow rate operations of a stand alone desalination plant co-located at Encina Generating Station. The analysis by hydrodynamic model simulation studied the effects of reduced intake flow rates ranging from 149.8 mgd to 304 mgd for both extreme minimums and means in ocean mixing. The results are summarized in Table 1 on page 67.

We find that intake flow rates of at least 218.9 mgd of unheated source water (producing end of pipe salinity of no more than 43.3 ppt) will satisfy both acute toxicity limits of 40 ppt and existing minimum dilution standards of 15 to 1 in the *zone of initial dilution* (ZID) for all ocean mixing conditions. Intake flow rates reduced to as little as 184.3 mgd (producing end of pipe salinity of no more than 46 ppt) will satisfy both acute toxicity limits existing minimum dilution standards for average ocean mixing conditions but not for extreme minimum mixing conditions having a recurrence probability of 0.013 %. Intake flow rates between 149.8 mgd and 172.8 mgd produce hyper salinity impacts that can probably be tolerated by indigenous marine organisms during mean-ocean mixing conditions, but result in unacceptably low minimum dilution levels in the ZID according to existing NPDES permit limits set for the power plant thermal effluent.

1) Introduction:

This study evaluates the dispersion and dilution of concentrated sea water (brine) associated with reduced flow rate operations of a stand alone desalination plant co-located at Encina Generating Station. The generating station presently consumes lagoon water at an average rate of about 530 mgd, and discharges that that flow volume into the ocean at a temperature elevated above ambient by $\Delta T = 5.5^{\circ}$C on average. Here we evaluate the production of 50 mgd of potable water by reverse osmosis (R.O.) using only 150-219 mgd of intake flow rate that remains unheated, $\Delta T = 0^{\circ}$ after blending with the brine by-product. The minimum flow rate evaluated in the certified project EIR involves intake flow rates of 304 mgd and was referred to as the "unheated historical extreme" because it combined a low flow rate condition with the historic minimum in ocean mixing to capture a worst case scenario assessment. We repeat that worst case assessment herein using even smaller intake flow rates that provide less initial dilution and higher end-of-pipe salinity. We also evaluate these low flow rate scenarios using average ocean mixing conditions to provide an indication of the more likely long term effects.

2) Initial Conditions:

The technical approach used to evaluate these new low flow rate scenarios involved the use of hydrodynamic transport models as detailed in Appendix E of the certified EIR (Jenkins and Wasyl, 2005). The initialization of those models is detailed below.

A) Flow Rates and Discharge Salinity: The power plant cooling water is drawn from the lagoon and is discharged into the ocean through an independent discharge channel located between Middle Beach and South Beach. The existing cascade of circulation and service water pumps available at Encina Generating

Station can provide a maximum once-through flow rate of 808 mgd, but has averaged about 530 over the long term (Jenkins and Wasyl, 2001). During peak user demand months for power (summer), plant flow rates are typically between 635 and 670 mgd (Elwany, et al, 2005). In the present analysis, we consider four new scenarios of reduced flow rate desalination operations producing the following discharge flow rates and end-of-pipe salinity:

Scenario 1 - Utilizing One Encina Intake Pump of Unit 5

Intake Flow Rate = 149.76 mgd of which
50 mgd – turns into potable water;
50 mgd is brine concentrate with salinity of 67 ppt
49.76 mgd – dilution water for the concentrate ($\Delta T = 0^{\circ}$)
Discharge Flow Rate = 99.76
End-of-pipe salinity = 50.3 ppt

Scenario 2 - Utilizing all pumps of Units 1 & 2 and one pump of Unit 3

Intake Flow Rate = 34.56 MGD x 5 pumps = 172.8 mgd of which
50 mgd – turns into potable water;
50 mgd is brine concentrate with salinity of 67 ppt
72.8 mgd – dilution water for the concentrate ($\Delta T = 0^{\circ}$)
Discharge Flow Rate = 122.8 mgd
End-of-pipe salinity = 47.1 ppt

Scenario 3 - Utilizing One Encina Intake Pump of Unit 5 + One Unit 1 Pump

Intake Flow Rate = 149.76 mgd + 34.56 = 184.32 of which
50 mgd – turns into potable water;
50 mgd is concentrate of salinity of 67,000 mg/L
84.32 mgd – dilution water for the concentrate ($\Delta T = 0^{\circ}$)
Discharge Flow Rate = 134.82 mgd
End-of-pipe salinity = 46 ppt

Scenario 4 - Utilizing One Encina Intake Pump of Unit 5 + Two Unit 1 Pumps

Intake Flow Rate = 149.76 mgd + 34.56 + 34.56 = 218.88 mgd of which
50 mgd – turns into potable water;
50 mgd is concentrate of salinity of 67,000 mg/L
118.88 mgd – dilution water for the concentrate ($\Delta T = 0^{o}$)
Discharge Flow Rate = 168.88 mgd
End-of-pipe salinity = 43.4 ppt

In addition to these four new low flow rate scenarios, we will also include the "Unheated Unit 4 Extreme Case" that was reported in Appendix E of the certified EIR (Jenkins and Wasyl, 2005). We will refer to this as the Scenario 5 low flow case that is characterized as follows:

Scenario 5 - Utilizing Two Encina Intake Pumps of Unit 4

Intake Flow Rate = 152.76 mgd x 2 = 304 mgd of which
50 mgd – turns into potable water;
50 mgd is concentrate of salinity of 67,000 mg/L
204 mgd – dilution water for the concentrate ($\Delta T = 0^{o}$)
Discharge Flow Rate = 254 mgd
End-of-pipe salinity = 40.11 ppt

B) Ocean Mixing Variables: Altogether there are six variables that enter into a solution for resolving the dispersion and dilution of the unheated concentrated seawater by-product discharged from the stand-alone desalination plant. These *mixing variables* may be organized into *boundary conditions* and *forcing functions*. The boundary conditions include: ocean salinity, ocean temperature and ocean water levels. The forcing function variables include waves, currents, and winds.

Overlapping 20.5 year long records of the boundary condition and forcing function variables are reconstructed in Sections 3.1 and 3.2 of Jenkins and Wasyl (2005) found in Appendix E of the certified EIR. These records contain 7,523 consecutive daily observations of each variable between 1980 and the middle of 2000. For clarity, these long term records are plotted here in Figures 1 and 2. We search this 20.5 year period for the historical combination of these variables that give an historic extreme day in the sense of benign ocean conditions that minimize mixing and dilution rates. We then overlay each of the four low flow rate scenarios on those extremely benign ocean conditions. The criteria for the historical extreme day was based on the simultaneous occurrence of the environmental variables having the highest combination of absolute salinity and temperature during the periods of minimal wave, wind, currents, and ocean water levels (including both tidal oscillations and climatic sea level anomalies). We repeat the analysis using average ocean mixing conditions. The average day scenarios were based on the 20.5 yr mean of the 6 ocean mixing variables.

C) Historical Extreme Case Assignments : The joint probability analysis produced a historical extreme day solution for 17 August 1992. This day is represented by the vertical dashed red line in Figures 1 and 2. The monthly period containing these extreme events are shown in Figures 3 and 4. The environmental factors of this day were associated with a building El Niño that subsequently climaxed in the winter of 1993. The ocean salinity was 33.51ppt, about the same as the long term mean, but the ocean temperature was 25.0 °C, within 0.1 °C of the 20.5 year maximum. The waves were only 0.16 m, which was the 20.5 year minimum. Winds were 3.4 knots and the maximum tidal current in the offshore domain was only 27.5 cm/sec (0.53 knots). The sluggish tidal current was due to

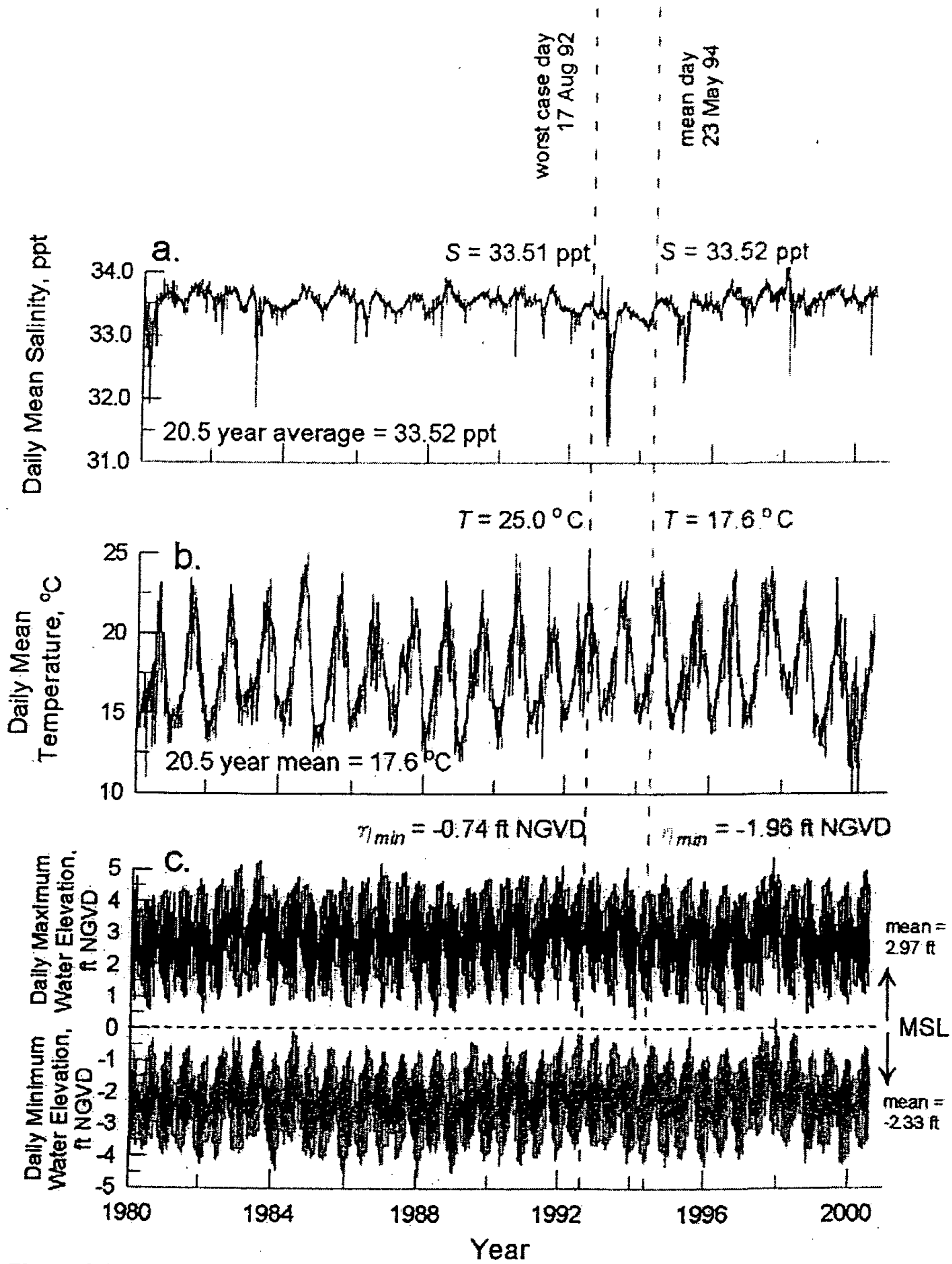

Figure 1. Period of record of boundary conditions, Encina Power Plant, 1980-2000.5: a) daily mea salinity, b) daily mean temperature, and c) daily high and low ocean water level elevati

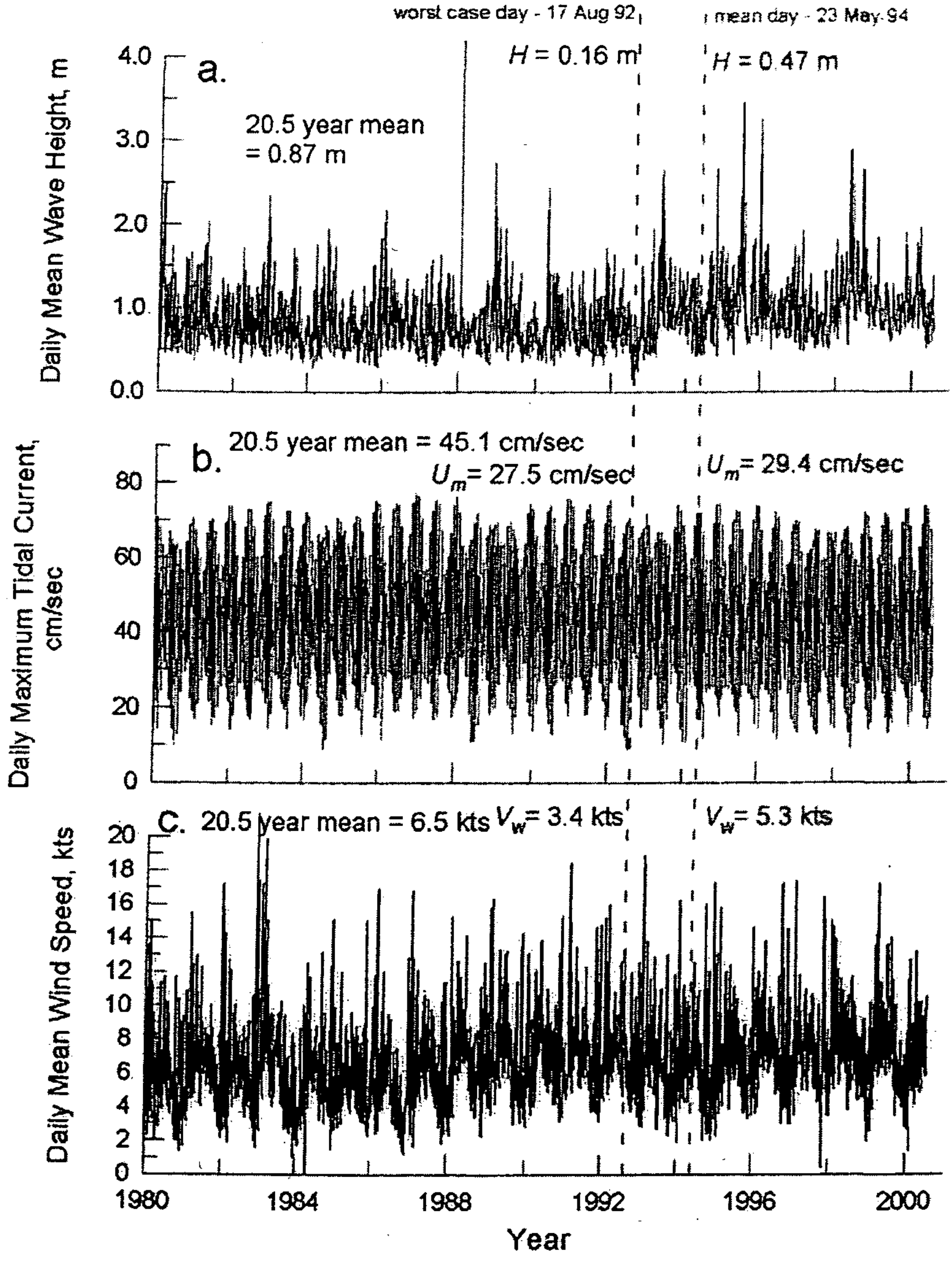

Figure 2. Period of record of forcing functions in the nearfield of Encina Power Plant, 1980-2000.5: a) daily mean wave height, b) daily maximum tidal current velocity, and c) daily mean wind.

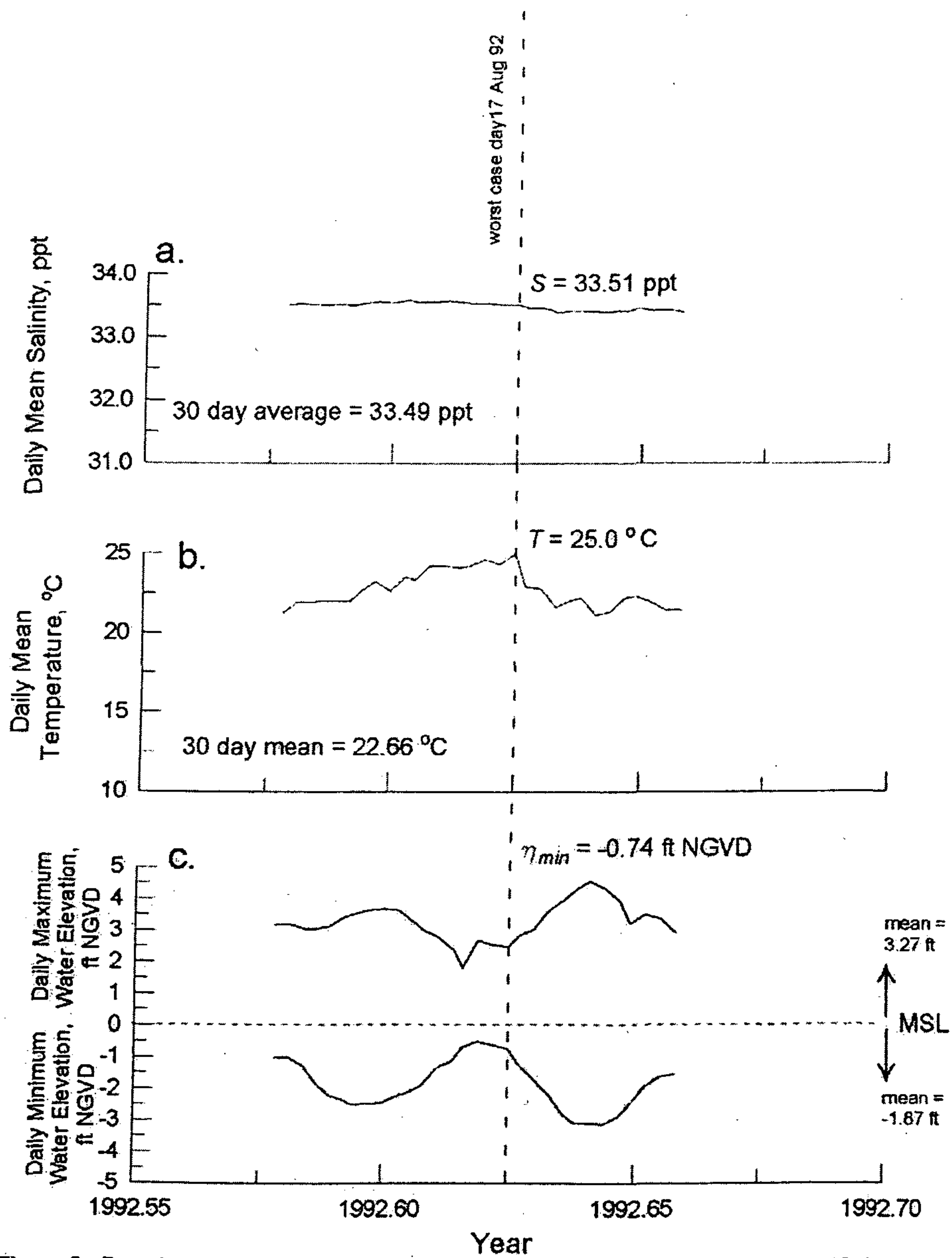

Figure 3. Boundary conditions in the nearfield of the Encina Power Plant: worst case 30 day period: a) daily mean salinity, b) mean temperature, and c) high and low ocean water elevations.

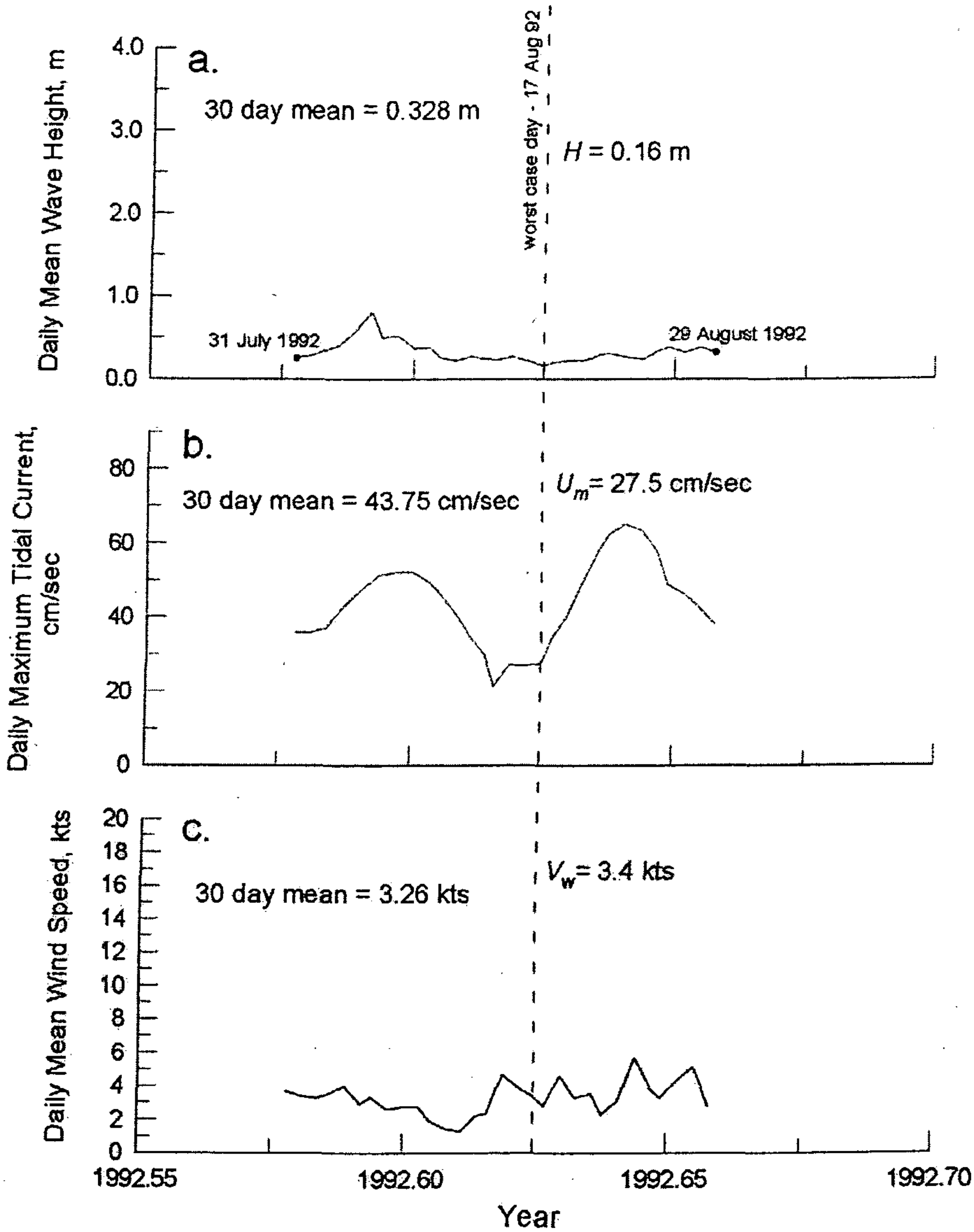

Figure 4. Forcing functions in the nearfield of Encina Power Plant, worst case 30 day period: a) daily mean wave height, b) daily maximum tidal current velocity, and c) daily mean wind.

neap tides occurring on this day with a minimum water level of -0.74 ft NGVD. This combination of environmental variables represents a situation that would place maximum thermal stress on the marine biology; and one in which the dilution of the concentrated seawater by-product of the desalination plant would occur very slowly due to minimal ocean mixing. The probability of occurrence of these worst case mixing conditions is 1day in 7,523 days, or 0.013%.

D) Average Case Assignments: The average daily combination of the 7 controlling variables over the 20.5 year period of record was found to be represented by the conditions on 23 May 1994. This day is represented in Figures 1 and 4 by the vertical dashed green line. This was a spring day with moderate temperature, winds, waves, and power generation. The Southern Oscillation Index (SOI) was zero indicating that the climate was in a neutral phase. Plant flow rate was 576 mgd, very near the annual mean of 550 mgd (Figure 3.4a). Ocean salinity was 33.52 ppt and ocean temperature was 17.6 °C, both identically the 20.5 year mean. Wave heights were 0.65 m, slightly below the 20.5 year mean, and maximum tidal currents reached 29.4 cm/sec (0.57 knots), also less than the 20.5 year mean. The daily low water level at -1.96 ft NGVD, very close to the mean low tide (MLT). Winds were 5.3 knots, slightly above the 20.5 year mean.

3) Results:

For each low flow rate scenario, results are presented for extreme and average conditions in terms of four principle model outputs: 1) salinity of the combined discharge on the sea floor, 2) dilution factors for the raw concentrate at the sea floor, 3) depth averaged salinity of the combined discharge, and 4) depth averaged dilution factors for the raw concentrate in the water column.

