P O S E I D O N   R E S O U R C E S

June 29, 2007

VIA CURRIER

Dr. Charles Cheng
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123

RE: TRANSMITTAL RVISED FLOW, ENTRAINMENT, AND IMPINGEMENT MINIMIZATION PLAN FOR THE CARLSBAD SEAWATER DESALINATION PROJECT

Dear Dr. Cheng:

Poseidon Resources Corporation (Poseidon) respectfully submits to the San Diego Regional Water Quality Control Board (Regional Board) the revised Flow, Entrainment, and Impingement Minimization Plan (Minimization Plan) for the Carlsbad Desalination Project in Carlsbad, CA. The Minimization Plan has been extensively revised to address the comments received from the Regional Board Staff and members of the public. Poseidon is requesting that the Regional Water Quality Control Board review and approve the Minimization Plan as provided in Section VI.2.e of Order No. R9-2006-0065.

Section VI.2.e of Order No. R9-2006-0065 provides that:

> *e. Flow, Entrainment and Impingement Minimization Plan*
>
> *The Discharger shall submit a Flow, Entrainment and Impingement Minimization Plan within 180 days of adoption of the Order. The plan shall assess the feasibility of site-specific plans, procedures, and practices to be implemented and/or mitigation measures to minimize the impacts to marine organisms when the CDP intake requirements exceed the volume of water being discharged by the EPS. The plan is subject to the approval of the Regional Water Board and is modified as directed by the Regional Water Board.*

The revised Minimization Plan was developed in fulfillment of the above-stated requirements. The Minimization Plan contains site-specific activities, procedures, practices and mitigation measures to minimize impacts to marine organisms when the Carlsbad Desalination Plant intake requirements exceed the volume of water being discharged by the Encina Power Station.

Poseidon Resources Corporation
501 West Broadway, Suite 840, San Diego, CA 92101, USA
619-595-7802 Fax: 619-595-7892

Executive Office: 1055 Washington Boulevard, Stamford, CT 06901

We look forward to working with the Regional Board on the review, modification (if necessary), and approval of the Minimization Plan for the Carlsbad Desalination Project.

Sincerely,

Peter M. MacLaggan
Senior Vice President

Enclosure

cc Mr. John Robertus, without enclosure
Mr. Michael McCann, without enclosure
Mr. Robert Morris, without enclosure
Dr. Michael Welch, without enclosure

CARLSBAD SEAWATER DESALINATION PROJECT

SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

REGION 9, SAN DIEGO REGION

ORDER NO. R-9-2006-0065

NPDES NO. CA0109223

REVISED

FLOW, ENTRAINMENT AND IMPINGEMENT MINIMIZATION PLAN

June 1, 2007

CARLSBAD SEAWATER DESALINATION PROJECT

FLOW, ENTRAINMENT AND IMPINGEMENT MINIMIZATION PLAN

TABLE OF CONTENTS

CHAPTER 2 ASSESMENT OF POTENTIAL FLOW MINIMIZATION MEASURES

CHAPTER 3 – ASSESSMENT OF IMPINGEMENT ASSOCIATED WITH DESALINATION PLANT OPERATIONS

CHAPTER 4 - ASSESSMENT OF ENTRAINMENT ASSOCIATED WITH DESALINATION PLANT OPERATIONS

CHAPTER 5 - INTAKE IMPINGEMENT AND ENRTAINMENT MINIMIZATION PLAN

ATTACHMENT 8 - POTENTIAL ADVERSE CHANGES IN AGUA HEDIONDA LAGOON RESULTING FROM ABANDONMENT OF THE LAGOON INTAKE, STEVE LE PAGE, MAY 18, 2007

EXECUTIVE SUMMARY

The Carlsbad seawater desalination project (CDP) is proposed to be located adjacent to the Encina Power Generation Station (EPS) and when constructed, will use the power plant cooling water system as source water for production of 50 MGD of fresh drinking water. When both the EPS and the desalination facility are operating, the EPS provides adequate volume of seawater for the operation of the desalination plant. Under this mode of operation, the incremental impingement and entrainment effects and discharge impacts of the desalination plant are insignificant.