Salinity fields are contoured in parts per thousand (ppt) according to the color bar scale at the bottom of each plot. For purposes of comparing scenarios, the salinity scale range spans from 33.5 ppt to 55.0 ppt. Ambient ocean salinity is stated in the caption of each salinity field plot. Of particular interest in the outcome of each historical extreme scenario will be areas in which the discharge plume elevates the local salinity above 40 ppt and above 36.9 ppt.

The dilution fields are contoured in base-10 log according to the color bar scale at the bottom of each plot, with a scale range that spans from 10^0 to 10^7. We are particularly concerned about the dilution factor of the raw concentrate in the water column at the edge of the ZID, 1000 ft in any direction from the mouth of the discharge channel. The present NPDES permit for the thermal effluent requires a dilution factor of 15 to 1 at the edge of the ZID.

A) Worst-Case Hyper-Saline Effects of the Low-Flow Scenario 1:

One Unit 4 circulation pump is assumed to be operating at 149.76 mgd. After blending with the concentrated sea salts discharged from the desalination plant the combined discharge exiting the discharge channel is 99.76 mgd. No power generation is also assumed so that the Delta-T is ? $T = 0°$ C. End-of-pipe salinity is 50.3 ppt, diluted in-the-pipe from an initial salinity of 67.02 ppt for the raw concentrate. Figure 5 gives the salinity field on the sea floor resulting from the worst case mixing conditions for low-flow Scenerio 1. The salinity field is averaged over a 24 hour period. The inner core of the hyper-saline bottom

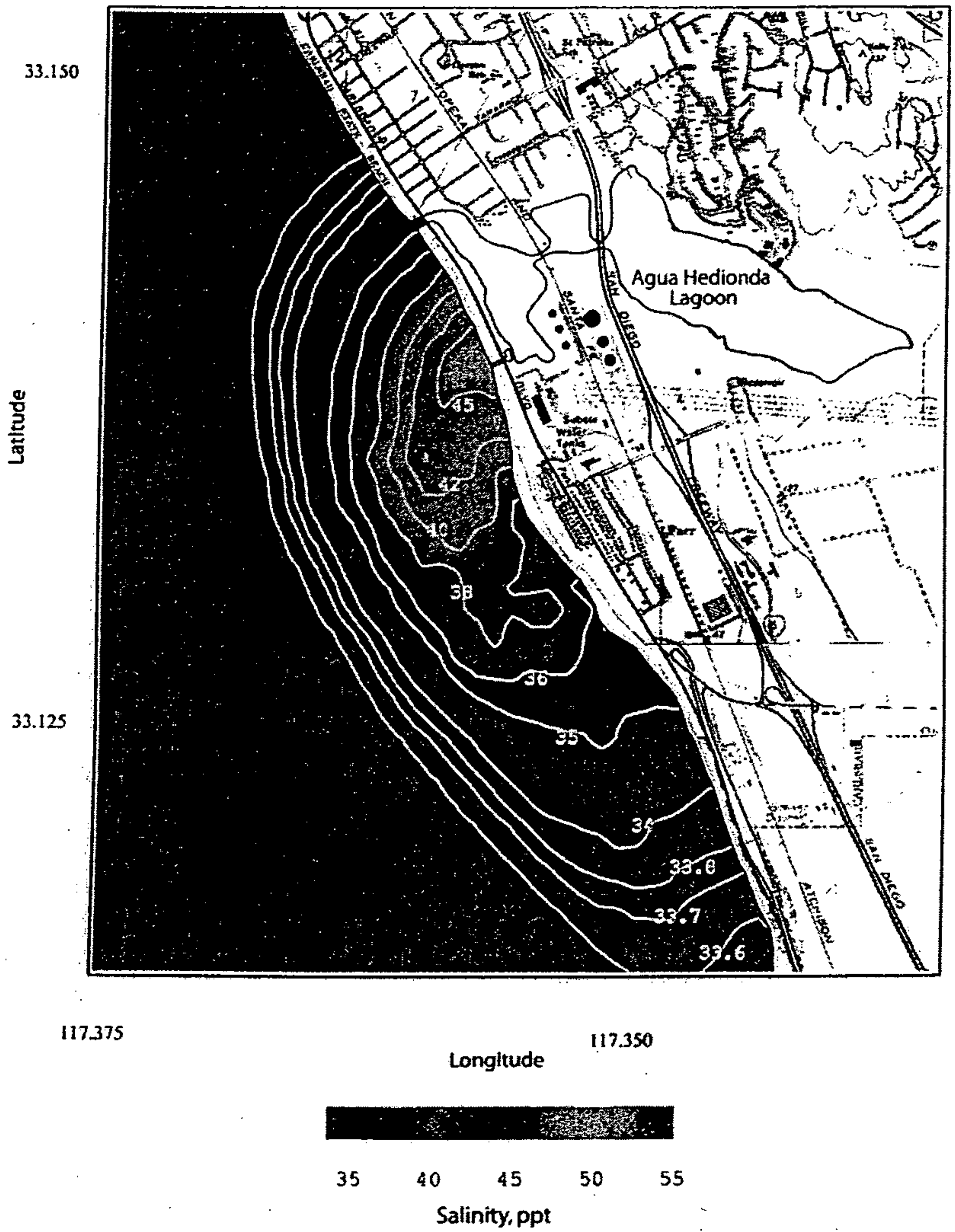

Figure 5. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

boundary layer is at a maximum salinity of 48.1 ppt, but covers an area of only 1.2 acres of the sub-tidal beach face. Offshore, the hyper-saline bottom boundary layer follows a southward trajectory and exposes about 111 acres of benthic environment to salinity in excess of 40 ppt. About 248 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 45.0 ppt, occurring 1000 ft offshore of the discharge channel. Bottom dilution factors for the raw concentrate are shown in Figure 6 for Scenario 1 with worst case ambient mixing. Minimum dilution on the sea bed at the edge of the ZID is 2.9 to 1 and dilutions are less than 15 to 1 on 282 acres of surf zone bottom and offshore seabed.

The relatively high salinity found on the seabed is confined to a thin bottom boundary layer that fails to mix upward into the water column due to the small bottom stresses and low eddy diffusivity of the worst case mixing conditions. Above this bottom boundary layer the salinity drops rapidly. Maximum salinity in the water column for Scenario 1 in Figure 7 is found to be 41.8 ppt in the surfzone immediately seaward of the discharge jetty. The pelagic area subject to salinity in excess of 40 ppt is 3.3 acres. About 28 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 38.21 ppt, found in the surf zone 1000 ft to the south of the discharge channel. Figure 8 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions improve to 7.1 to 1 at the edge of the ZID. Dilutions are less than 15 to 1 in 29.6 acres of pelagic surf zone habitat.

While the worst case mixing conditions for low flow Scenario 1 produce some locally high bottom salinties in the range of 45 ppt and some minimum dilution numbers (~ 7 to 1) that are less than one would like to see in some highly

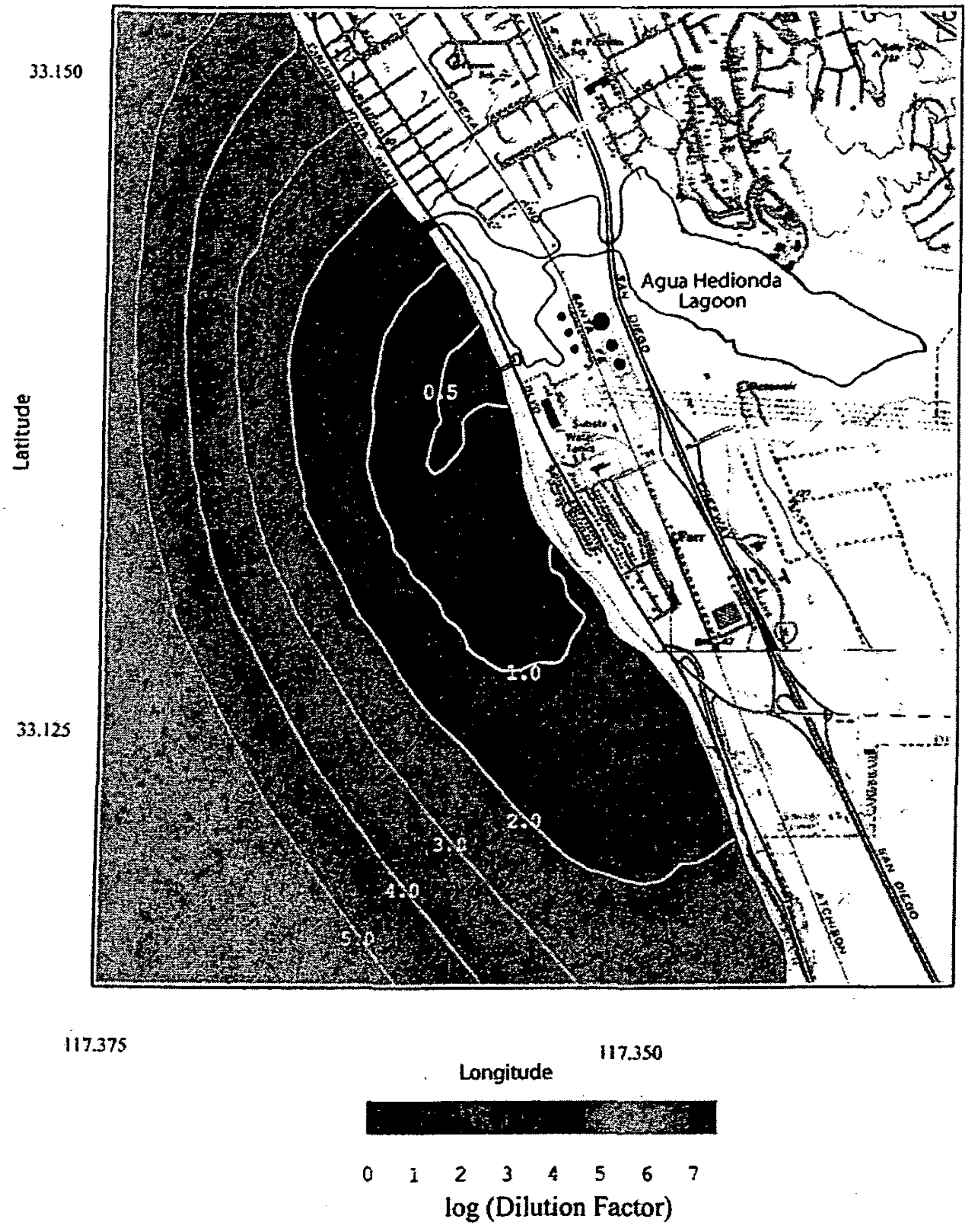

Figure 6. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0$ °C. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

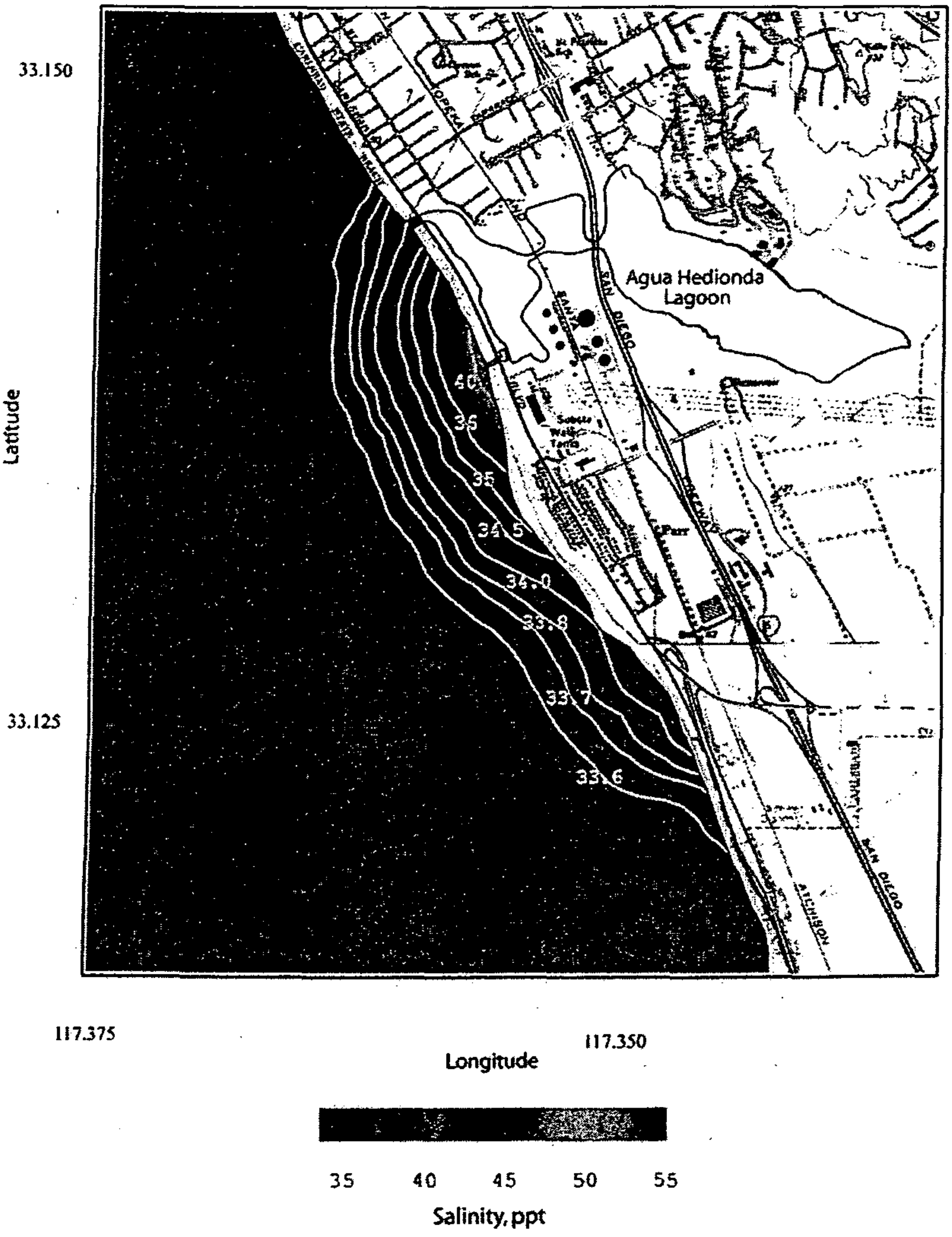

Figure 7. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0$ °C. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

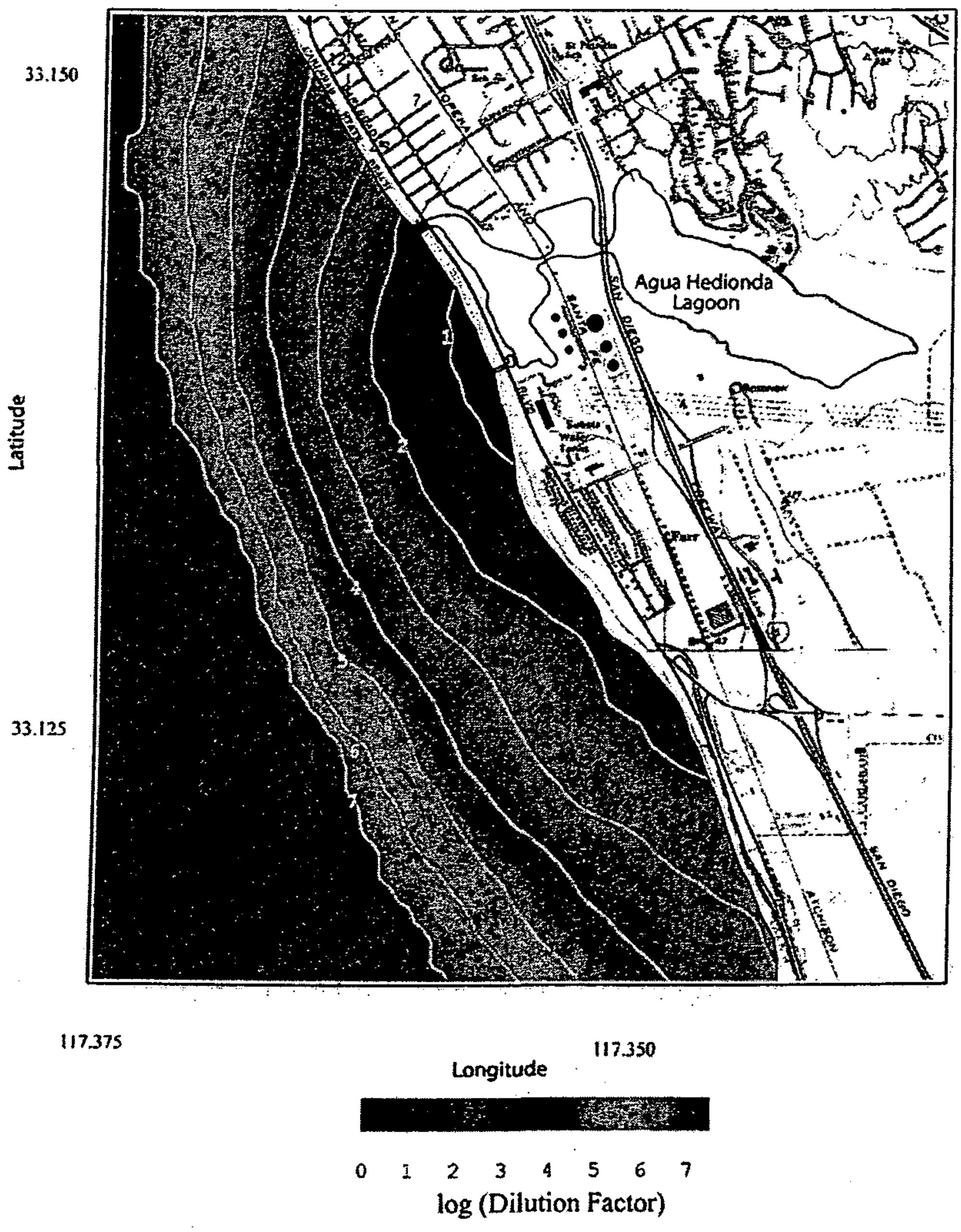

Figure 8. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0$ °C. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

localized inshore areas, the minimal ocean mixing conditions that contributed to this result are quite rare, occurring 1 day in 7,523, or a recurrence probability of 0.013%.

B) Worst-Case Hyper-Saline Effects of the Low-Flow Scenario 2:

All pumps of Units 1 and 2 and one pump from Unit 3 are assumed to be operating at a combined intake flow rate of 172.8 mgd. After blending with the concentrated sea salts discharged from the desalination plant the combined discharge exiting the discharge channel is 122.8 mgd. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. End-of-pipe salinity is 47.1 ppt, diluted in-the-pipe from an initial salinity of 67.02 ppt for the raw concentrate. In Figure 9 the inner core of the hyper-saline bottom boundary layer is found to be at a maximum salinity of 42.4 ppt and covers an area of 42.7 acres of the sub-tidal beach face and sandy bottom nearshore habitat. Offshore, the hyper-saline bottom boundary layer follows a southward trajectory and exposes about 87.1 acres of benthic environment to salinity in excess of 40 ppt. About 205 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 42.2 ppt, occurring 1000 ft offshore of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 10 indicate that minimum dilution on the sea bed at the edge of the ZID is 3.86 to 1 and bottom dilutions are less than 15 to 1 on 249 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for Scenario 2 is found in Figure 11 to be 40.3 ppt in the surfzone immediately seaward of the discharge jetty. The pelagic area subject to salinity in excess of 40 ppt is 2.8 acres. About 14.3 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum

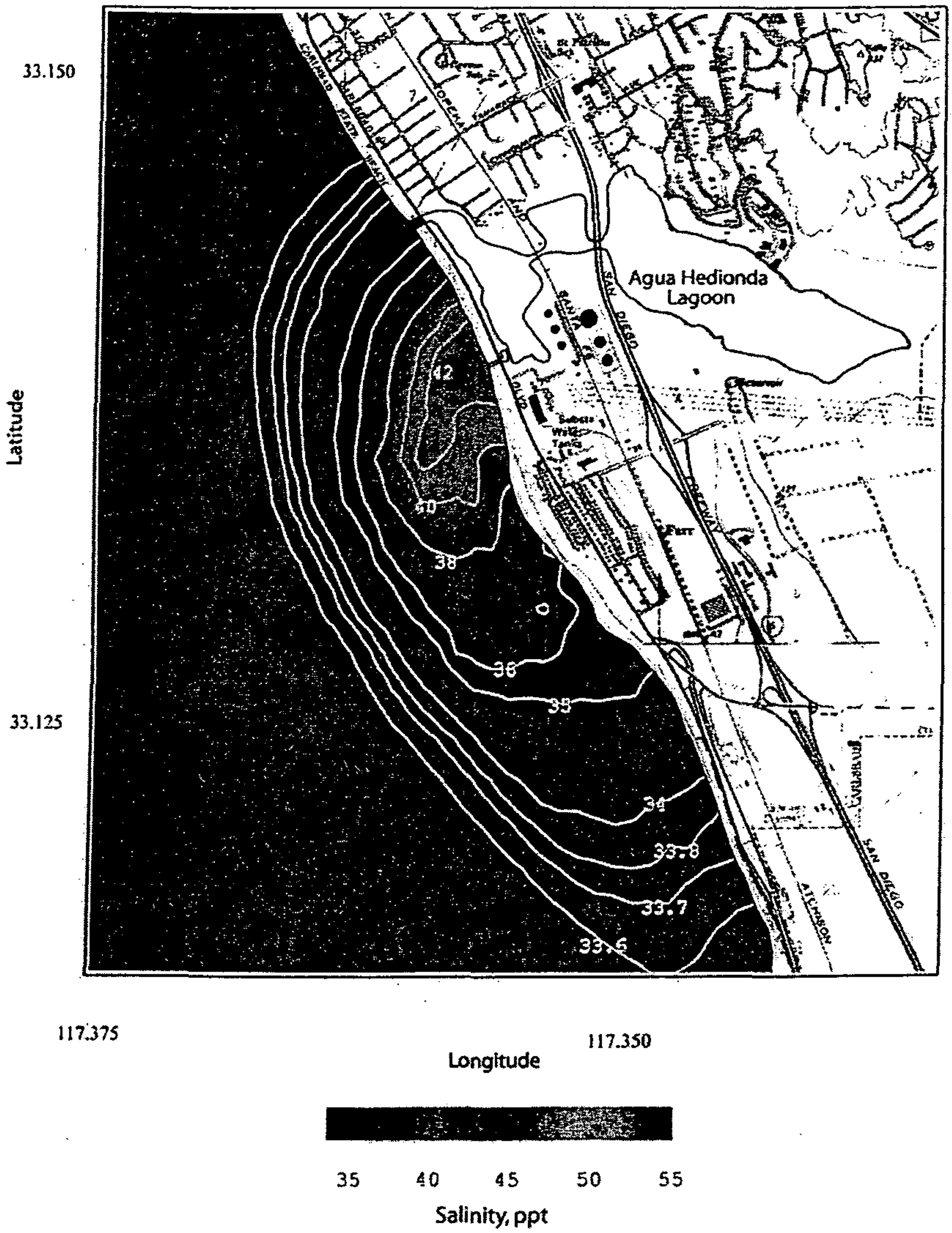

Figure 9. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

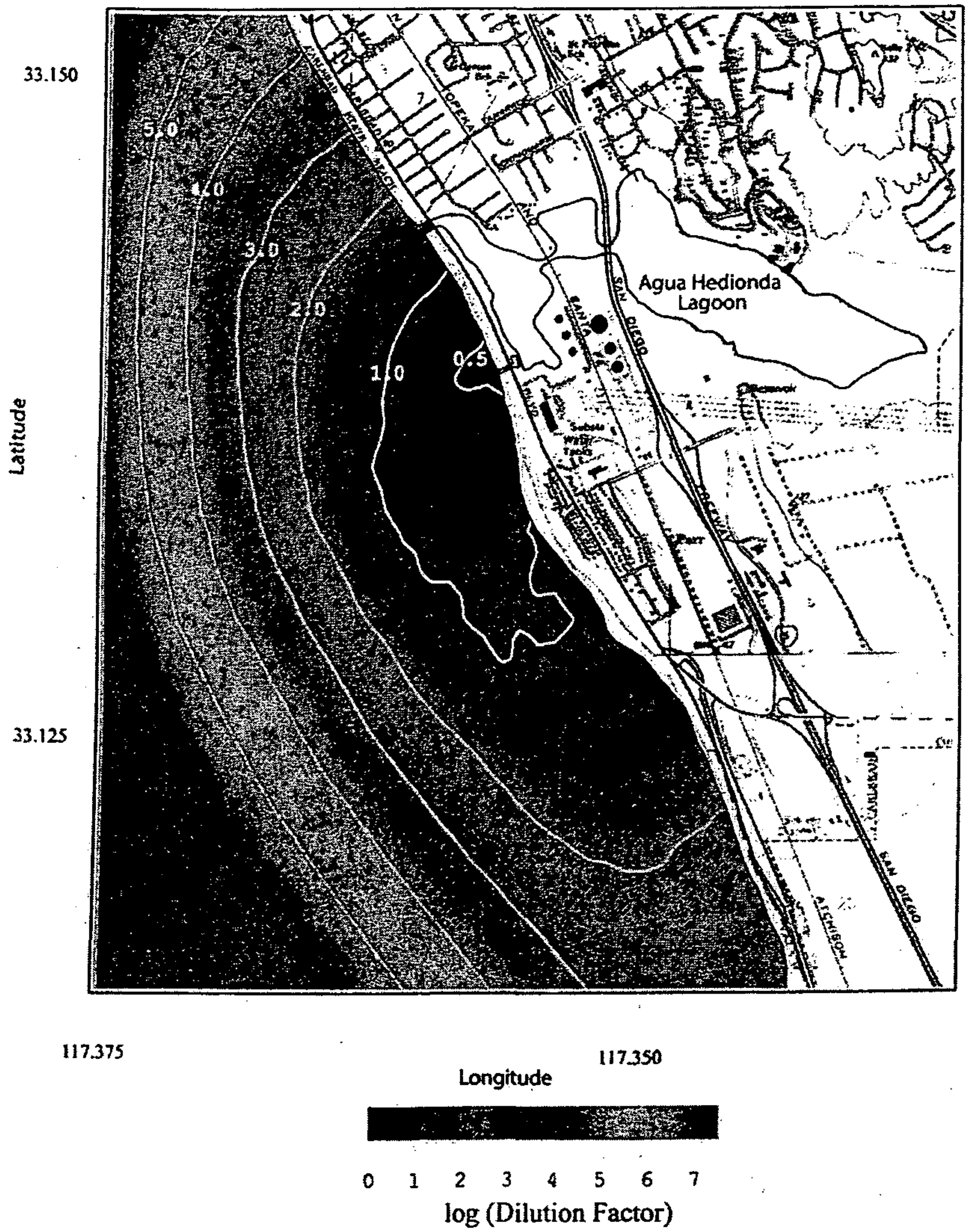

Figure 10. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

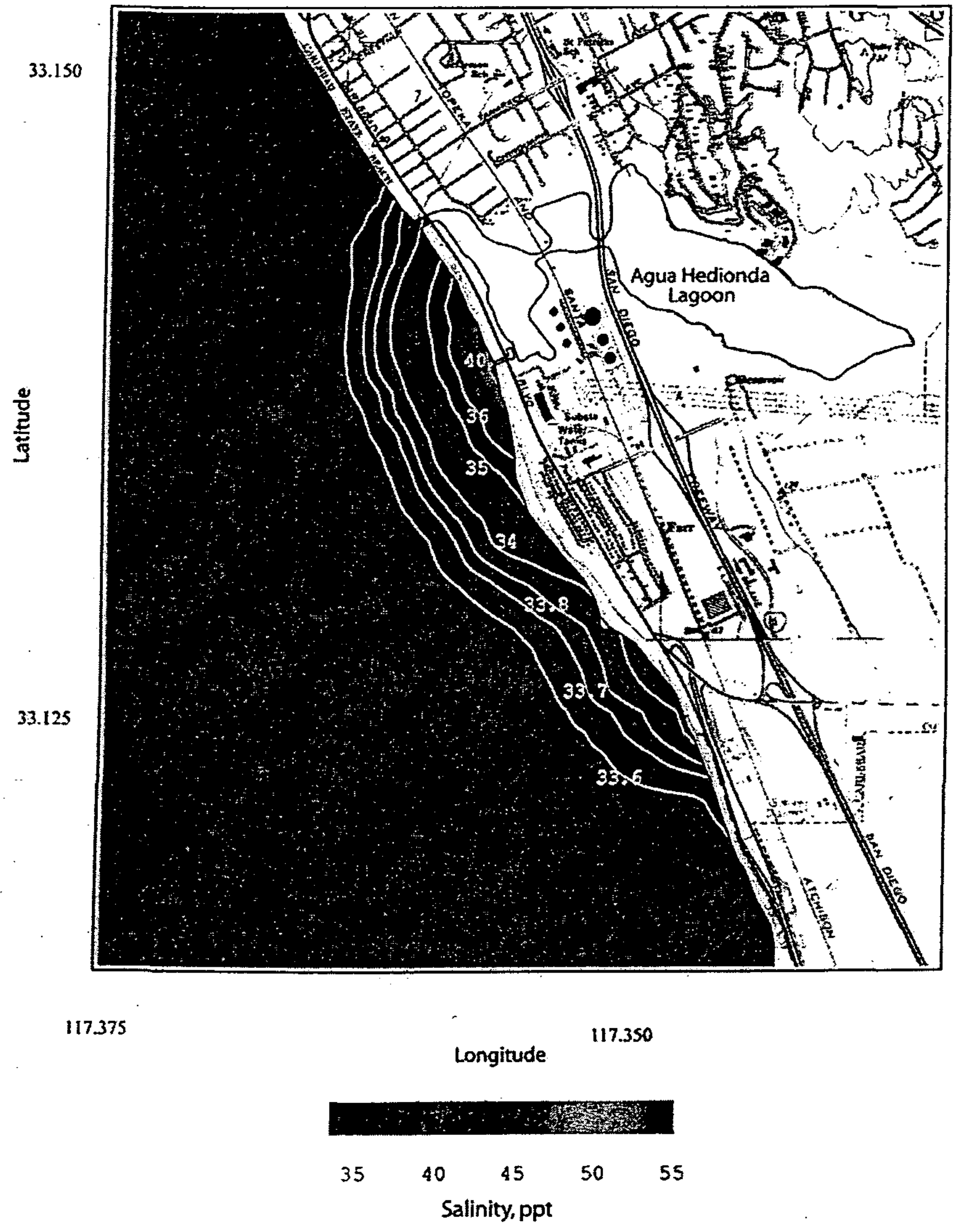

Figure 11. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

water column salinity at the edge of the ZID is 36.9 ppt, found in the surf zone 1000 ft to the south of the discharge channel. Figure 12 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions improve to 9.9 to 1 at the edge of the ZID. Dilutions are less than 15 to 1 in 23.4 acres of pelagic surf zone and nearshore habitat in the immediate neighborhood of the discharge channel. The minimal ocean mixing conditions that contributed to the Scenario 2 worst case are rare, occurring 1 day in 7,523, or a recurrence probability of 0.013%.

C) Worst-Case Hyper-Saline Effects of the Low-Flow Scenario 3:

One pump from Unit 1 and one pump from Unit 5 are assumed to be operating at a combined intake flow rate of 184.32 mgd. After blending with the concentrated sea salts discharged from the desalination plant the combined discharge exiting the discharge channel is 134.32 mgd. No power generation is assumed so that the Delta-T is $\Delta T = 0^{0}$C. End-of-pipe salinity is 46.0 ppt, diluted in-the-pipe from an initial salinity of 67.02 ppt for the raw concentrate. In Figure 13 the inner core of the hyper-saline bottom boundary layer is found to be at a maximum salinity of 42.0 ppt and covers an area of 14.7 acres of the sub-tidal beach face and sandy bottom nearshore habitat. Offshore, the hyper-saline bottom boundary layer follows a southward trajectory and exposes about 71.9 acres of benthic environment to salinity in excess of 40 ppt. About 188 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 42.0 ppt, occurring 1000 ft offshore of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 14 indicate that minimum dilution on the sea bed at the edge of the ZID is 3.95 to 1 and bottom dilutions are less than 15 to 1 on 225 acres of surf zone bottom and offshore seabed.

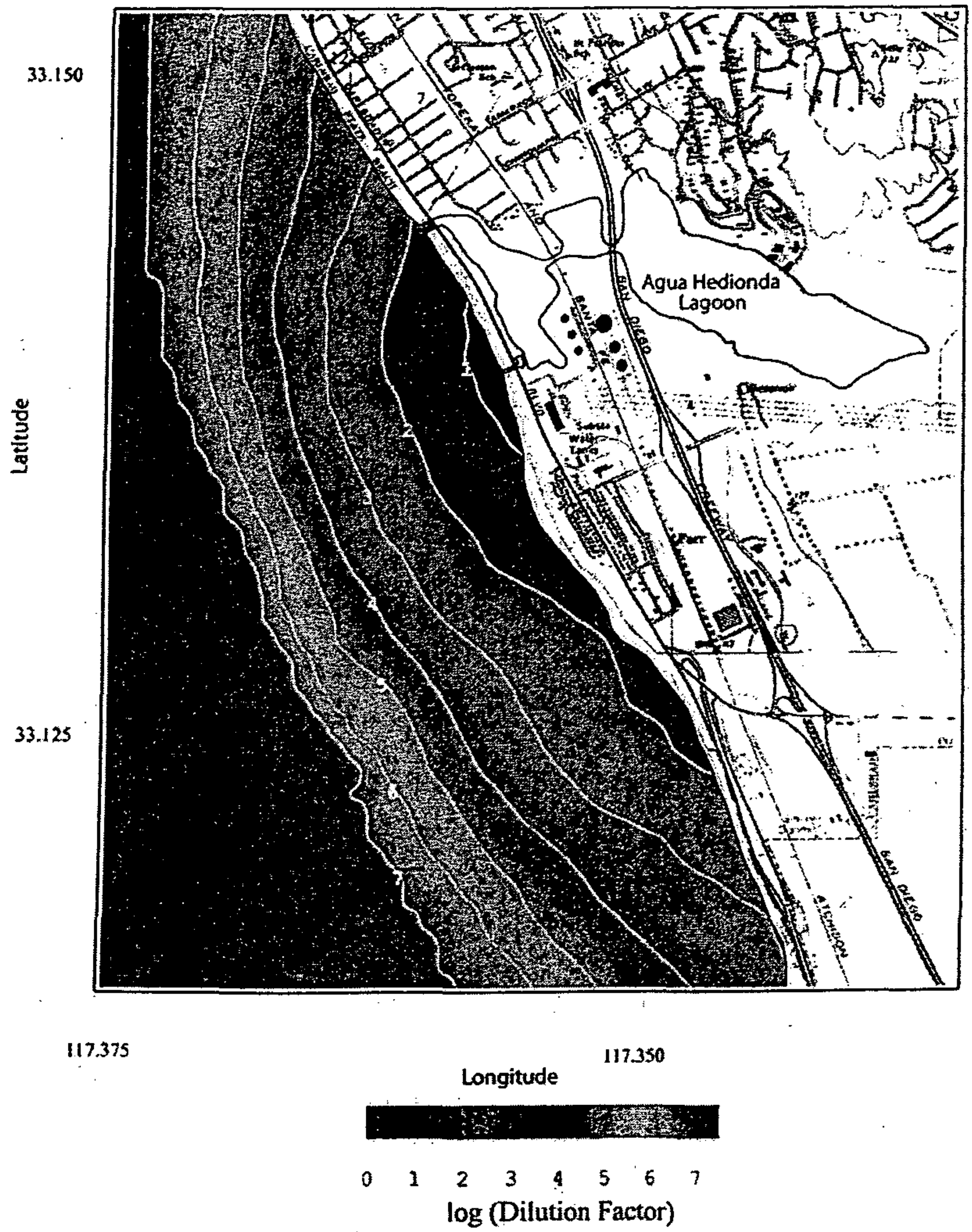

Figure 12. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\,^{0}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

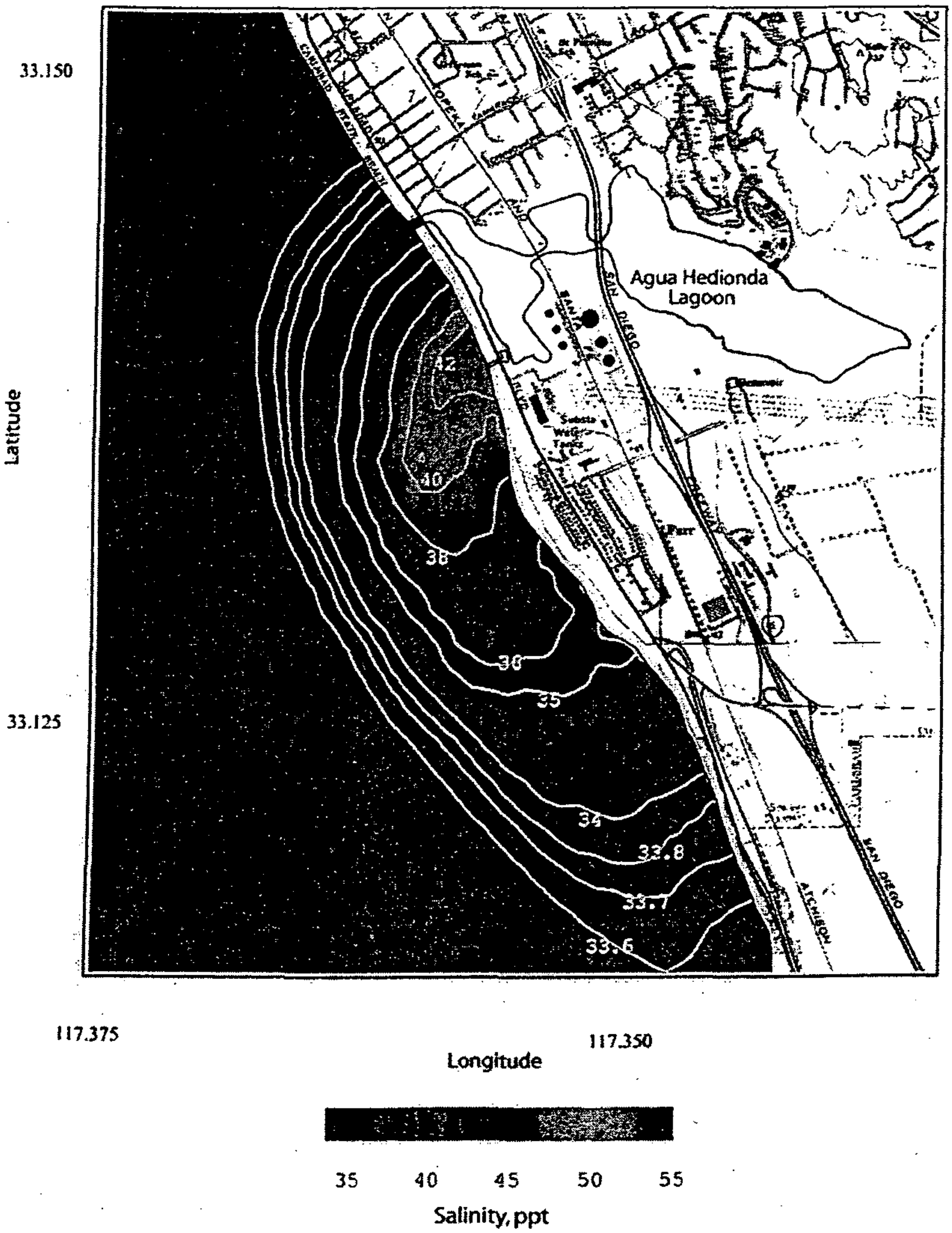

Figure 13. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

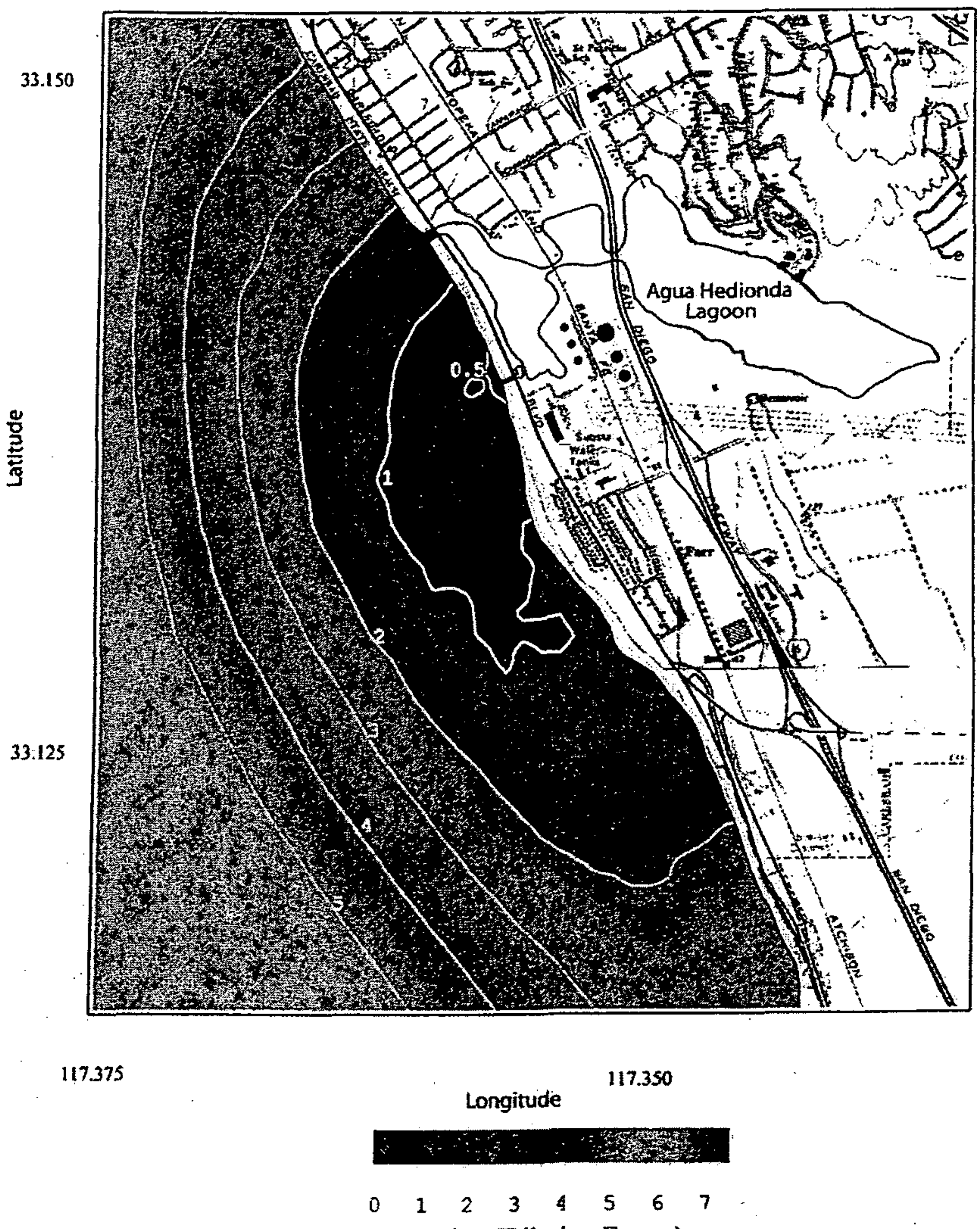

Figure 14. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

Maximum salinity in the water column for worst case Scenario 3 is found in Figure 15 to be 40.0 ppt in the surfzone immediately seaward of the discharge jetty. The pelagic area subject to salinity in excess of 40 ppt is 1 acre. About 12.3 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 36.7 ppt, found in the surf zone 1000 ft to the south of the discharge channel. Figure 16 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 10.5 to 1 at the edge of the ZID. Dilutions are less than 15 to 1 in 12.9 acres of pelagic surf zone and nearshore habitat in the immediate neighborhood of the discharge channel. The minimal ocean mixing conditions that contributed to the Scenario 3 worst case are rare, occurring 1 day in 7,523, giving a recurrence probability of 0.013%.

D) Worst-Case Hyper-Saline Effects of the Low-Flow Scenario 4:

Two pumps from Unit 1 and one pump from Unit 5 are assumed to be operating at a combined intake flow rate of 218.88 mgd. After blending with the concentrated sea salts discharged from the desalination plant the combined discharge exiting the discharge channel is 168.88 mgd. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. End-of-pipe salinity is 43.4 ppt, diluted in-the-pipe from an initial salinity of 67.02 ppt for the raw concentrate. In Figure 17 the inner core of the hyper-saline bottom boundary layer is found to be at a maximum salinity of 41.0 ppt and covers an area of 2.7 acres of the sub-tidal beach face and sandy bottom nearshore habitat. Offshore, the hyper-saline bottom boundary layer follows a southward trajectory and exposes about 19.9 acres of benthic environment to salinity in excess of 40 ppt. About 147 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum

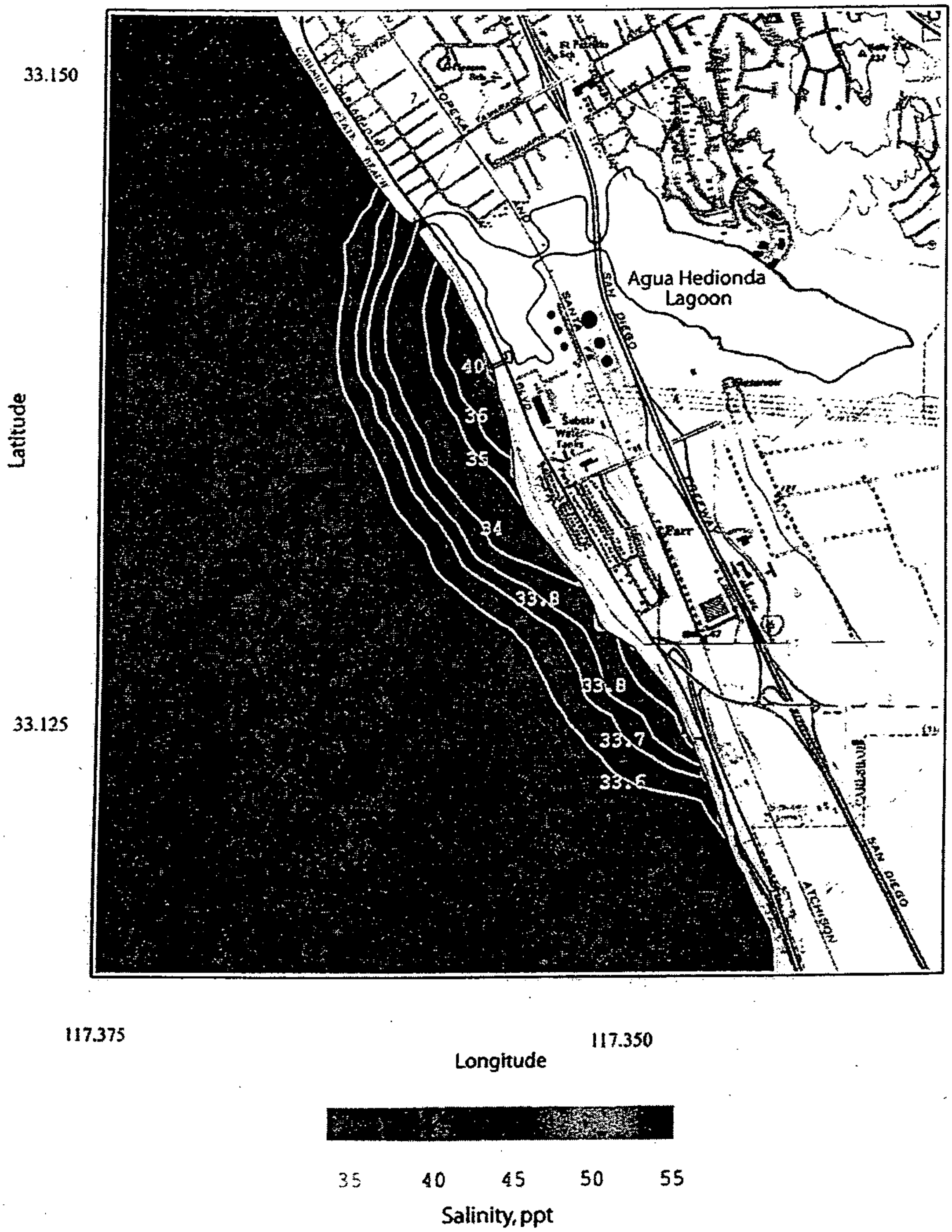

Figure 15. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

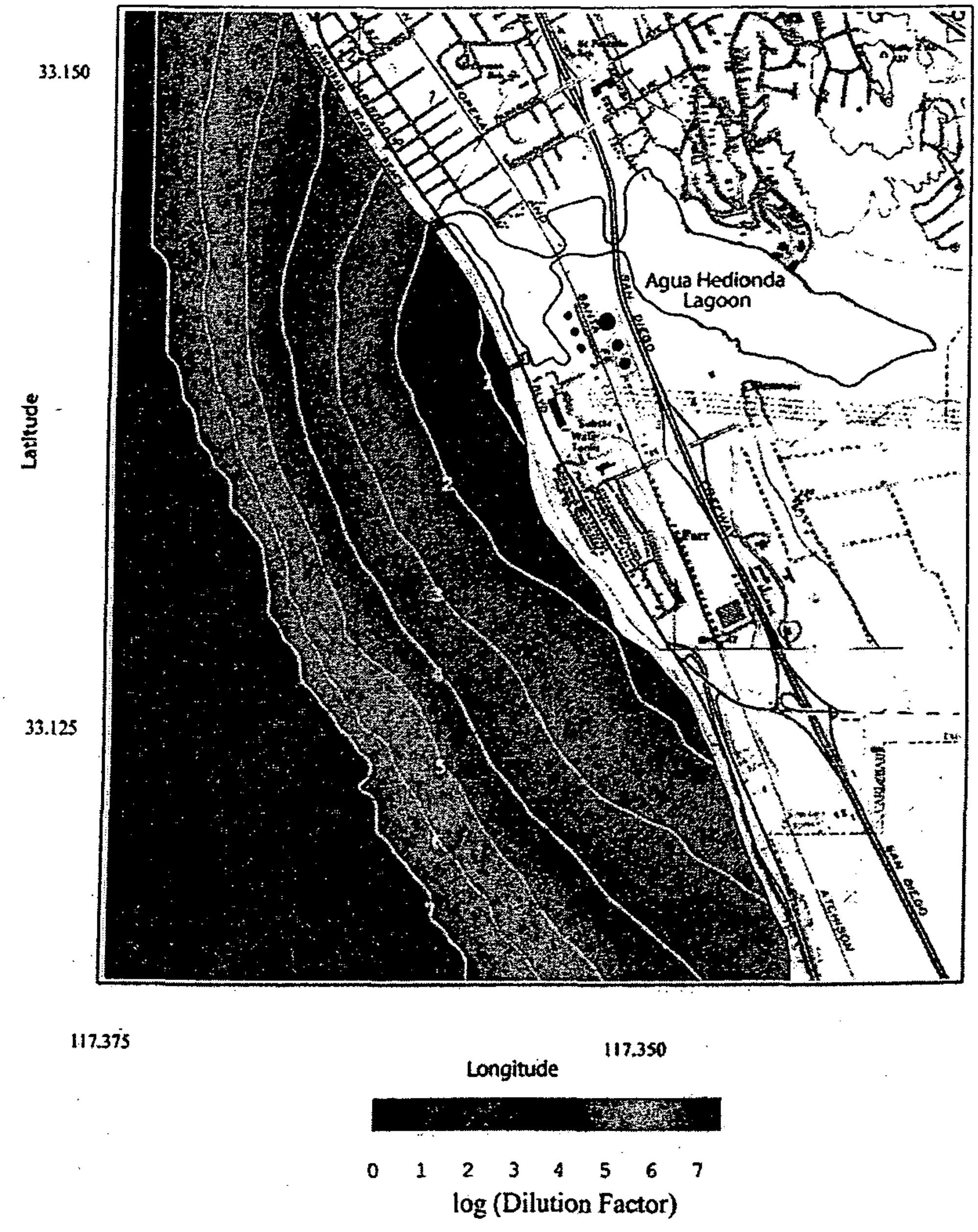

Figure 16. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

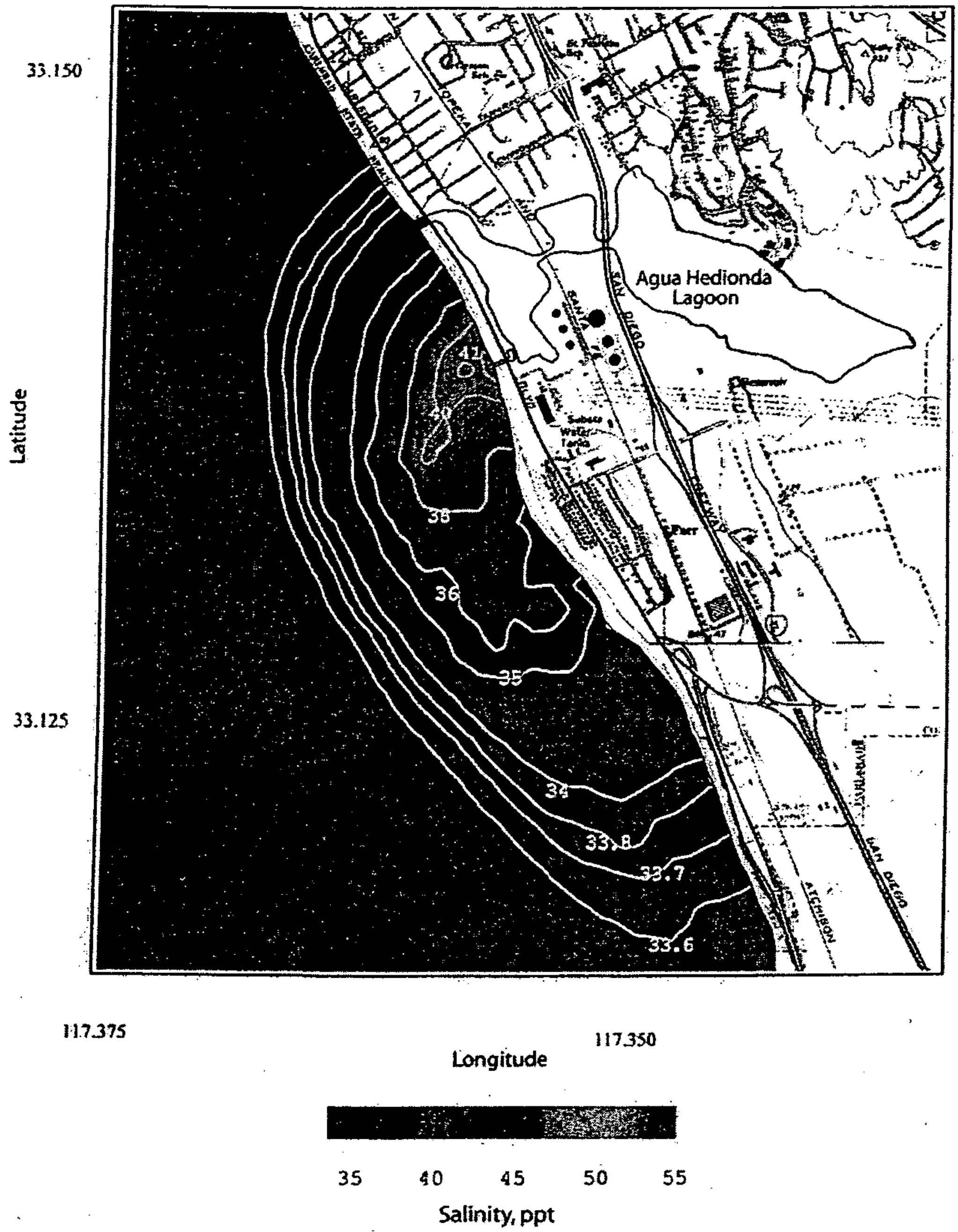

Figure 17. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

bottom salinity found anywhere along the boundaries of the ZID is 40.0 ppt, occurring 1000 ft offshore of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 18 indicate that minimum dilution on the sea bed at the edge of the ZID is 5.16 to 1 and bottom dilutions are less than 15 to 1 on 168 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for worst case Scenario 4 is found in Figure 19 to be 38.0 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt. About 8.7 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 35.75 ppt, found in the surf zone 1000 ft to the north of the discharge channel. Figure 20 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 15.0 to 1 at the edge of the ZID, in compliance with 316(A) minimum dilution permit standards. Therefore, from both a salinity tolerance and regulatory perspective, the Scenario 4 low-flow case is acceptable even for worst case mixing conditions. Dilutions are less than 15 to 1 in 8.6 acres of pelagic surf zone inside the ZID in the immediate neighborhood of the discharge channel. The minimal ocean mixing conditions that contributed to the Scenario 4 worst case are rare, occurring 1 day in 7,523, giving a recurrence probability of 0.013%.

E) Worst-Case Hyper-Saline Effects of the Low-Flow Scenario 5:

This is the "*unheated Unit 4 historical extreme case*" that was presented in Appendix E of the certified EIR. It is reproduced herein to facilitate comparisons with the worst case outcomes of low-flow Scenarios 1-4. Two pumps from Unit 4 are assumed to be operating at a combined intake flow rate of 304 mgd. After blending with the concentrated sea salts discharged from the desalination plant the combined discharge exiting the discharge channel is 254 mgd. No power

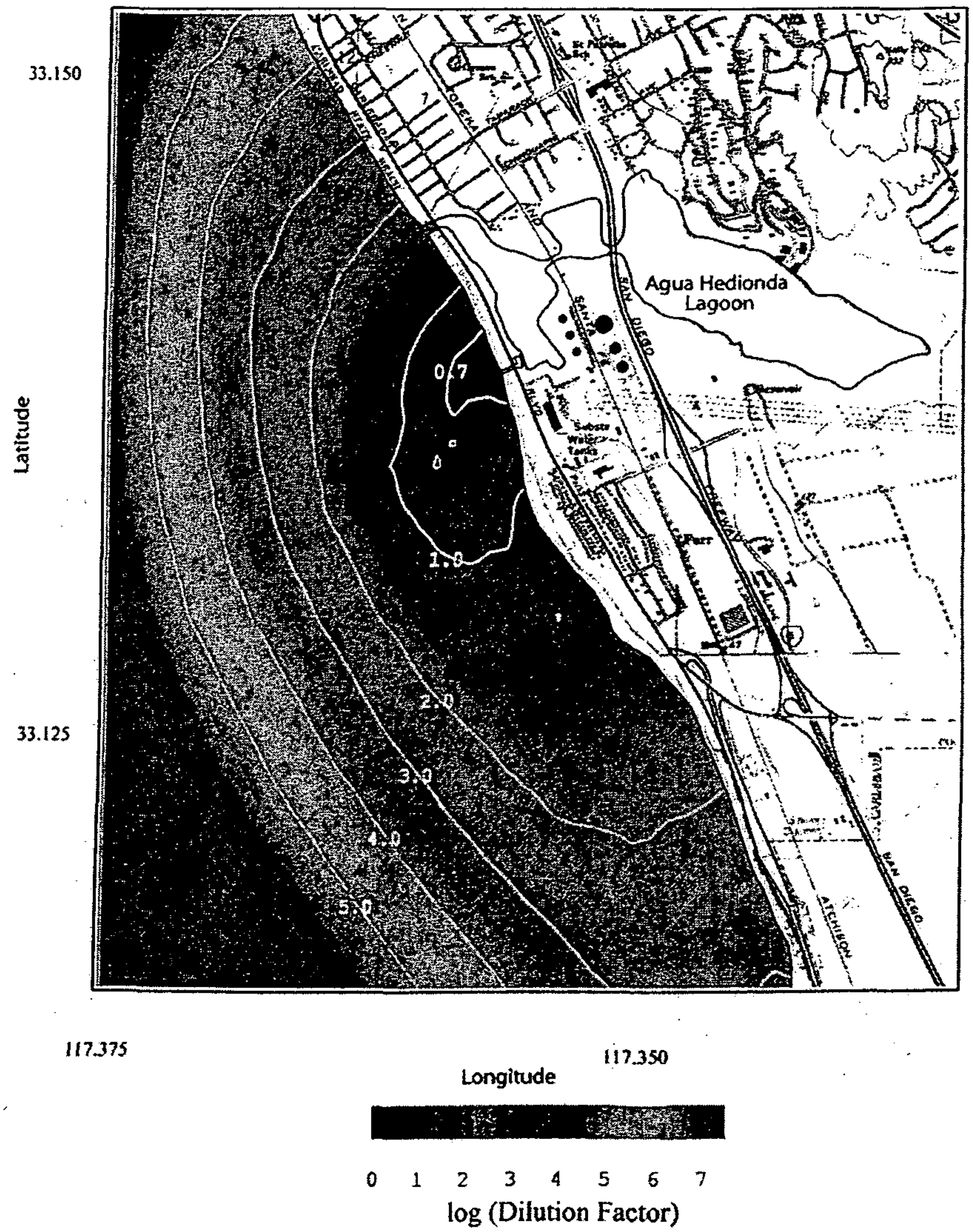

Figure 18. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

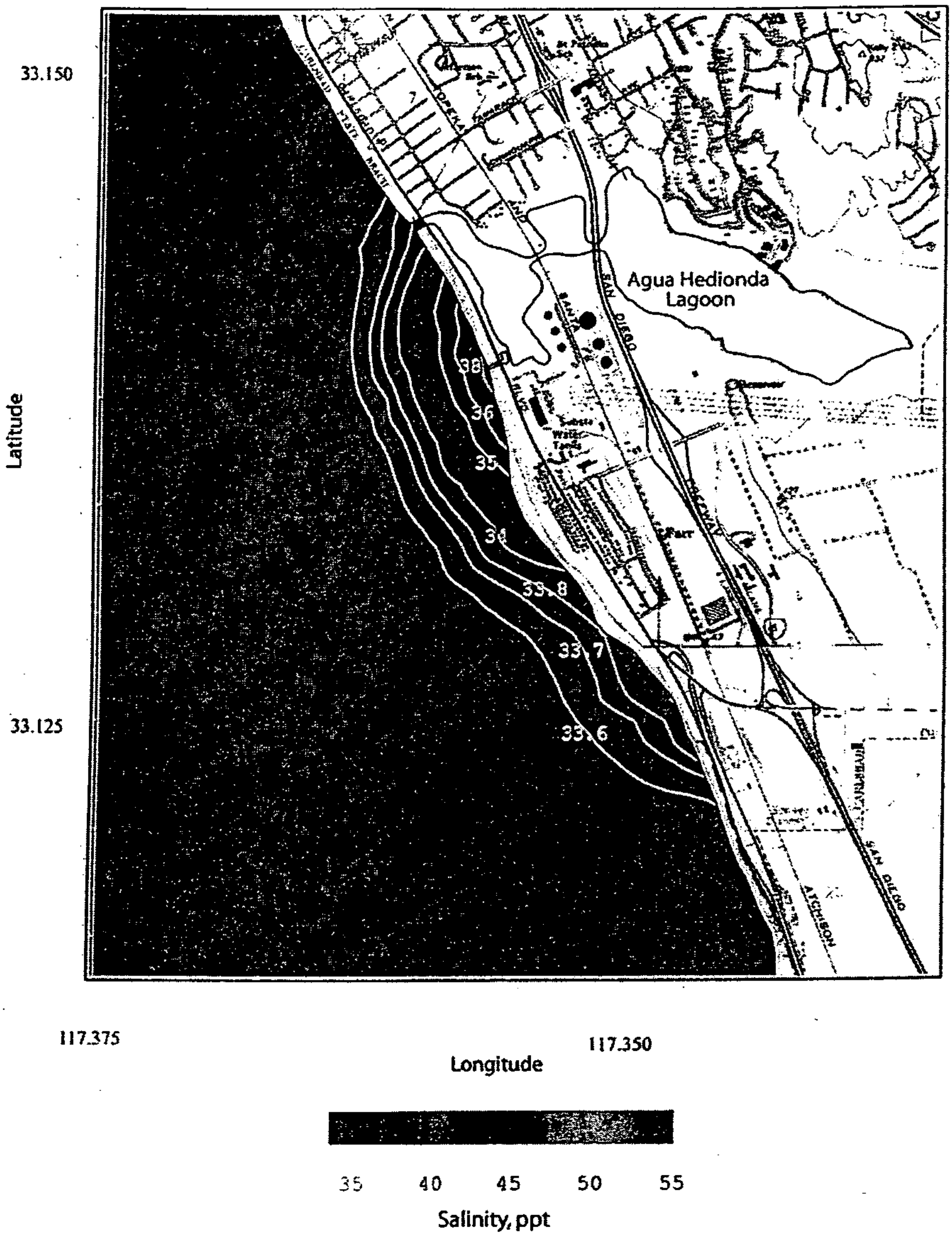

Figure 19. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

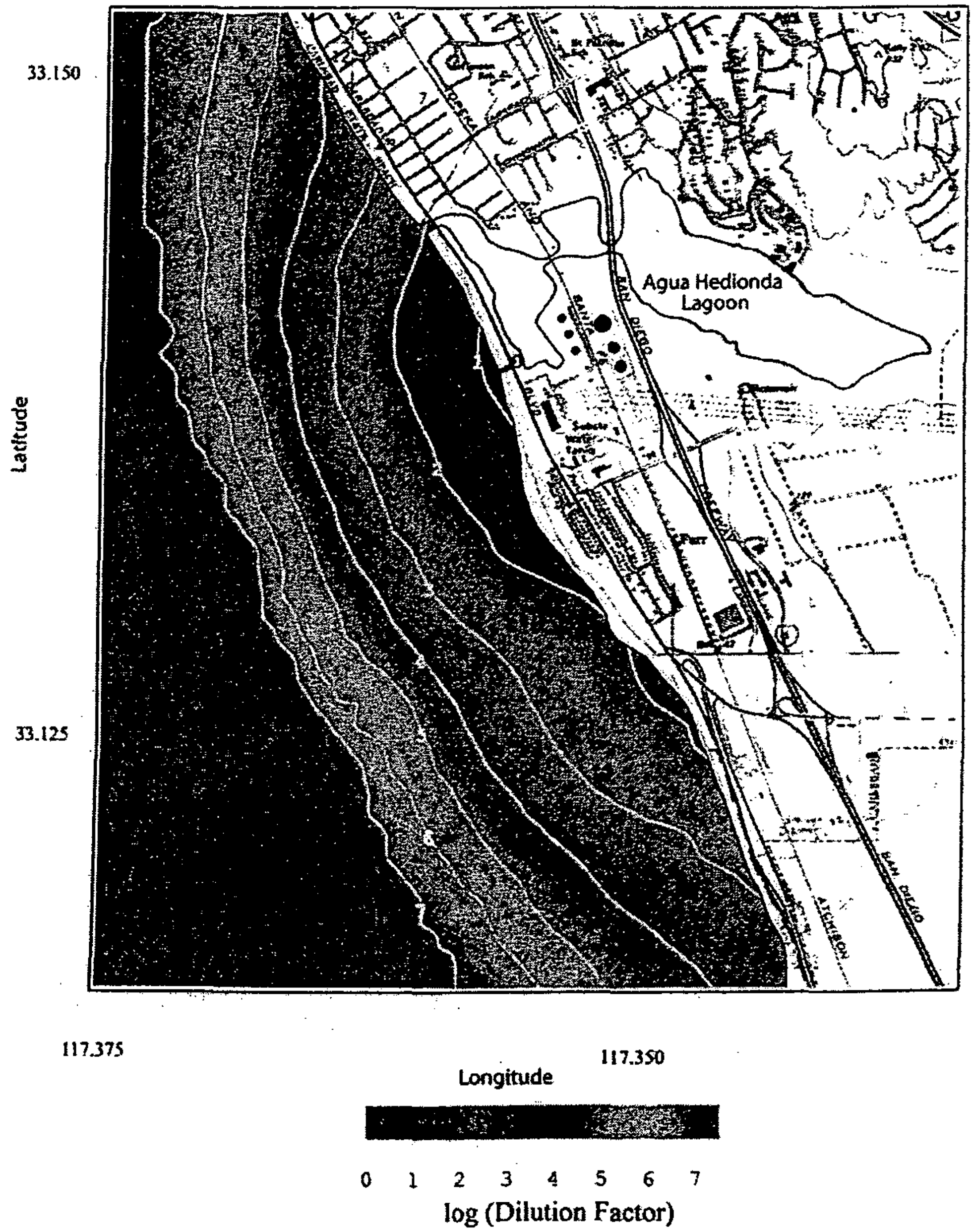

Figure 20. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. End-of-pipe salinity is 40.1 ppt, diluted in-the-pipe from an initial salinity of 67.02 ppt for the raw concentrate. In Figure 21 the inner core of the hyper-saline bottom boundary layer is found to be at a maximum salinity of 39.0 ppt and covers an area of 2.4 acres of the sub-tidal beach face and sandy bottom nearshore habitat. (Nowhere is the salinity in excess of 40 ppt). About 44 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 38.2 ppt, occurring 1000 ft offshore of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 22 indicate that minimum dilution on the sea bed at the edge of the ZID is 7.1 to 1 and bottom dilutions are less than 15 to 1 on 75 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for worst case Scenario 5 is found in Figure 23 to be 36.0 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt, nor is any pelagic habitat subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 35.2 ppt, found in the surf zone 1000 ft to the south of the discharge channel. Figure 24 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 19.8 to 1 at the edge of the ZID, in compliance with 316(A) minimum dilution permit standards. Therefore, from both a salinity tolerance and regulatory perspective, the Scenario 5 low-flow case from the certified EIR is acceptable even for worst case mixing conditions. Dilutions are less than 15 to 1 in 1.1 acres of pelagic surf zone inside the ZID in the immediate neighborhood of the discharge channel. The minimal ocean mixing conditions that contributed to the Scenario 5 worst case are rare, occurring 1 day in 7,523, giving a recurrence probability of 0.013%.

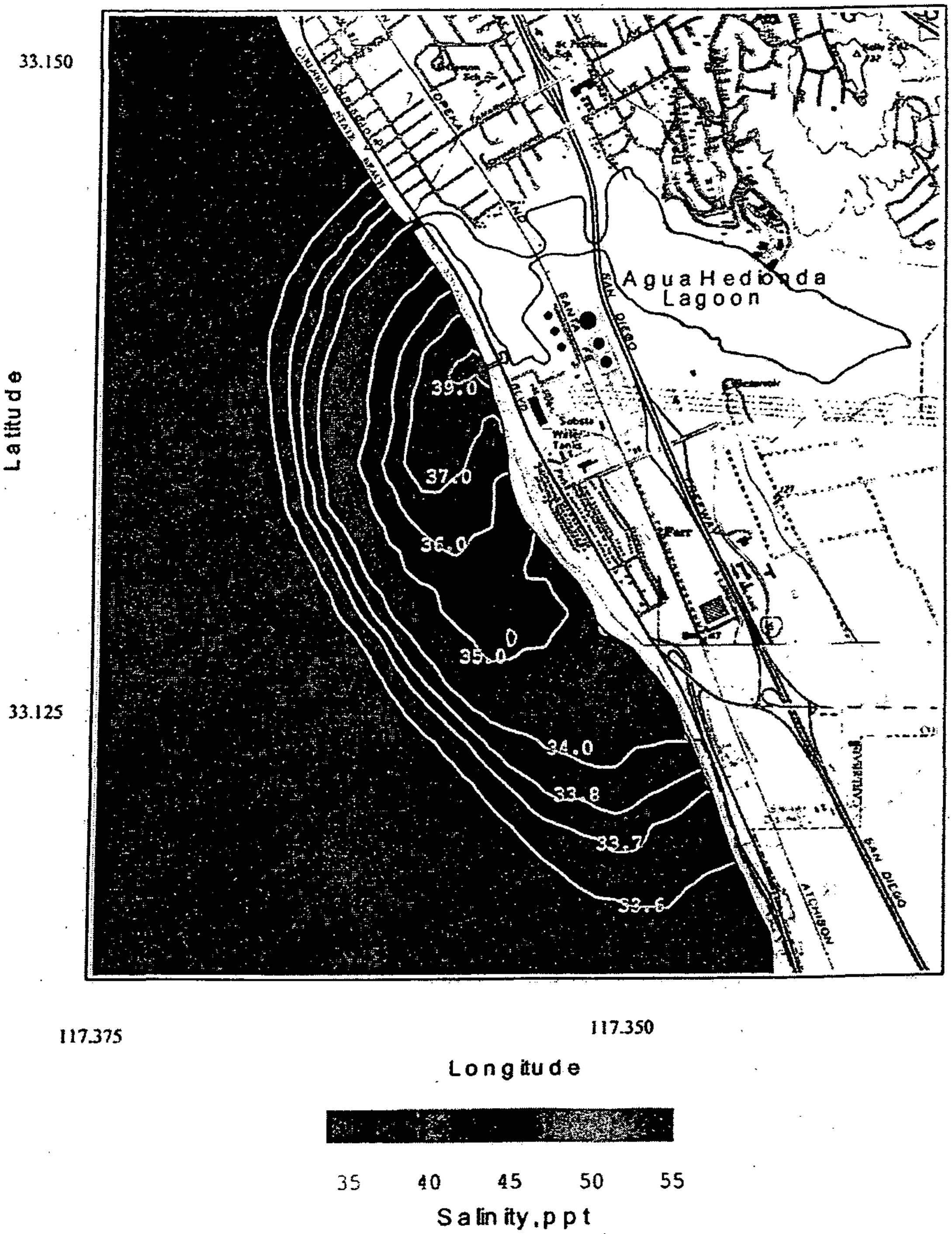

Figure 21. Scenario 5 worst case with two Unit 4 circulation 2 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