The purpose of this Flow, Entrainment and Impingement Minimization Plan (Minimization Plan) is to develop and evaluate viable procedures, practices and mitigation measures which would be implemented by the Discharger (Poseidon Resources Corporation) to minimize the impacts to marine organisms when the CDP intake requirements exceed the volume of water being discharged by the EPS. Based on review of operational data from the EPS, such conditions occurred for less than 10 percent of the time in 2006 and less than 5 percent of the time in the last 5 years. The lowest reported power plant intake flow for the period of 2002 to 2005 was 99.8 MGD; while the lowest intake flow reported for year 2006 was 136.5 MGD.

IMPINGEMENT AND ENTRAINMENT ASSOCIATED WITH DESALINATION PLANT OPERATIONS

The entrainment and impingement assessment included in this Minimization Plan is based on comprehensive data collection study completed at the existing intake of the Encina Power Generation Station following a San Diego Regional Water Quality Control Board (Regional Board) approved data collection protocol during the Period of June 01, 2004 and May 31, 2005. This is the most up-to-date data available for this facility.

Potential Impingement Contribution

The total daily weight of the impinged marine organisms when the desalination plant is operating on a stand-alone basis at 304 MGD and the power plant is not operating is estimated at 1.92 lbs/day (0.96 kg/day).

Significance of Impingement Losses

To put this figure in perspective, the average daily fish consumption of an adult pelican is over 2.5 lbs. It is also helpful to note that 1.92 lbs/day of impinged organisms represents 0.0000001 percent of the total volume of material flowing through the intake.

Potential Entrainment Contribution

The proportional entrainment mortality of the most commonly entrained larval fish living in Agua Hedionda Lagoon was estimated by applying the Empirical Transport Model (ETM) to the complete data set from the period of June 01, 2004 and May 31, 2005. The potential entrainment contribution of the desalination facility operations was computed based on a total flow of 304 MGD (104 MGD flow to the desalination facility and 200 MGD discharged into the outfall).

Based on the average flow of 304 MGD, the average proportional entrainment mortality computed was 12.2 percent.

Significance of Entrainment Losses

The small fraction of marine organisms lost to CDF entrainment would have no effect on the species' ability to sustain their populations because of their widespread distribution and reproductive potential. The most frequently entrained species are very abundant in the area of EPS intake, Agua Hedionda Lagoon, and the Southern California Bight, and therefore, the actual ecological effects due to entrainment from the Carlsbad Desalination Facility are insignificant. Species of direct recreational and commercial value constitute a very small fraction (less than 1 percent) of the entrained organisms and therefore, the operation of the Carlsbad Desalination Facility does not result in significant ecological impact. Additionally, none of the entrained organisms are listed as threatened or endangered species. Contrast this impact to that of the State Water Project. On May 31, 2007 State Water officials turned off the pumps that send water to southern California from the Sacramento-San Joaquin Delta to protect imperiled fish. This spring, both a federal and a state judge ruled that the water operations were illegally endangering the smelt and salmon.

FLOW, IMPINGMENT AND ENTRAINMENT MINIMIZATION PLAN

The Porter-Cologne Water Quality Control Act requires the minimization of the potential adverse effects associated with the operation of water treatment plant intakes. Based on the comprehensive analysis of a number of flow minimization, impingement and entrainment reduction alternatives, the Minimization Plan has identified the following combination of best available and feasible operational, technological and mitigation measures to maintain, restore and enhance the marine environment in the vicinity of the desalination plant intake:

- Operational Measures – during periods of power plant shutdowns or intake flow reduction below the minimum flow needed for desalination plant operation the Discharger will operate the combination of power plant intake pumps that minimizes the additional flows collected for seawater desalination, thereby reducing the incremental impingement and entrainment effects attributed to desalination plant operations.

- Technological Measures – The Discharger will install variable frequency drives on the desalination plant intake pumps to minimize the amount of intake flow entrained into the desalination plant.