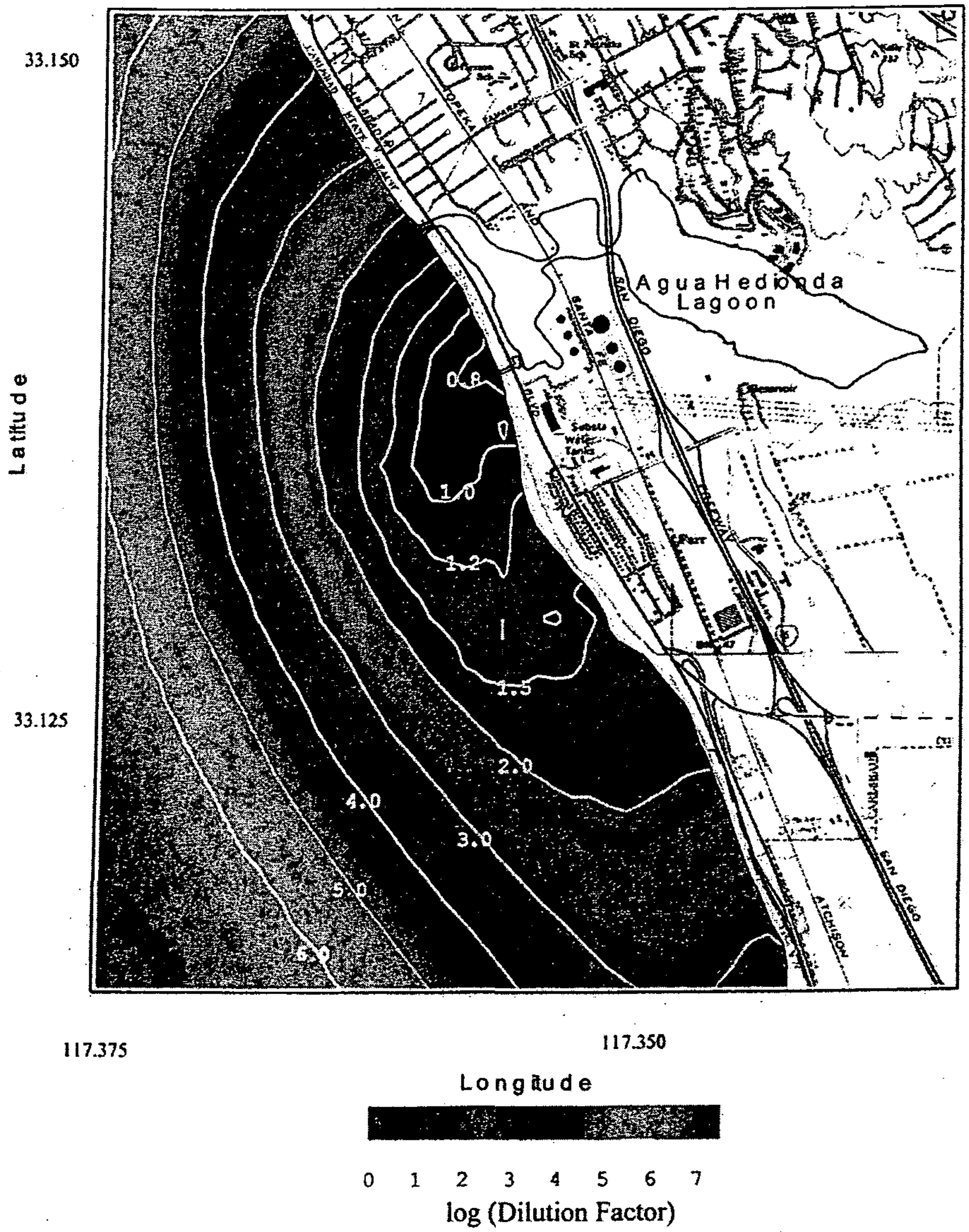

Figure 22. Scenario 5 worst case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

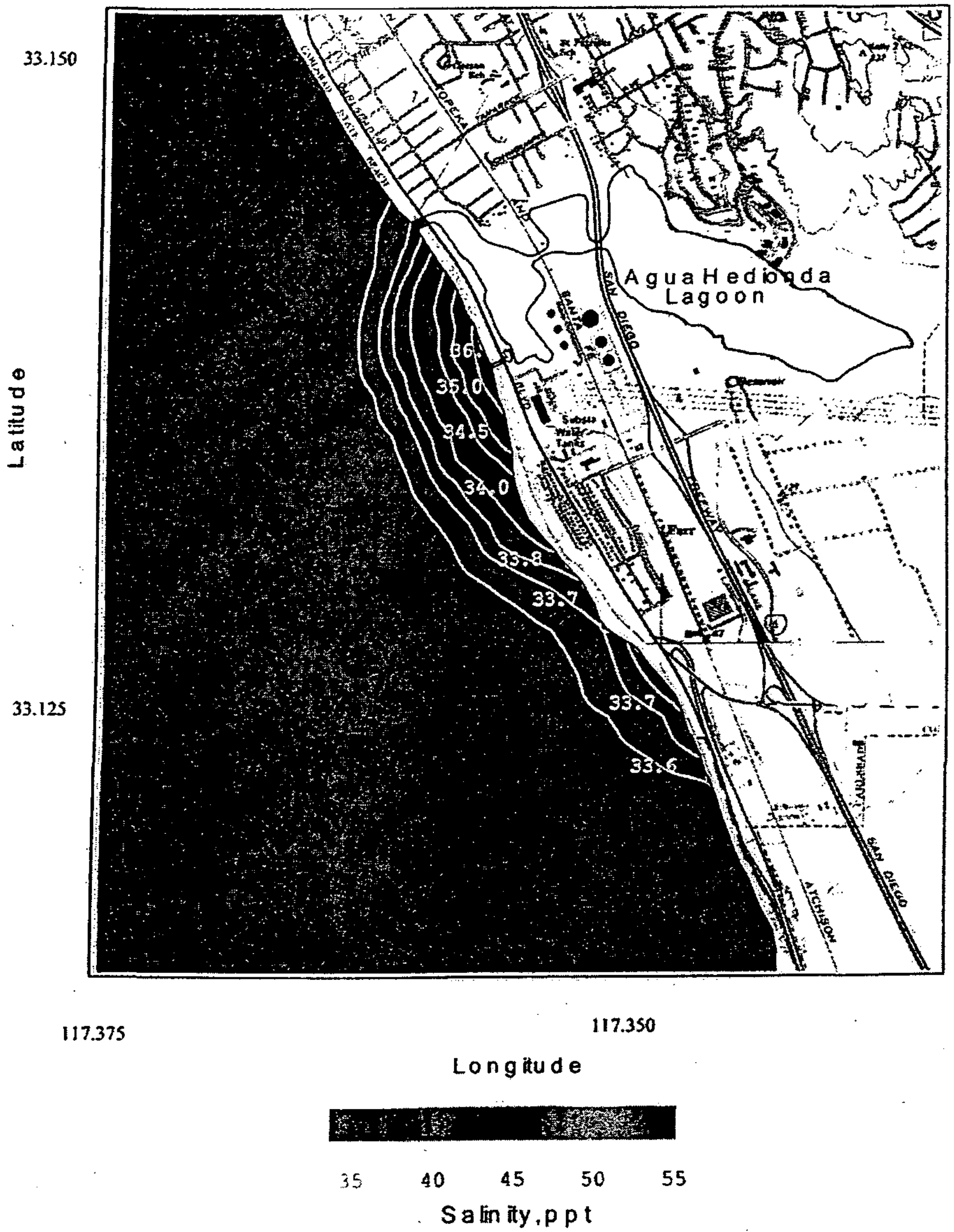

Figure 23. Scenario 5 worst case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

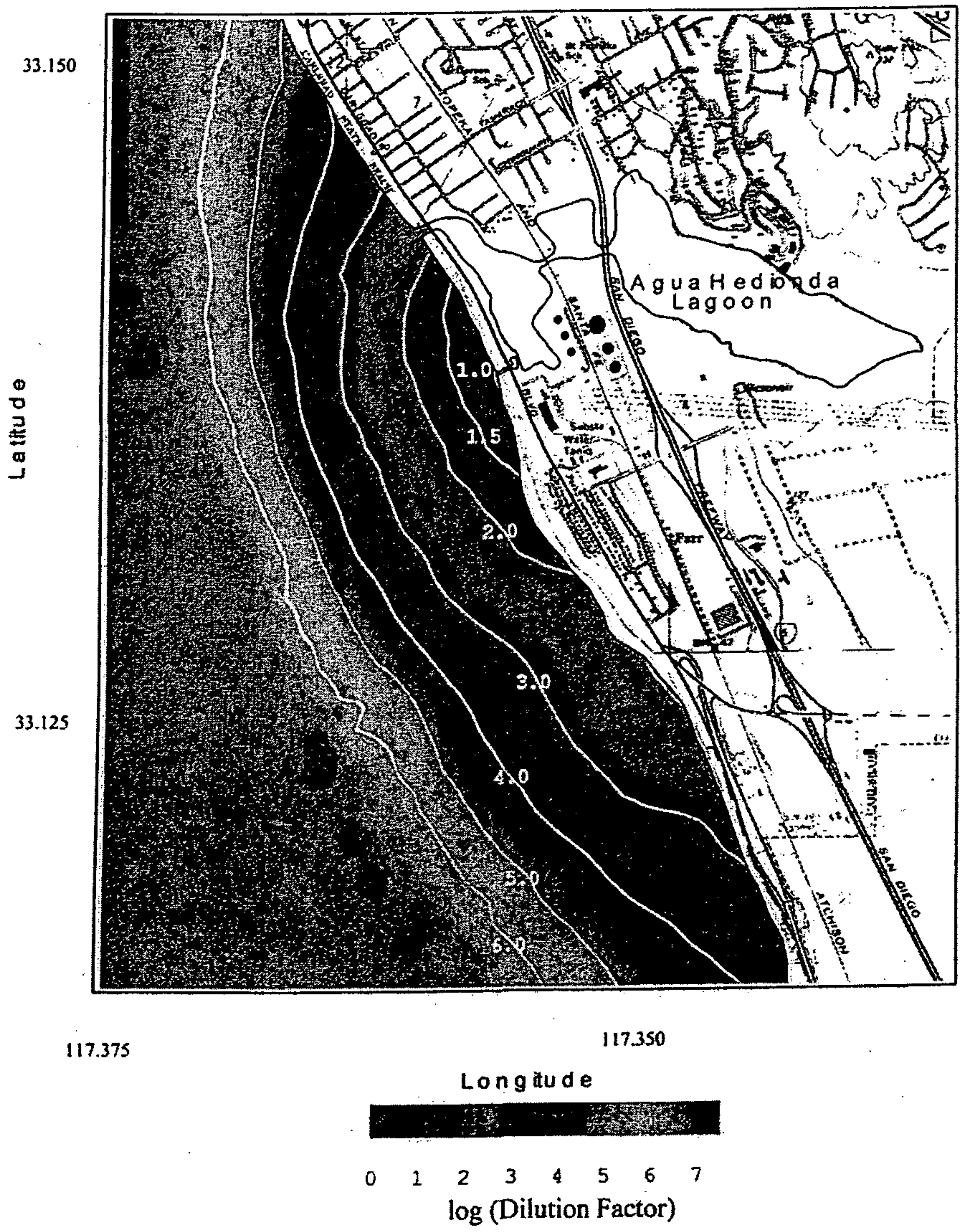

Figure 24. Scenario 5 worst case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

F) Average-Case Hyper-Saline Effects of the Low-Flow Scenario 1:

One Unit 4 circulation pump is assumed to be operating at 149.76 with 99.76 mgd being discharged into the ocean discharge channel at a salinity of 50.3 ppt after blending with the concentrated sea salts from the desalination plant. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. Figure 25 gives the salinity field on the sea floor resulting from the average case mixing conditions for low-flow Scenario 1. The salinity field is averaged over a 24 hour period. Maximum bottom salinities reach 42.3 ppt and cover an area of 8.1 acres of the sub-tidal beach face and sandy bottom nearshore habitat. The hyper-saline bottom boundary layer exposes about 19.4 acres of benthic environment to salinity in excess of 40 ppt. About 39.4 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 40.0 ppt, occurring at the shoreline 1000 ft south of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 26 indicate that minimum dilution on the sea bed at the south end of the ZID at the shoreline is 5.2 to 1 and bottom dilutions are less than 15 to 1 on 69 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for average case Scenario 1 is found in Figure 27 to be 40.5 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt. About 13.6 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 36.9 ppt, found in the surf zone at the shoreline 1000 ft south of the discharge channel. Figure 28 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 9.9 to 1 at the south end of the ZID. Everywhere else along the perimeter of the ZID the minimum water column dilution is greater than 15 to 1.

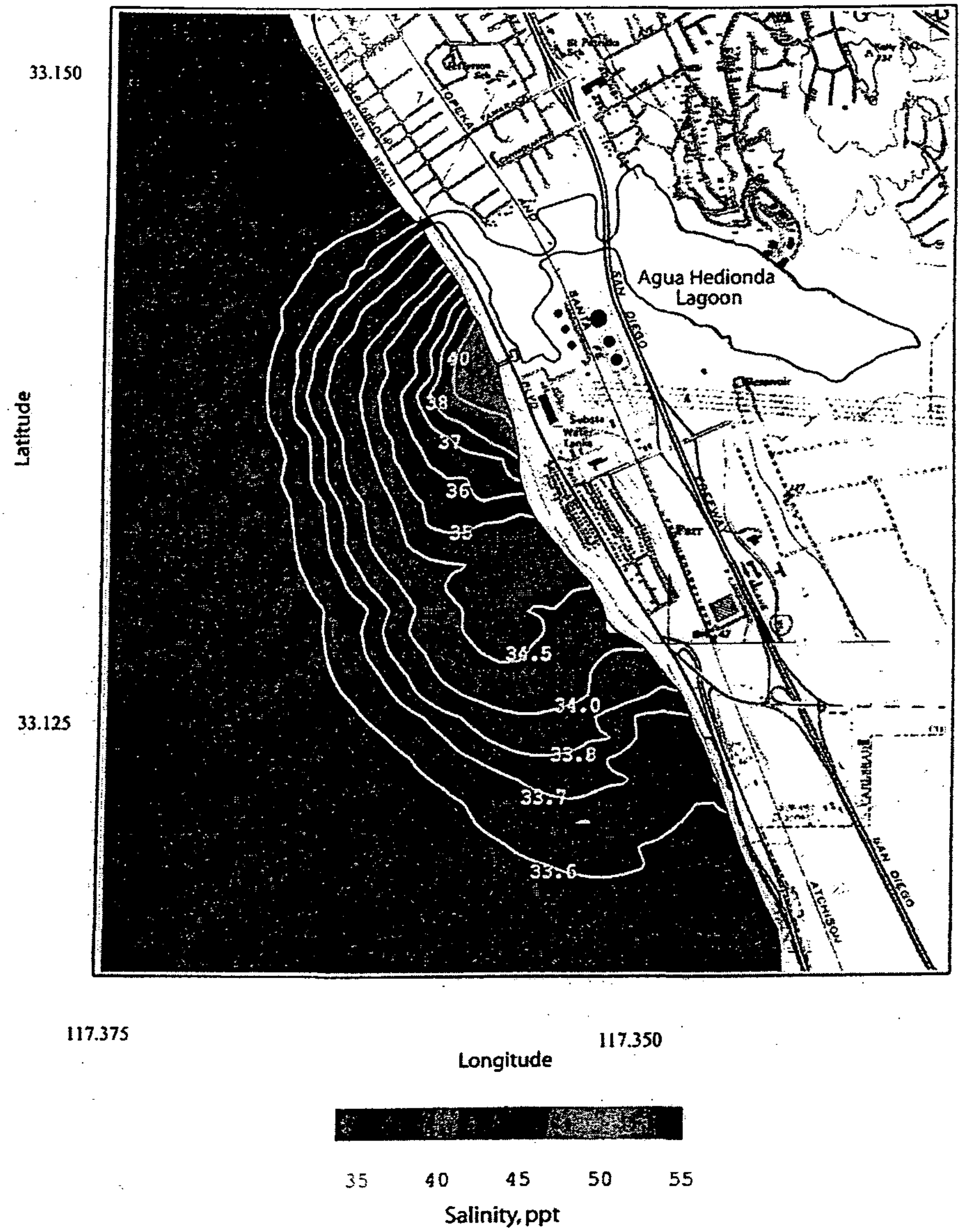

Figure 25. Scenario 1 average case with 1 Unit 5 circulation pump, for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

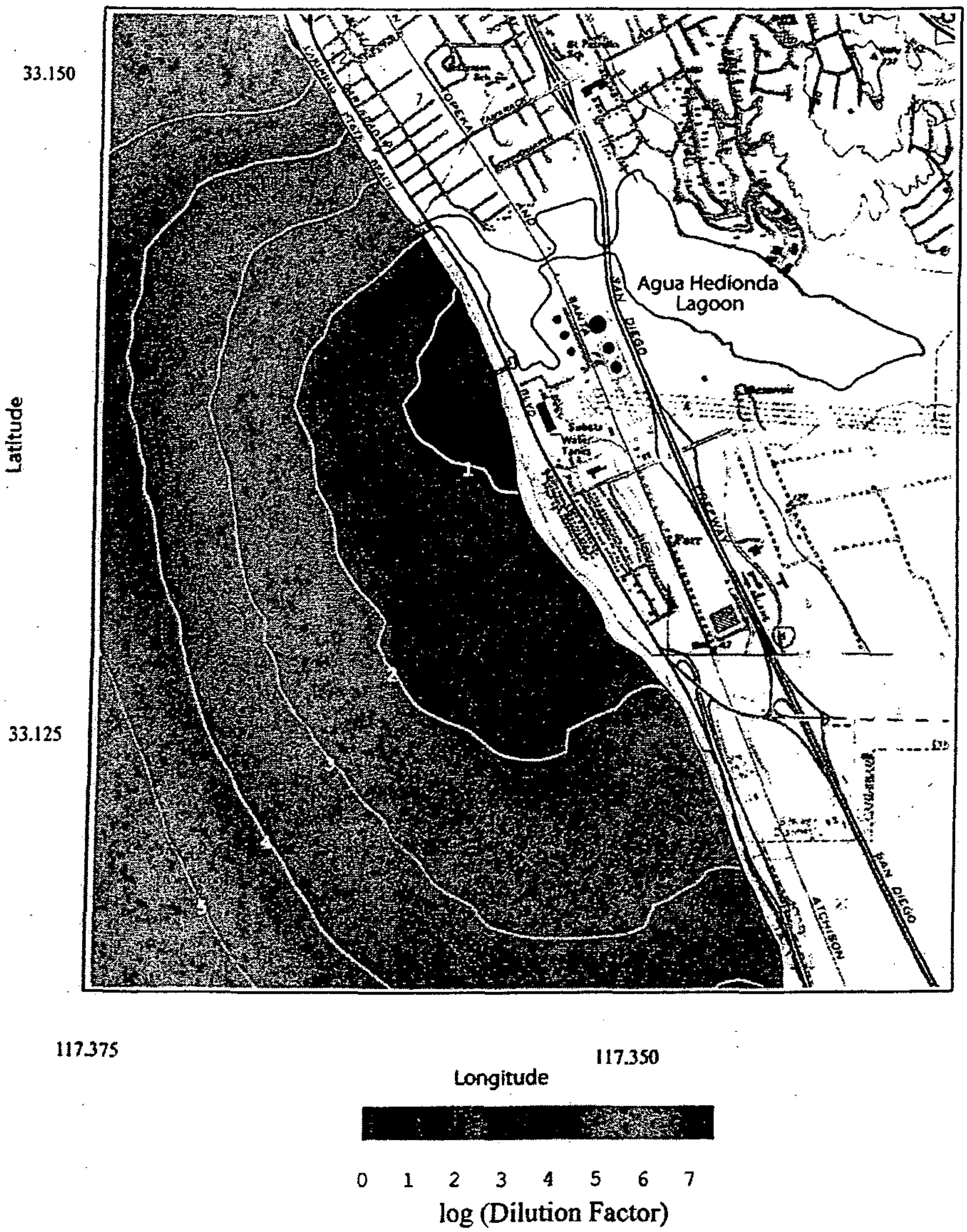

Figure 26. Scenario 1 average case with one Unit 5 circulation pump for DT = 0 °C. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

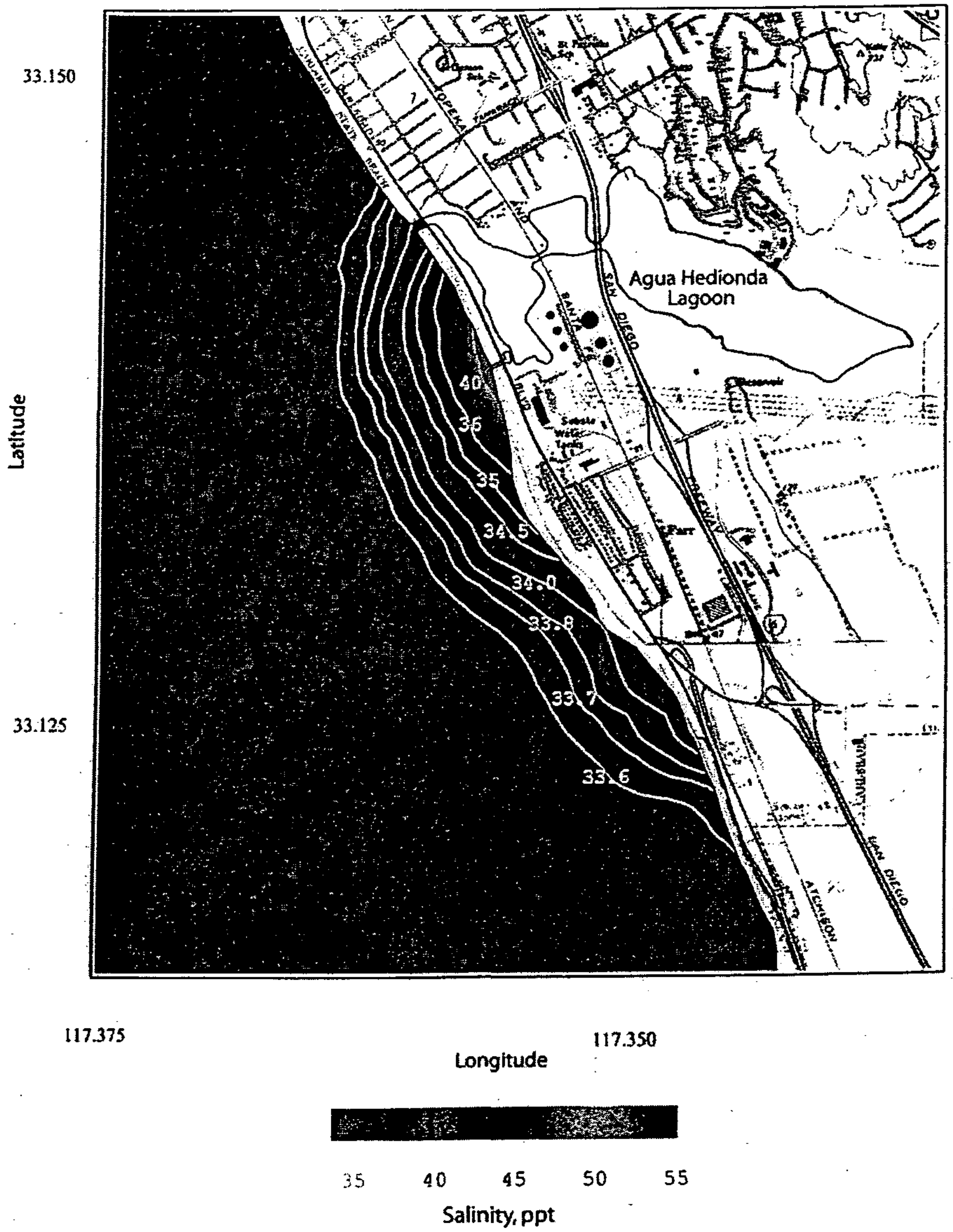

Figure 27. Scenario 1 average case with one Unit 5 circulation pump for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

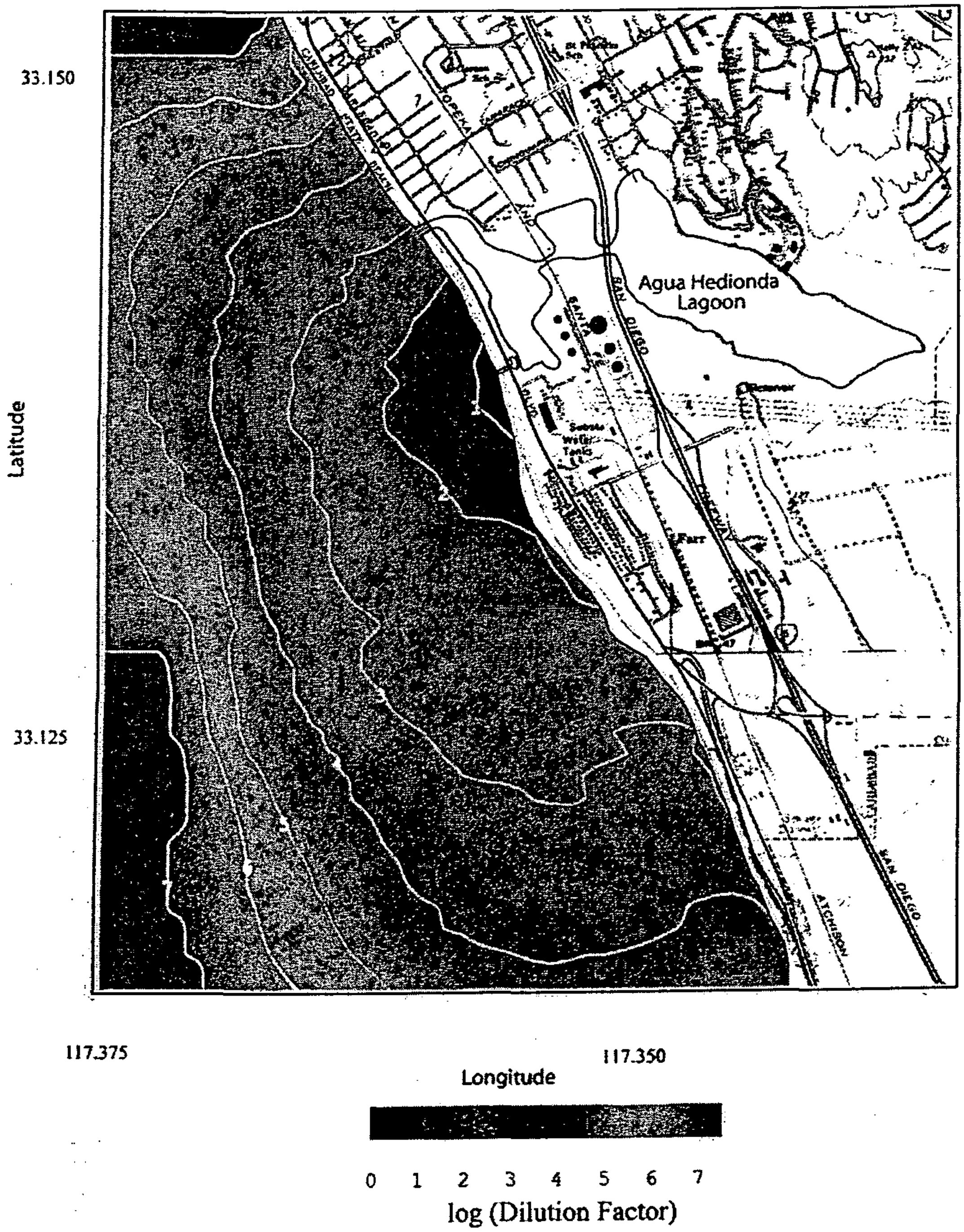

Figure 28. Scenario 1 average case with one Unit 5 circulation pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

Water column dilutions are less than 15 to 1 in 9.2 acres of pelagic surf zone, nearly all of which is inside the ZID in the immediate neighborhood of the discharge channel. The 20.5 year average of ocean mixing conditions that contributed to the Scenario 1 have a recurrence probability of 50%.

G) Average-Case Hyper-Saline Effects of the Low-Flow Scenario 2:

All pumps of Units 1 and 2 and one pump from Unit 3 are assumed to be operating at a combined intake flow rate of 172.8 mgd, with 122.8 mgd being discharged into the ocean discharge channel at a salinity of 47.1 ppt after blending with the concentrated sea salts from the desalination plant. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$ C. Figure 29 gives the salinity field on the sea floor resulting from the average case mixing conditions for low-flow Scenario 2. The salinity field is averaged over a 24 hour period. Maximum bottom salinities reach 42.0 ppt and cover an area of 2.0 acres of the sub-tidal beach face and sandy bottom nearshore habitat. The hyper-saline bottom boundary layer exposes about 9.9 acres of benthic environment to salinity in excess of 40 ppt. About 30.5 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 38.8 ppt, occurring at the shoreline 1000 ft south of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 30 indicate that minimum dilution on the sea bed at the south end of the ZID at the shoreline is 6.3 to 1 and bottom dilutions are less than 15 to 1 on 37.4 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for average case Scenario 2 is found in Figure 31 to be 37.7 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt. About 0.6 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum

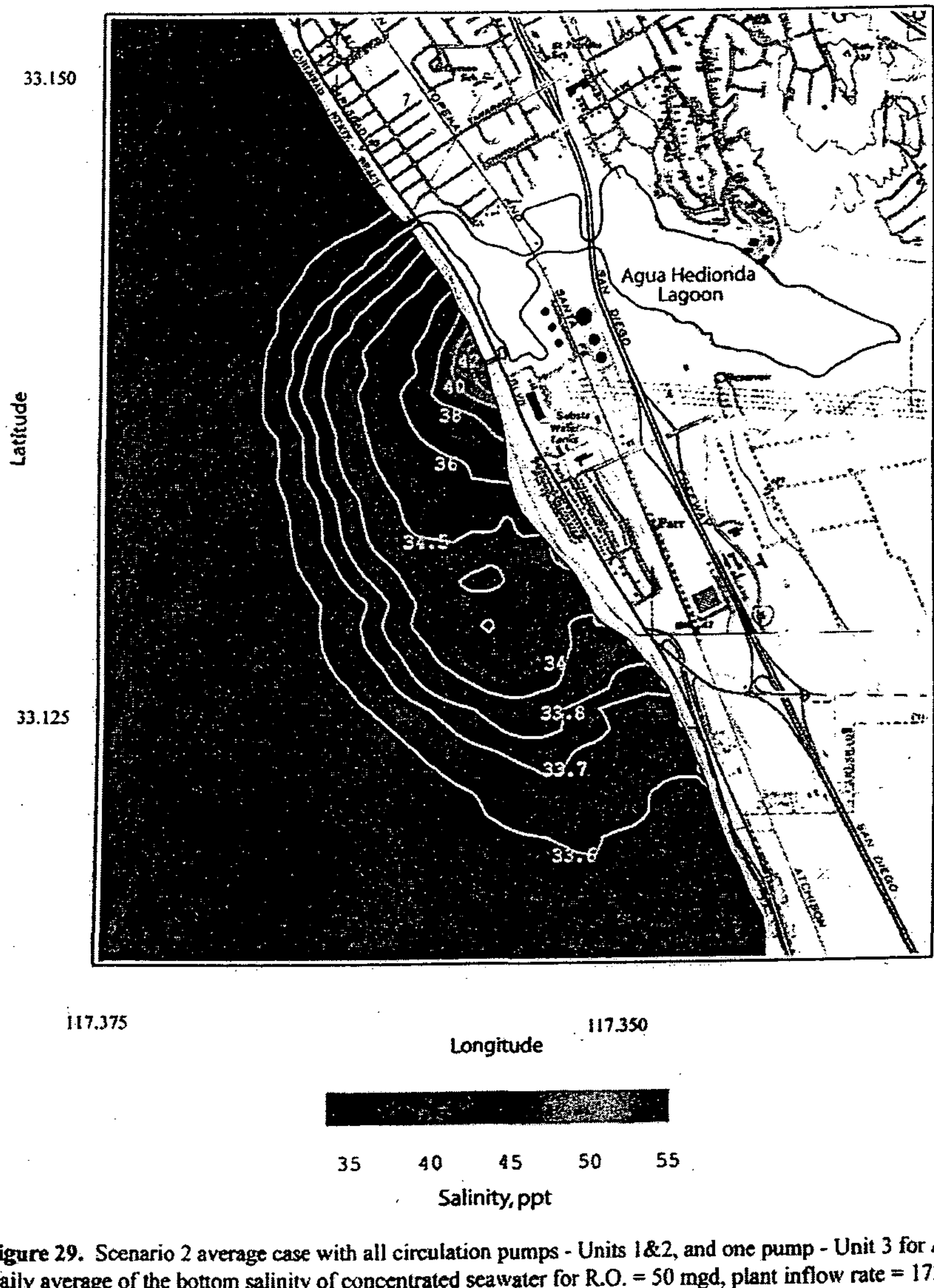

Figure 29. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

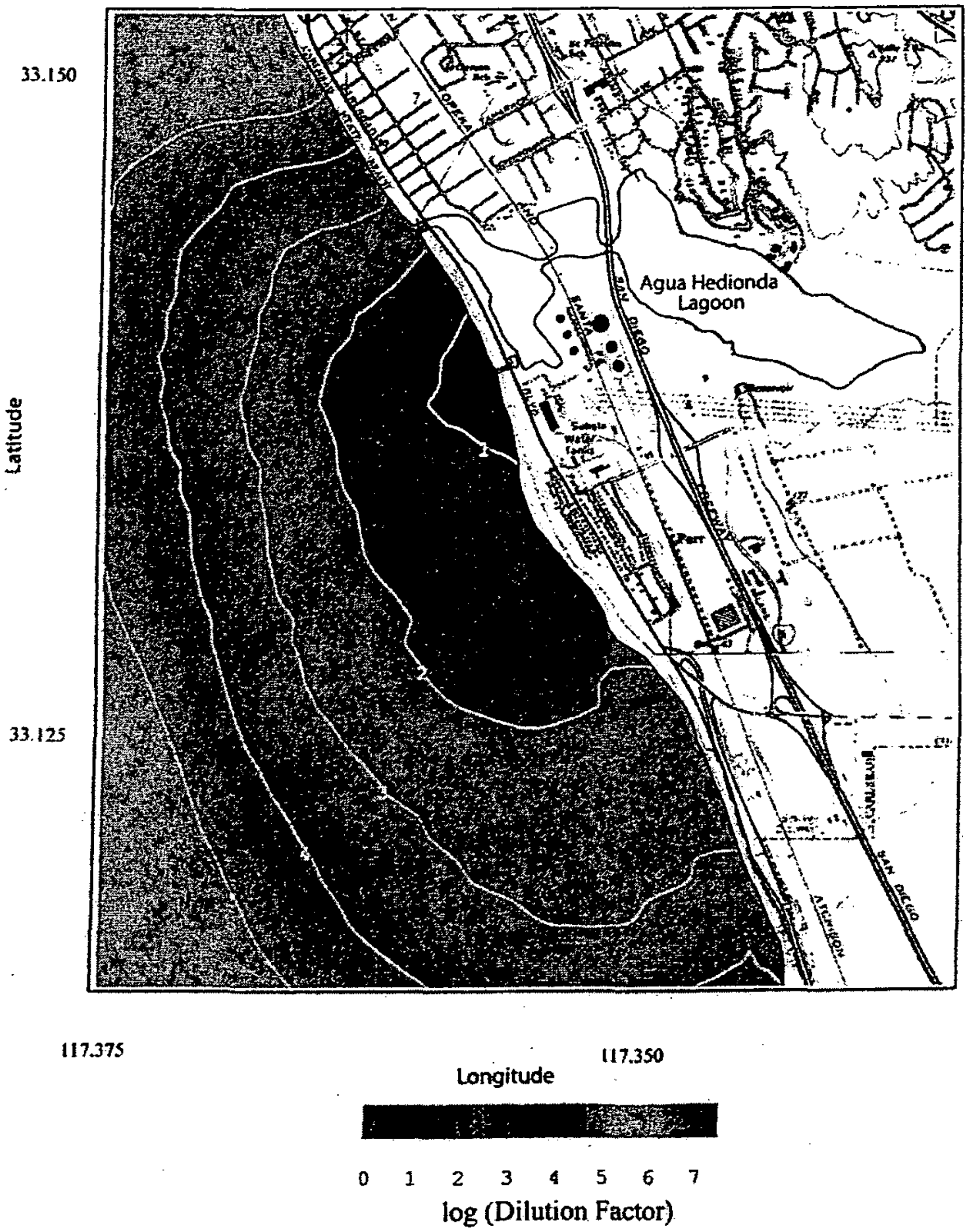

Figure 30. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

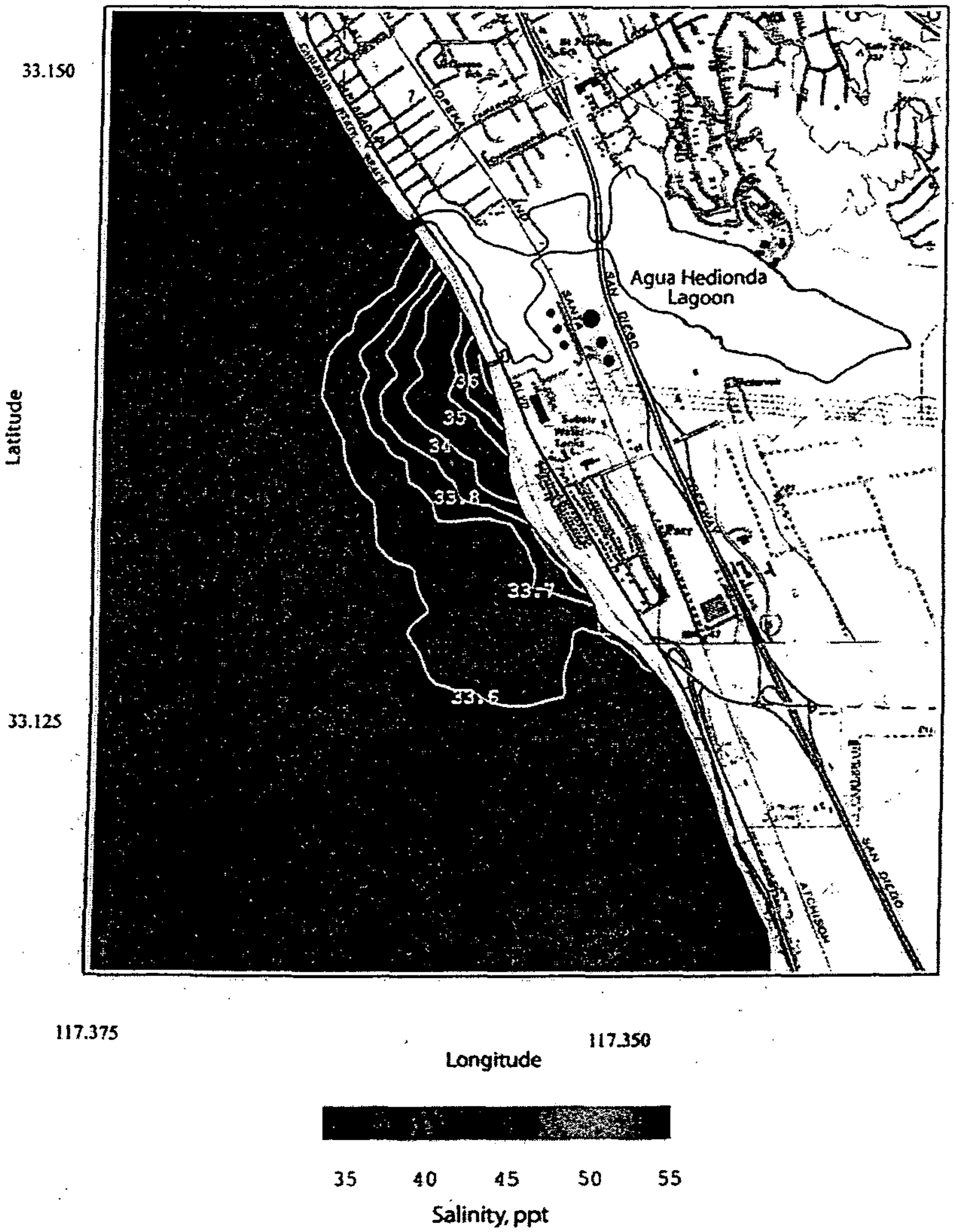

Figure 31. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

water column salinity at the edge of the ZID is 36.0 ppt, found in the surf zone at the shoreline 1000 ft south of the discharge channel. Figure 32 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 13.5 to 1 at the north end of the ZID. Dilutions are less than 15 to 1 in 5.7 acres of pelagic surf zone, all of which is inside the ZID in the immediate neighborhood of the discharge channel. The 20.5 year average of ocean mixing conditions that contributed to the Scenario 2 have a recurrence probability of 50%.

H) Average-Case Hyper-Saline Effects of the Low-Flow Scenario 3:

One pump from Unit 1 and one pump from Unit 5 are assumed to be operating at a combined intake flow rate of 184.32 mgd, with 134.32 mgd being discharged into the ocean discharge channel at a salinity of 46.0 ppt after blending with the concentrated sea salts from the desalination plant. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. Figure 33 gives the salinity field on the sea floor resulting from the average case mixing conditions for low-flow Scenario 3. The salinity field is averaged over a 24 hour period. Maximum bottom salinities reach 41.4 ppt and cover an area of 0.8 acres of the sub-tidal beach face and sandy bottom nearshore habitat. The hyper-saline bottom boundary layer exposes about 8.0 acres of benthic environment to salinity in excess of 40 ppt, all of which is inside the perimeter of the ZID. About 25.6 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 38.0 ppt, occurring at the shoreline 1000 ft south of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 34 indicate that minimum dilution on the sea bed at the south end of the ZID at the shoreline is 7.5 to 1 and bottom dilutions are less than 15 to 1 on 30.1 acres of surf zone bottom and offshore seabed.