- Mitigation Measures – The Discharger will fund $1.84 million of restoration projects that enhance the near shore coastal environment in the vicinity of the Project, such as wetland restoration; invasive species removal and prevention; marine and/or estuarine habitat restoration and enhancement. In the case of permanent shutdown of the EPS and/or abandonment of the use of once-through cooling for the power plant operations, the Discharger will conduct periodic dredging of the Aqua Hedionda Lagoon in order to keep the lagoon entrance open and thereby to maintain the biological productivity and environmental health of Agua Hedionda Lagoon to mitigate erosion along the City of Carlsbad state beach and to restore and enhance grunion spawning habitat.

RATIONALE FOR THE PROPOSED OPERATIONAL MEASURES

The existing power plant intake pumps would be operated to deliver the flow needed to maintain desalination plant operations. Preference would be given to operational scenarios resulting in lowest intake flow that can be achieved with the pumps available at the time this mode of operation has to be practiced.

The average intake flow collected through the existing power plant intake would be maintained at 304 MGD by running a combination of pumps. Previous studies of the desalination plant discharge at this flow indicates that operation of the desalination plant will be in full compliance with Regional Board Order R9-2006-0065.

RATIONALE FOR THE PROPOSED TECHNOLOGICAL MEASURES

The seawater desalination plant will use an average of 304 MGD of seawater flow, of which 104 MGD will be processed through the desalination plant treatment facilities for production of 50 MGD of fresh water, and 200 MGD will be discharged directly, without processing, and will blend with the concentrated seawater generated during the desalination process prior to discharge into the ocean. The actual intake flow needed to operate the desalination facility is expected to vary.

In order to minimize entrainment and impingement of marine organisms, the Discharger proposes to install variable frequency drives (VFDs) on the desalination plant intake pumps. The VFDs will limit the intake flow processed through the desalination plant to the minimum flow necessary to meet operational and permit requirements at any given time, which in turn will minimize the entrainment and impingement of marine organisms.

RATIONALE FOR PROPOSED MITIGATION MEASURES

The proposed mitigation measures are based on a model (Empirical Transport Model) that estimated the portion of the larvae of each target fish species at risk of entrainment with the intake source water. Multiplying the average percent of populations at risk by the physical area from which the fish larvae might be entrained, yields an estimate of the amount of habitat that must be restored to replace the lost fish larvae. This estimate is referred to as the *area (acreage) of habitat production foregone (APF).*

The entrainment effect of the stand-alone operation of the desalination plant extends over 12.2 percent of the total area that could be potentially impacted by the intake operations. Specifically, 12.2 percent of the area of Aqua Hedionda Lagoon's habitat that supports the entrained species is 36.8 acres. Thus, the maximum area of habitat production foregone (APF) that could be attributed to the desalination plant operation is 36.8 acres. This maximum APF is estimated under worst-case conditions when the power plant does not generate energy year-around and the exiting pumps are operated solely to deliver 304 MGD of seawater for the operation of the desalination plant.

The market rate for the restoration of suitable replacement habitat is $50,000/acre. Therefore, the mitigation expenditures required for the stand-alone operation of the desalination plant, is $50,000/acre x 36.8 acres = $1.84 million. Taking under consideration that the power plant has operated for over 95 percent of the time, the Discharger proposes to contribute 10 percent of the maximum estimate, i.e., $184,000 for the first year of desalination plant operations to a mitigation trust fund. If during subsequent years of desalination plant operations, the actual additional amount of water collected to sustain desalination plant operations exceeds 10 percent of the total amount needed for stand alone operations, than the Discharger would contribute additional funds to provide mitigation for the difference. Ultimately, if and when the power plant operation is discontinued permanently, the Discharger would contribute the remaining difference between the funds already contributed to the mitigation trust fund and the maximum amount of $1.84 million.