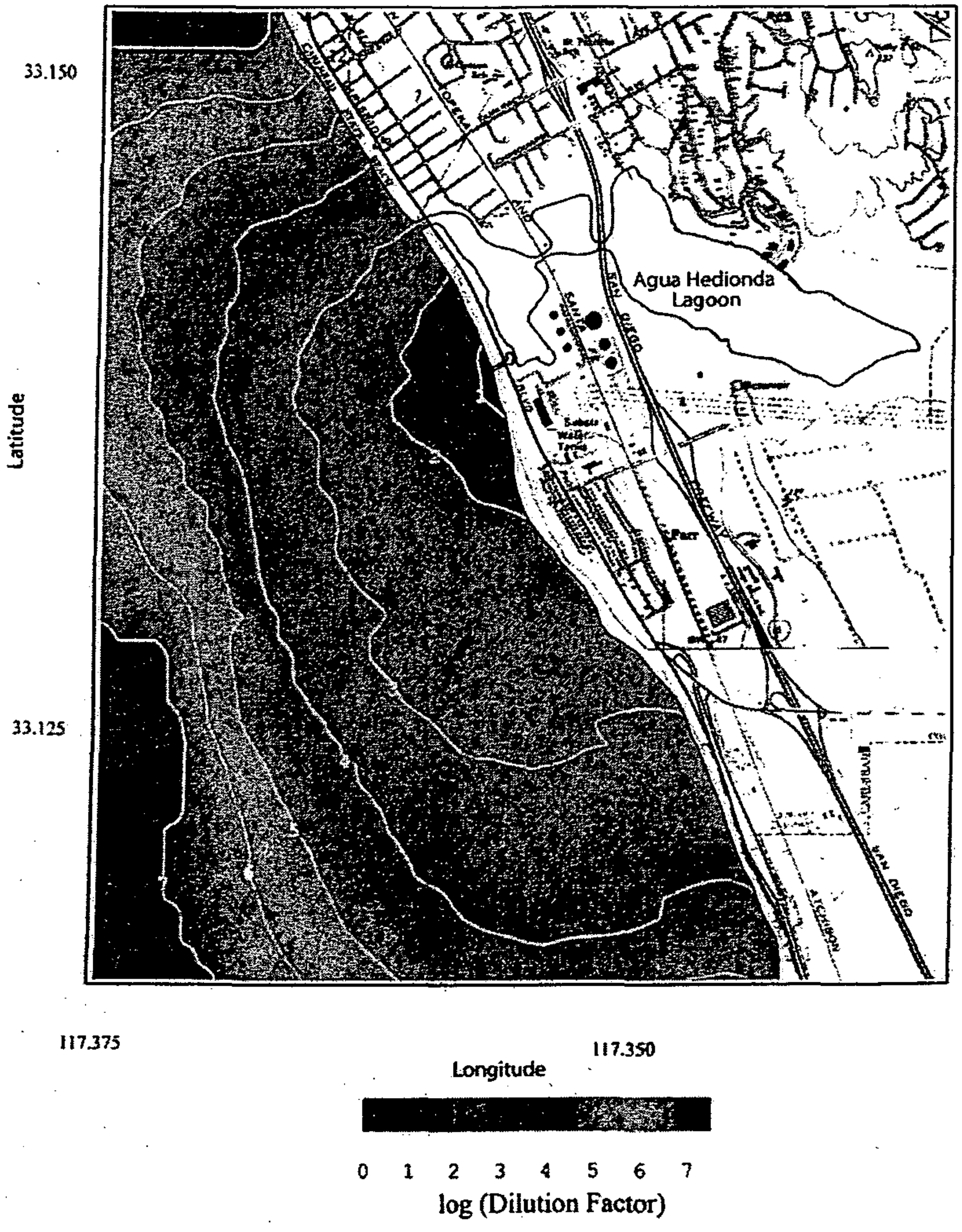

Figure 32. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

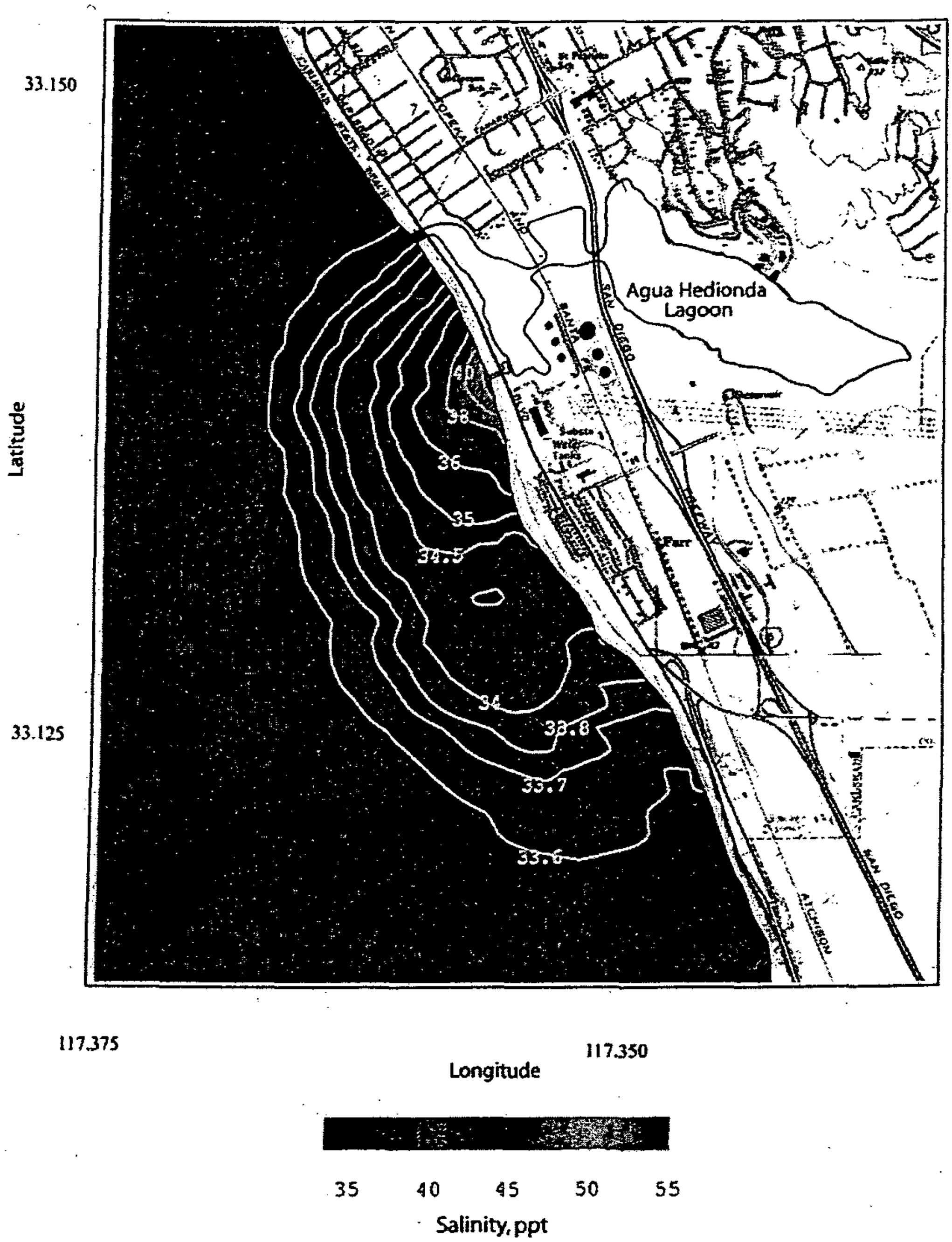

Figure 33. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

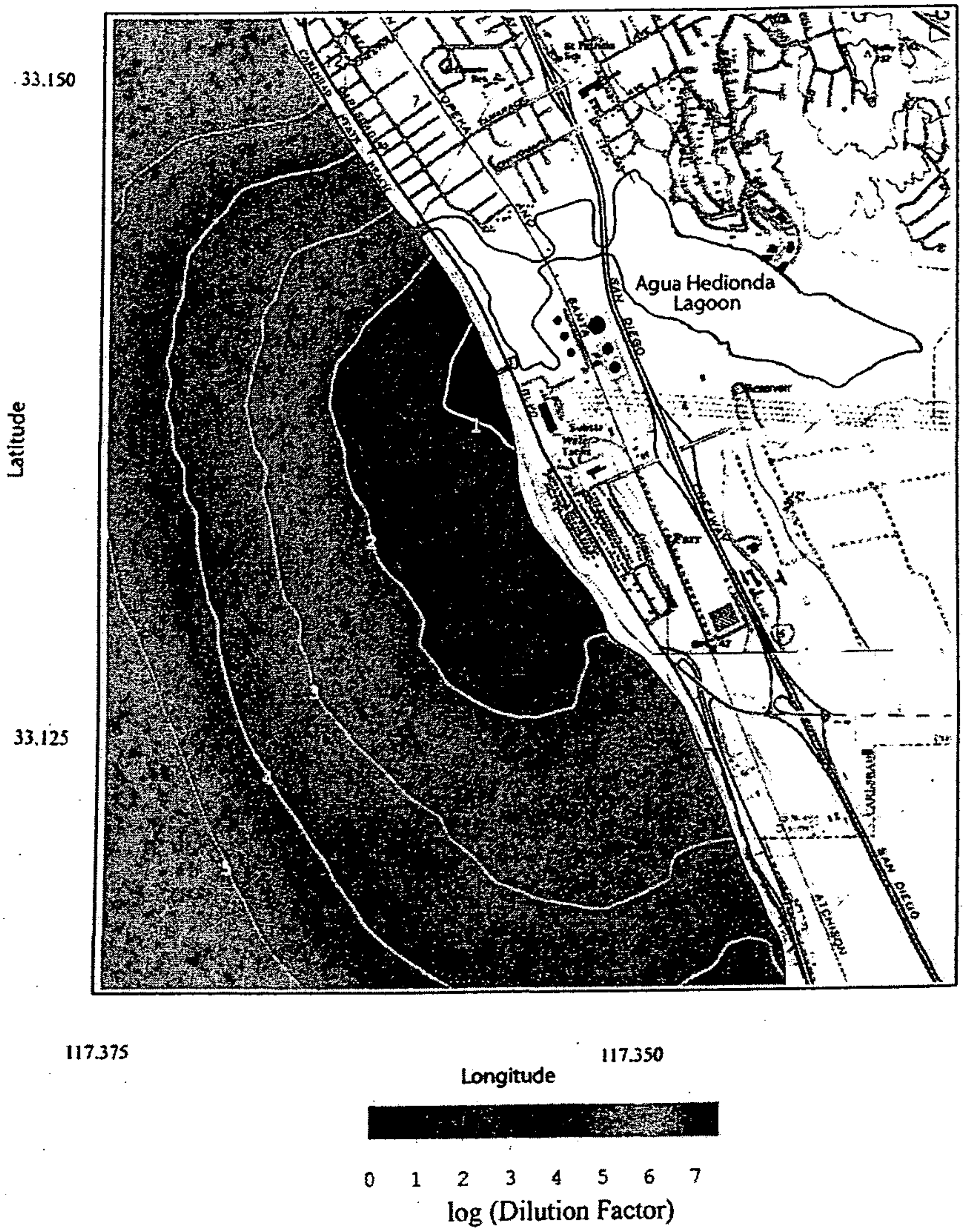

Figure 34. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

Maximum salinity in the water column for average case Scenario 3 is found in Figure 35 to be 37.0 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt. About 0.2 acres of pelagic habitat are subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 35.4 ppt, found in the surf zone at the shoreline 1000 ft south of the discharge channel. Figure 36 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 17.7 to 1 at the north end of the ZID, in compliance with 316(A) minimum dilution permit standards. Therefore, from both a salinity tolerance and regulatory perspective, the Scenario 3 low-flow case is acceptable for average ocean mixing conditions. Dilutions are less than 15 to 1 in 4.1 acres of pelagic surf zone, all of which is inside the ZID in the immediate neighborhood of the discharge channel. The 20.5 year average of ocean mixing conditions that contributed to the Scenario 3 have a recurrence probability of 50%.

I) Average-Case Hyper-Saline Effects of the Low-Flow Scenario 4:

Two pumps from Unit 1 and one pump from Unit 5 are assumed to be operating at a combined intake flow rate of 218.88 mgd, with 168.88 mgd being discharged into the ocean discharge channel at a salinity of 43.4 ppt after blending with the concentrated sea salts from the desalination plant. No power generation is assumed so that the Delta-T is $\Delta T = 0^{\circ}$C. Figure 37 gives the salinity field on the sea floor resulting from the average case mixing conditions for low-flow Scenario 4. The salinity field is averaged over a 24 hour period. Maximum bottom salinities reach 40.1 ppt and cover an area of 0.1 acres of the sub-tidal beach face and sandy bottom nearshore habitat. The hyper-saline bottom boundary layer exposes about 2.0 acres of benthic environment to salinity in excess of 40 ppt, all of which is

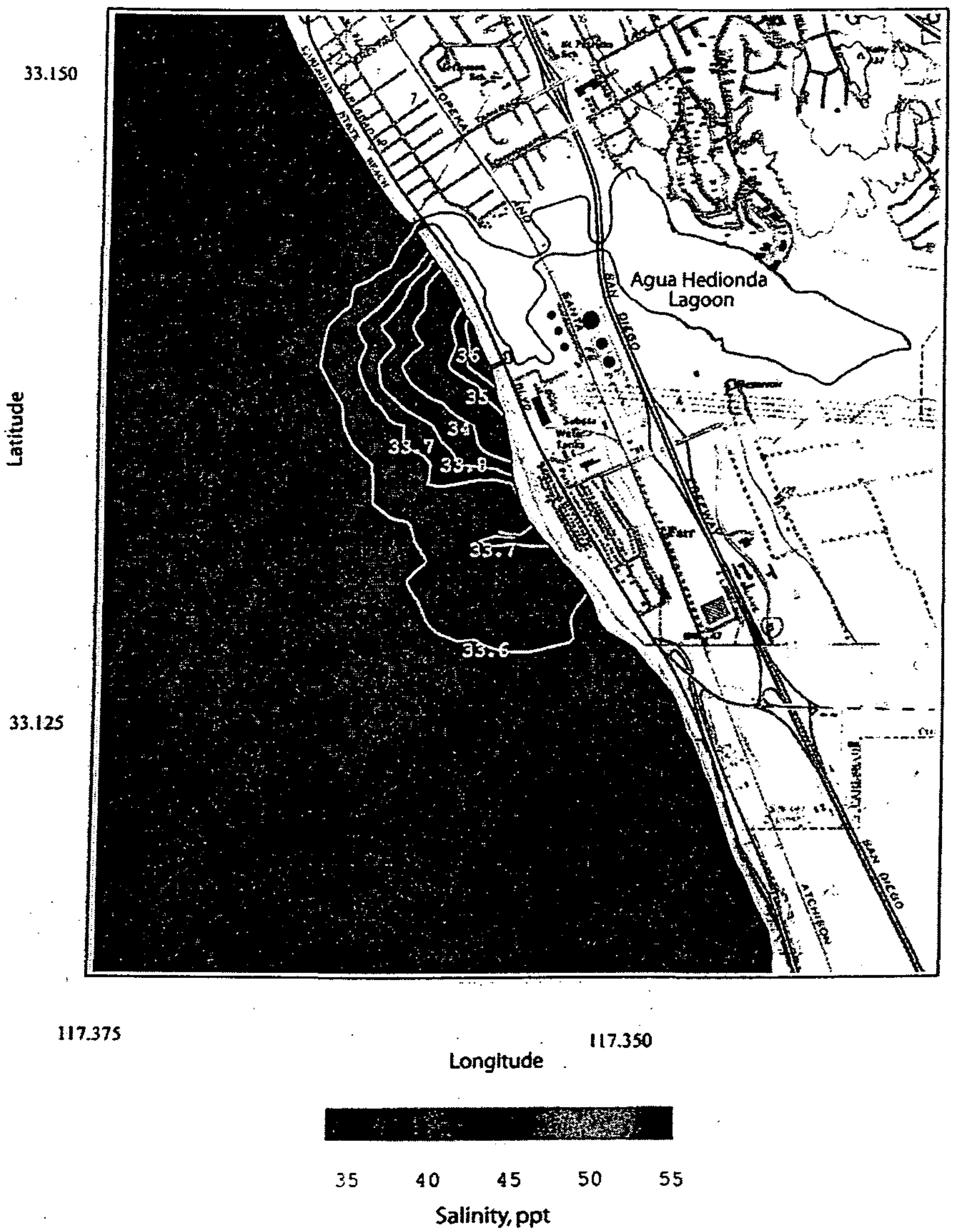

Figure 35. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

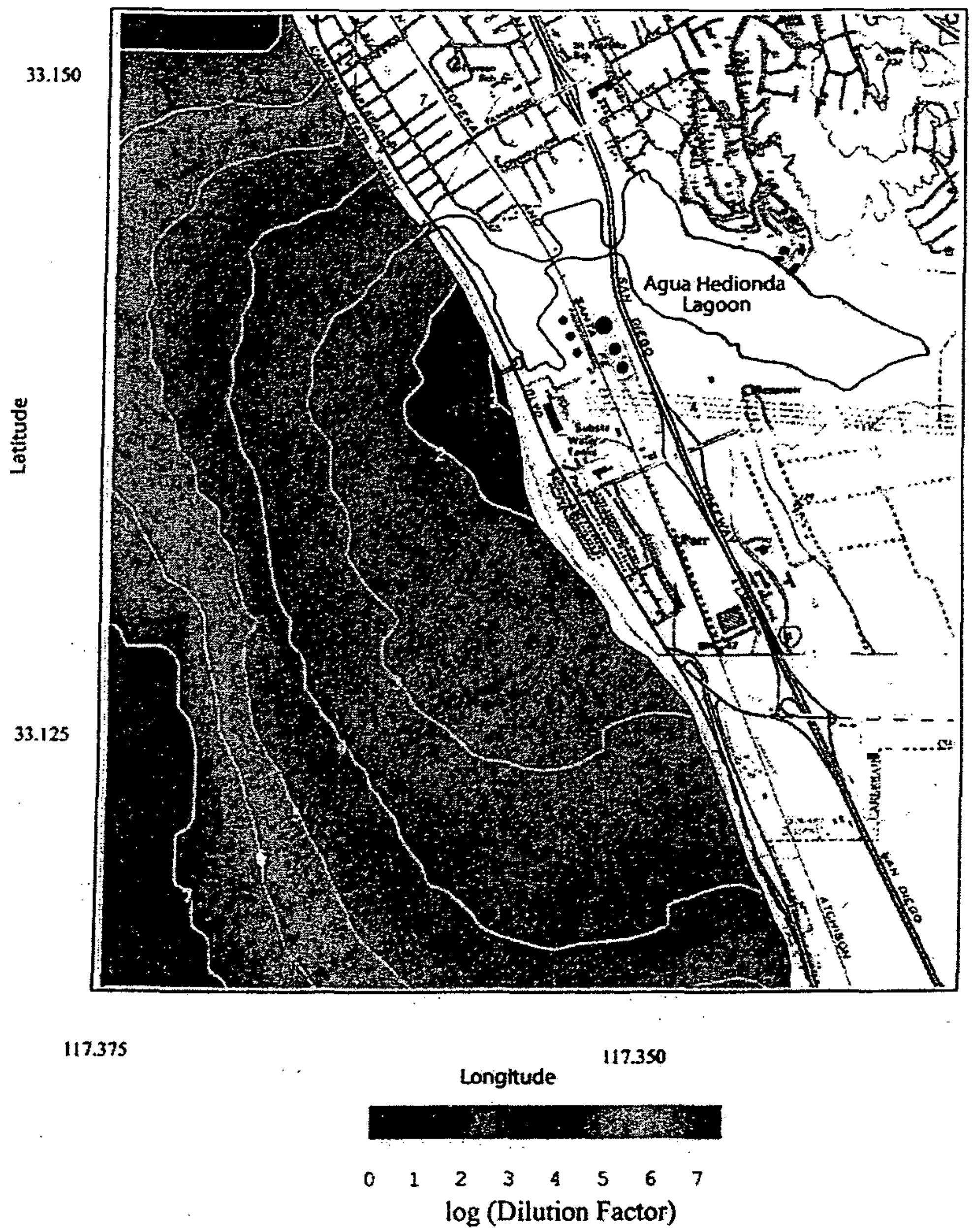

Figure 36. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

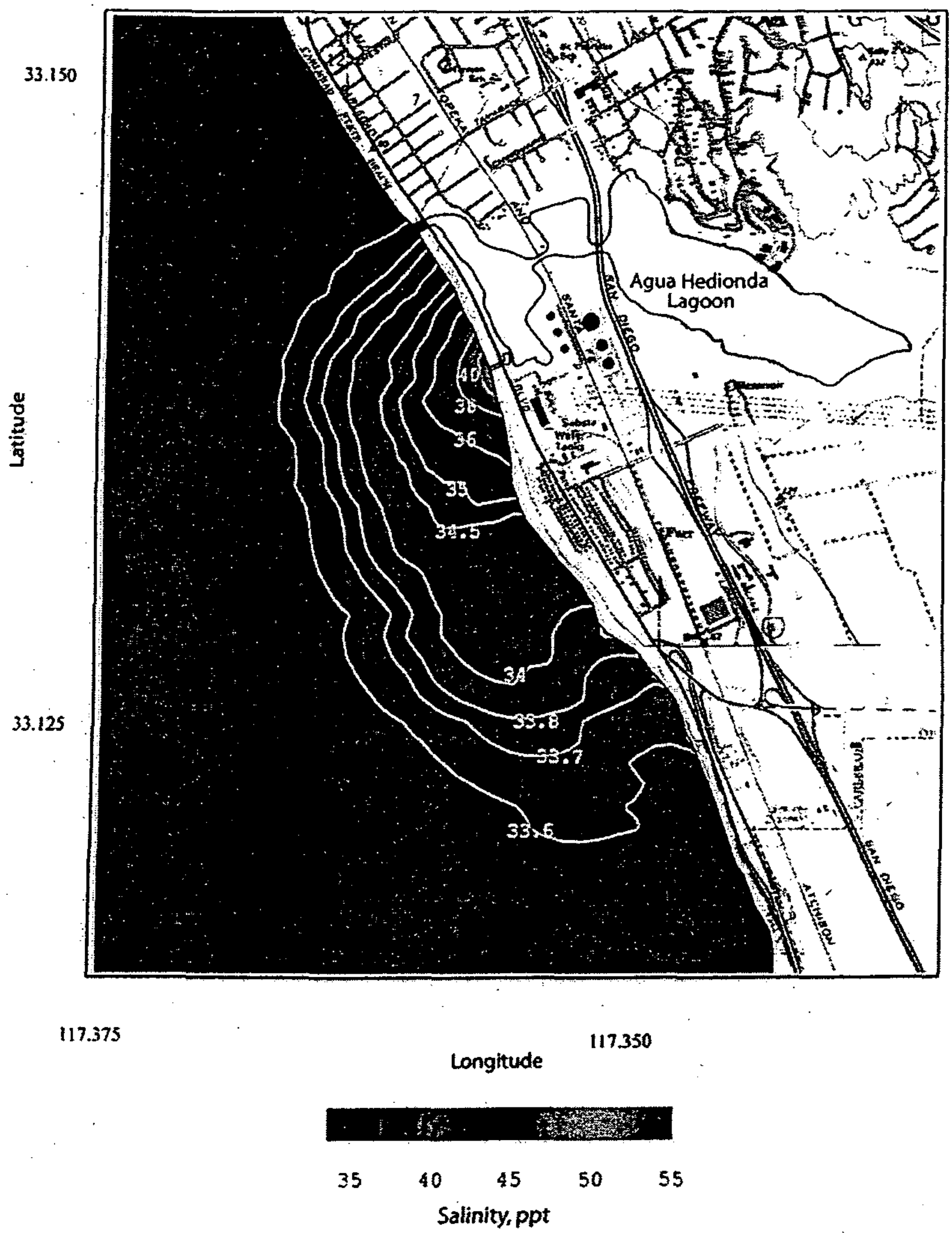

Figure 37. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

inside the perimeter of the ZID. About 16.4 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 37.0 ppt, occurring at the shoreline 1000 ft south of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 38 indicate that minimum dilution on the sea bed at the south end of the ZID at the shoreline is 9.6 to 1 and bottom dilutions are less than 15 to 1 on 25.6 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for average case Scenario 4 is found in Figure 39 to be 36.2 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt, nor is any pelagic habitat subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 35.1 ppt, found in the surf zone at the shoreline 1000 ft south of the discharge channel. Figure 40 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 21.1 to 1 at the south end of the ZID, in compliance with 316(A) minimum dilution permit standards. Therefore, from both a salinity tolerance and regulatory perspective, the Scenario 4 low-flow case is acceptable for average ocean mixing conditions. Dilutions are less than 15 to 1 in 2.2 acres of pelagic surf zone, all of which is inside the ZID in the immediate neighborhood of the discharge channel. The 20.5 year average of ocean mixing conditions that contributed to the Scenario 4 have a recurrence probability of 50%.

J) Average-Case Hyper-Saline Effects of the Low-Flow Scenario 5:

Two pumps from Unit 4 are assumed to be operating at a combined intake flow rate of 304 mgd, with 254 mgd being discharged into the ocean discharge channel at a salinity of 40.11 ppt after blending with the concentrated sea salts from the desalination plant. No power generation is assumed so that the Delta-T

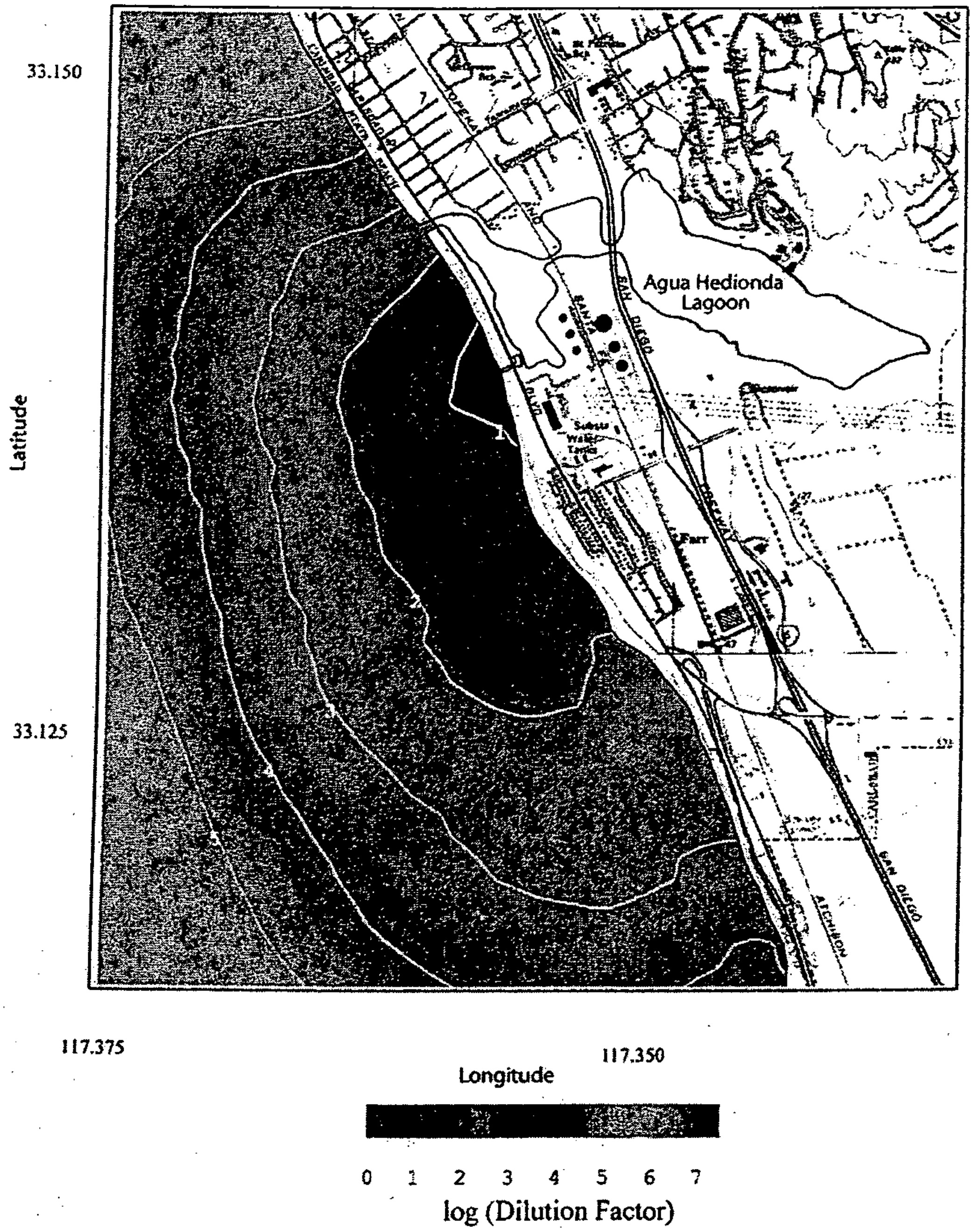

Figure 38. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

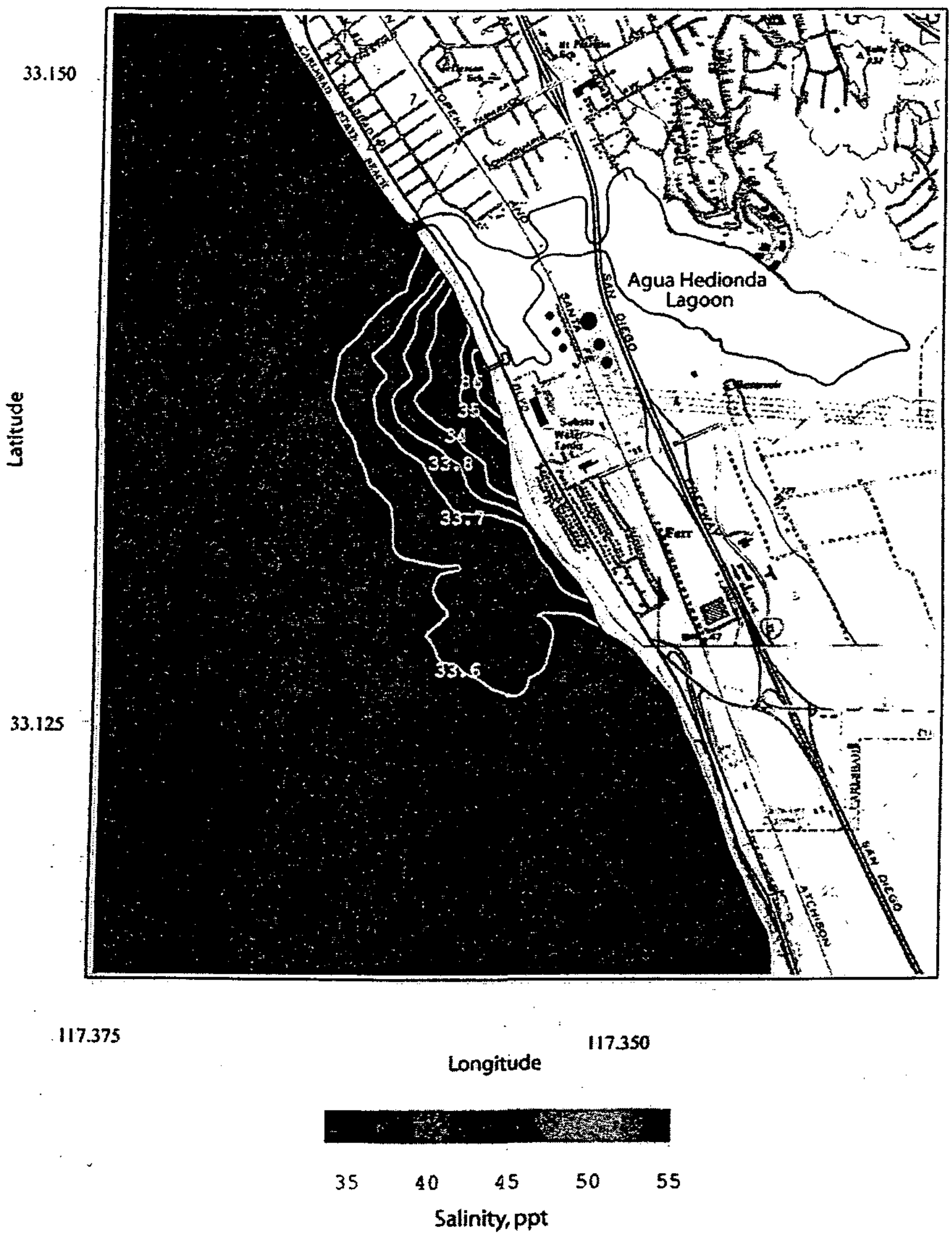

Figure 39. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

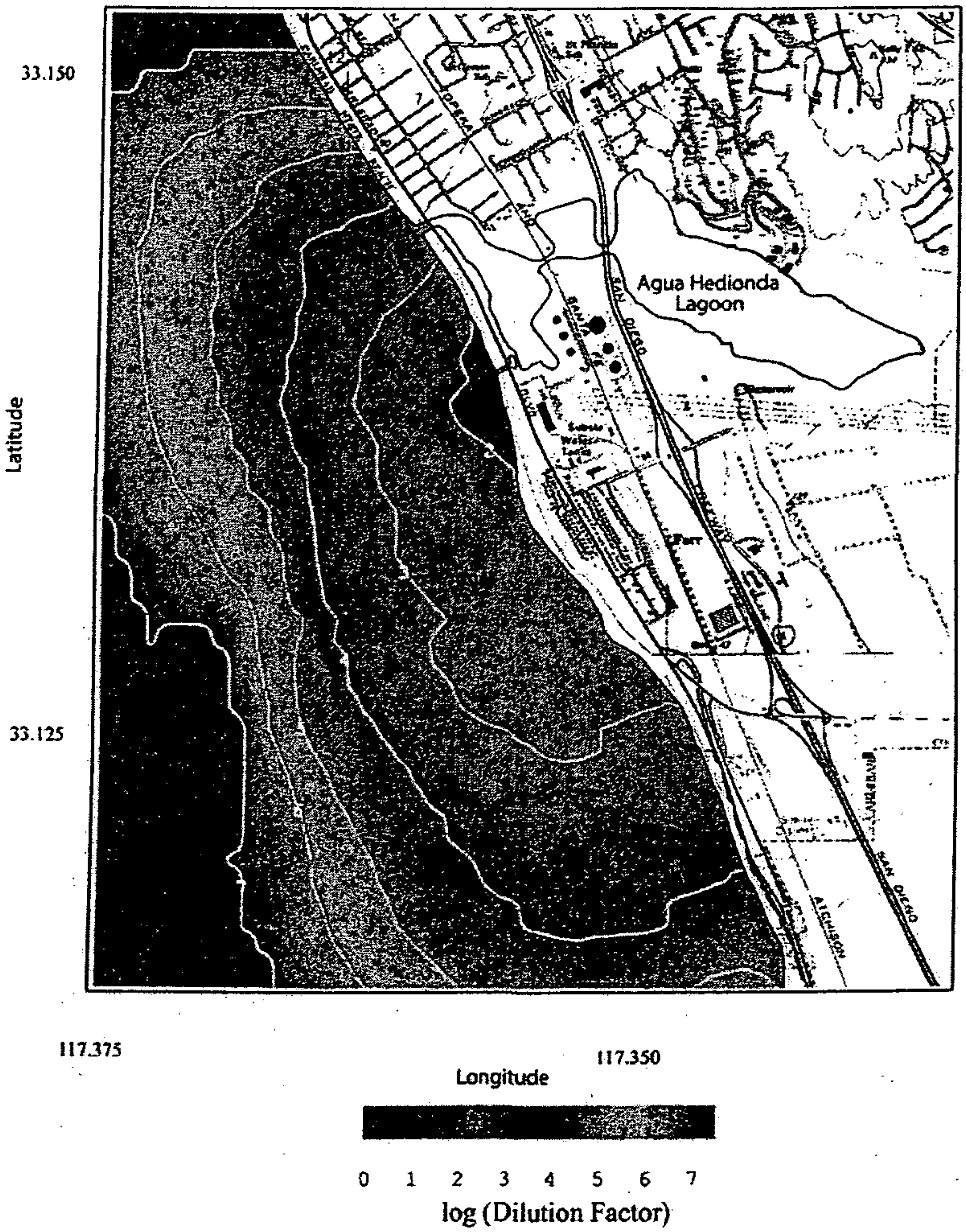

Figure 40. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

is $\Delta T = 0^{\circ}C$. While these are the same pump combinations and end-of-pipe salinity as the "*unheated Unit 4 historical extreme case*" that was presented in Appendix E of the certified EIR, the average case mixing results were not given in the certified EIR. We present them herein for completeness.

Figure 41 gives the salinity field on the sea floor resulting from the average case mixing conditions for low-flow Scenario 5. The salinity field is averaged over a 24 hour period. Maximum bottom salinities reach 38.1 ppt and cover an area of 1.5 acres of the sub-tidal beach face and sandy bottom nearshore habitat. No benthic habitat is exposed to salinity in excess of 40 ppt. About 8.3 acres of seabed are subjected to salinity elevated 10 % above ambient ocean conditions. Maximum bottom salinity found anywhere along the boundaries of the ZID is 36.0 ppt, occurring at the shoreline 1000 ft south of the discharge channel. Bottom dilution factors for the raw concentrate in Figure 42 indicate that minimum dilution on the sea bed at the south end of the ZID at the shoreline is 13.5 to 1 and bottom dilutions are less than 15 to 1 on 12.4 acres of surf zone bottom and offshore seabed.

Maximum salinity in the water column for average case Scenario 5 is found in Figure 43 to be 36.0 ppt in the surfzone immediately seaward of the discharge jetty. No pelagic area is subject to salinity in excess of 40 ppt, nor is any pelagic habitat subjected to salinity reaching 10% over ambient. Maximum water column salinity at the edge of the ZID is 34.7 ppt, found in the surf zone at the shoreline 1000 ft south of the discharge channel. Figure 44 shows that in the water column, where 316(A) dilution standards apply, minimum dilutions are 28.2 to 1 at the south end of the ZID, in compliance with 316(A) minimum dilution permit standards. Therefore, from both a salinity tolerance and regulatory perspective, the

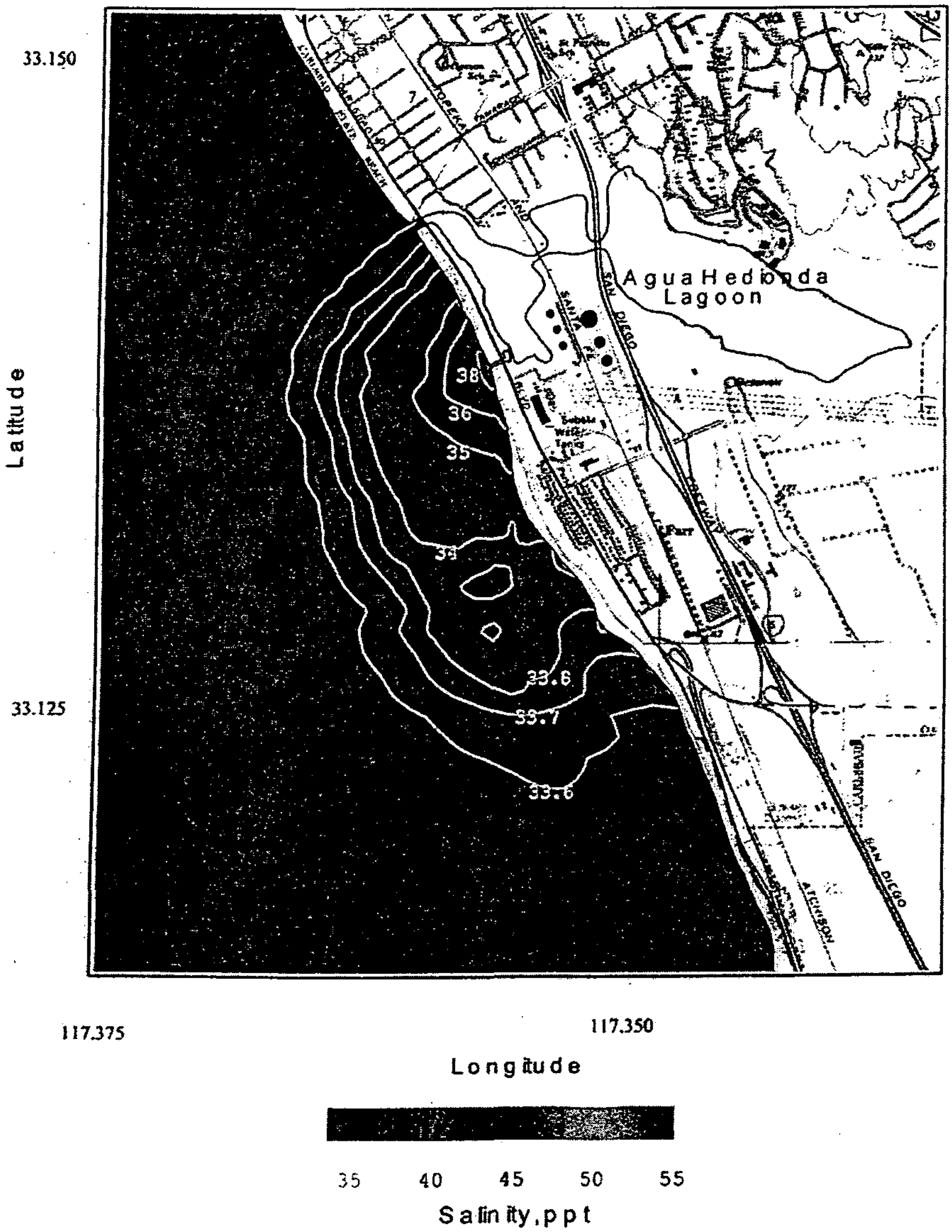

Figure 41. Scenario 5 average case with two Unit 4 circulation 2 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

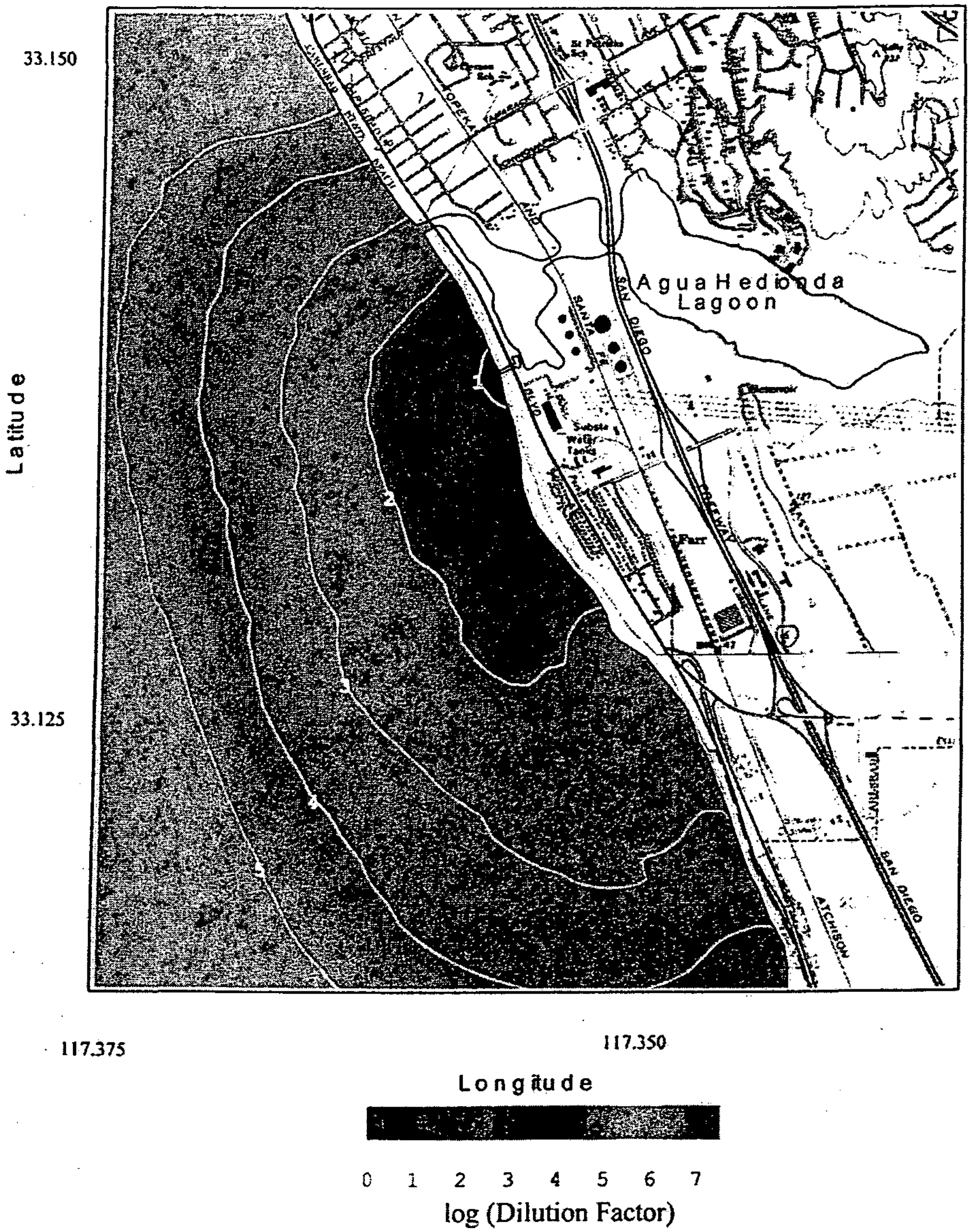

Figure 42. Scenario 5 average case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May 1994.

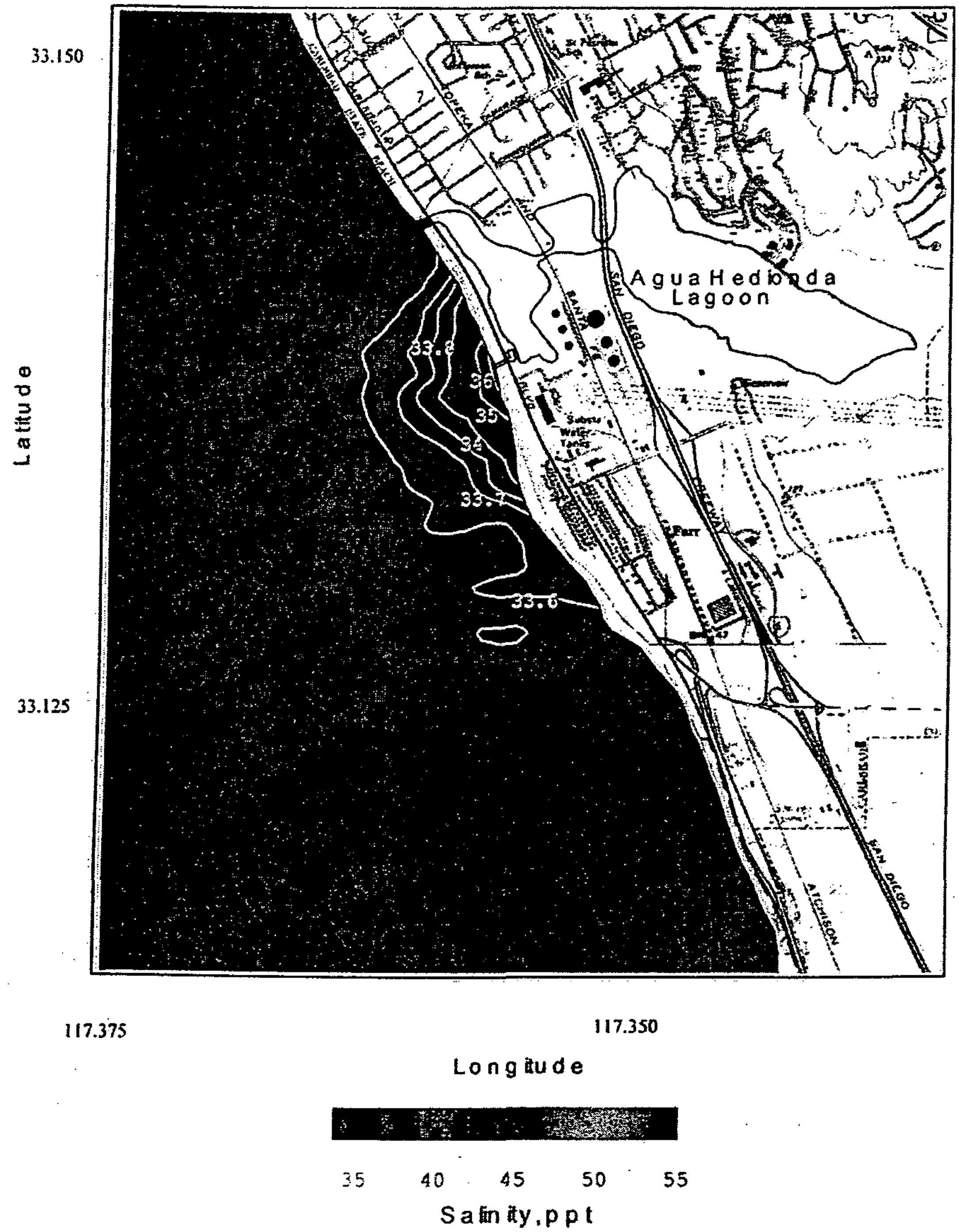

Figure 43. Scenario 5 average case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May 1994.

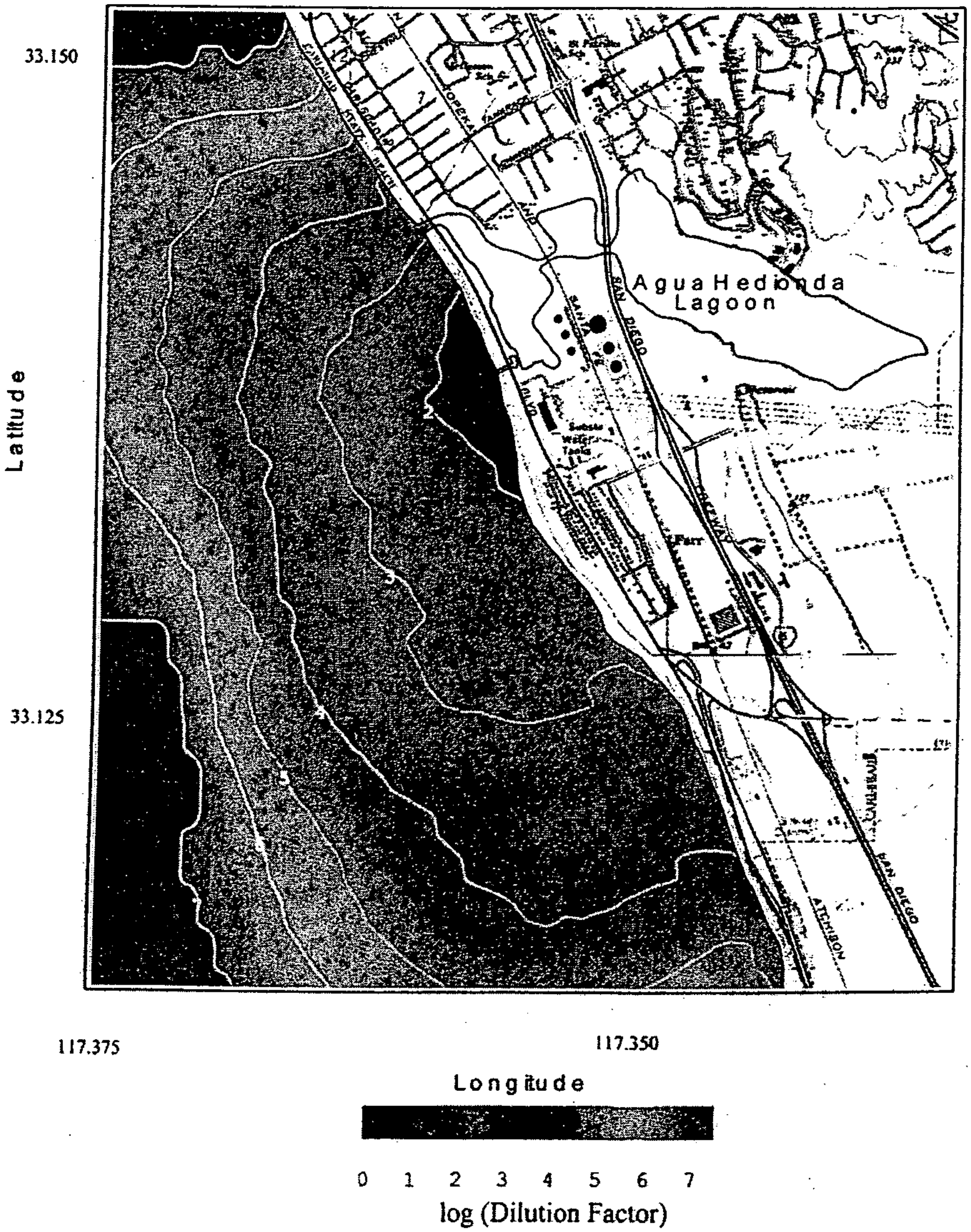

Figure 44. Scenario 5 average case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May 1994.

Scenario 5 low-flow case is acceptable for average ocean mixing conditions. Dilutions are less than 15 to 1 in 0.7 acres of pelagic surf zone, all of which is inside the ZID in the immediate neighborhood of the discharge channel. The 20.5 year average of ocean mixing conditions that contributed to the Scenario 4 have a recurrence probability of 50%.

4) Summary and Conclusions:

This study evaluates the dispersion and dilution of concentrated sea water (brine) associated with reduced flow rate operations of a stand alone desalination plant co-located at Encina Generating Station. The analysis by hydrodynamic model simulation studied the effects of reduced intake flow rates ranging from 149.8 mgd to 304 mgd for both extreme minimums and means in ocean mixing. The results are summarized in Table 1 below.

We find that intake flow rates of at least 218.9 mgd of unheated source water (producing end of pipe salinity of no more than 43.3 ppt) will satisfy both acute toxicity limits of 40 ppt and existing minimum dilution standards of 15 to 1 in the *zone of initial dilution* (ZID) for all ocean mixing conditions. Intake flow rates reduced to as little as 184.3 mgd (producing end of pipe salinity of no more than 46 ppt) will satisfy both acute toxicity limits existing minimum dilution standards for average ocean mixing conditions but not for extreme minimum mixing conditions having a recurrence probability of 0.013 %. Intake flow rates between 149.8 mgd and 172.8 mgd produce hyper salinity impacts that can probably be tolerated by indigenous marine organisms during mean-ocean mixing conditions, but result in unacceptably low minimum dilution levels in the ZID according to existing NPDES permit limits set for the power plant thermal effluent.

Table 1. Salinity Changes For Average and Extreme Desalination Facility Operating Conditions With and Without the Power Generation at Encina Generating Station

Scenario	Plant Inflow Rate (mgd)	Maximum Bottom Salinity (ppt)	Benthic Area Exposed to Salinity > 36.9 ppt	Maximum Water Column Salinity (ppt)	Pelagic Area Exposed to Salinity > 36.9	Minimum Pelagic Dilution at ZID	Frequency of Occurrence
Historical Average (w/ power plant)	576 (ΔT= 5.5 °C)	36.0	0.0	34.4	0.0	68.4 to 1	50%
Historical Extreme (w/ power plant)	304 (ΔT= 5.5 °C)	37.9	15	36.1	0.0	24.1 to 1	<0.01%
Scenario 1 Historical Average (w/o power plant)	149.76 (ΔT= 0 °C)	42.3	39.4	40.5	13.6	9.9 to 1	50%
Scenario 1 Historical Extreme (w/o power plant)	149.76 (ΔT= 0 °C)	48.1	248	41.8	28	7.1 to 1	0.013%
Scenario 2 Historical Average (w/o power plant)	172.8 (ΔT= 0 °C)	42.0	30.5	37.7	0.6	13.5 to 1	50%
Scenario 2 Historical Extreme (w/o power plant)	172.8 (ΔT= 0 °C)	42.4	205	40.3	14.3	9.9 to 1	0.013%
Scenario 3 Historical Average (w/o power plant)	184.3 (ΔT= 0 °C)	41.4	25.6	37.0	0.2	17.7 to 1	50%
Scenario 3 Historical Extreme (w/o power plant)	184.3 (ΔT= 0 °C)	42.0	188	40.0	12.3	10.5 to 1	0.013%
Scenario 4 Historical Average (w/o power plant)	218.9 (ΔT= 0 °C)	40.1	16.4	36.2	0.0	21.1 to 1	50%
Scenario 4 Historical Extreme (w/o power plant)	218.9 (ΔT= 0 °C)	41.0	147	38.0	8.7	15.0 to 1	0.013%
Scenario 5 Historical Average (w/o power plant)	304 (ΔT= 0 °C)	38.1	8.3	36.0	0.0	28.2 to 1	50%
Scenario 5 Historical Extreme (w/o power plant)	304 (ΔT= 0 °C)	39.0	44	36.0	0.0	19.8 to 1	0.013%

Reference:

Jenkins, S. A. And J. Wasyl, 2005, "Hydrodynamic Modeling of Dispersion and Dilution of Concentrated Seawater Produced by the Ocean Desalination Project at the Encina Power Plant, Carlsbad, CA, Part II: Saline Anomalies due to Theoretical Extreme Case Hydraulic Scenarios, " submitted to Poseidon Resources, 97pp.

EIR (2005) "Precise Development Plan and Desalination Plant," EIR 03-05-Sch #2004041081, prepared for City of Carlsbad by Dudek and Associates, December, 2005.