CHAPTER 1

INTRODUCTION

1.1 PURPOSE

On August 16, 2006 the San Diego Regional Water Quality Control Board (RWQCB) adopted Order No. R9-2006-0065 for Poseidon Resources Corporation's Carlsbad Desalination Project discharge to the Pacific Ocean via the Encina Power Station discharge channel. Section VI.2.e. of the adopted order provides that:

> *e. Flow, Entrainment and Impingement Minimization Plan*
>
> *The Discharger shall submit a Flow, Entrainment and Impingement Minimization Plan within 180 days of adoption of the Order. The plan shall assess the feasibility of site-specific plans, procedures, and practices to be implemented and/or mitigation measures to minimize the impacts to marine organisms when the CDP intake requirements exceed the volume of water being discharged by the EPS. The plan is subject to the approval of the Regional Water Board and is modified as directed by the Regional Water Board.*

This Flow, Entrainment and Impingement Minimization Plan (Minimization Plan) is developed in fulfillment of the above-stated requirements and contains site-specific activities, procedures, practices and mitigation measures which are planned to be implemented to minimize impacts to marine organisms when the Carlsbad Desalination Plant (CDP) intake requirements exceed the volume of water being discharged by the EPS.

1.2 DESCRIPTION OF EXISITNG POWER PLANT INTAKE FACILITIES

The EPS is a once-trough cooling power plant which uses seawater to remove waste heat from the power generation process. Cooling water is withdrawn from the Pacific Ocean via the Aqua Hedionda Lagoon. The cooling water intake structure complex is located approximately 2,200 feet from the ocean inlet of the lagoon. Variations in the water surface level due to tide are from low -5.07 feet to a high +4.83 feet from the mean sea level (MSL). The intake structure is located in the lagoon approximately 525 feet in front of the generating units.

The mouth of the intake structure is 49 feet wide. Booms are situated in the lagoon across the front of the intake structure to screen floating debris. Water passes first trough metal coarse screens (trash racks with vertical bars spaced 3-1/2 inches apart) to screen large debris and marine species. The intake forebay tapers into two 12-foot wide intake tunnels. From these tunnels the cooling water one or more of four 6-foot wide conveyance tunnels. Cooling water for conveyance tunnels 1 and 2 passes though two vertical traveling screens to prevent fish, grass, kelp, and debris from entering intakes for power plant generation Units 1, 2 and 3. Conveyance tunnels 3 and 4 carry cooling water to intakes for power plant generation Units 4 and 5, respectively. Vertical traveling screens are located at the intakes of pumps for unit 4 and unit 5. Figure 1-1 provides a general schematic of the power plant intake system configuration.

Each pump intake consists of two circulating water pump cells and one or two service pump cells. During normal operation, one circulating pump serves each half of the condenser, i.e., when one unit is online, both pumps are in operation.

A total of 7 (seven) vertical screens are installed to remove marine life and debris that has passed through the trash racks. The screens are conventional through-flow, vertically rotating, single entry-single exit, band-type metal screens which are mounted in the screen wells of the intake channel. Each screen consists of series of baskets or screen panels attached to a chain drive. The screening surface is made of 3/8-inch stainless steel mesh panels, with the exception of the Unit 5 screens, which have 5/8-inch square openings.

The screens rotate automatically when the buildup of debris on the screening surface causes the water level behind the screen to drop below that of the water in front of the screen and a predetermined water level differential is reached. The screens can also be pre-set to rotate automatically at a present interval of time. The screen's rotational speed is 3 feet per minute, making one complete revolution in approximately 20 minutes. A screen wash system using seawater from the intake tunnel washes debris from the traveling screen into a debris trough. Accumulated debris are discharged periodically back to the ocean via the power plant discharge lagoon. Table 1-1 summarizes the capacity of the individual power plant intake pumps.

It is important to note that the power plant intake pumping station consists of cooling water intake pumps that convey water through the condensers of the electricity generation units of the power plant and have a total capacity of 794.9 MGD (552,000 gpm) and of service water pumps for the auxiliary systems of the power plant, which total capacity is 62.1 MGD (43,200 gpm). During temporary shutdown of the power plant generation units, only the cooling water pumps are taken out of service. The service water pumps remain in operation at all times in order to maintain the functionality of the power plant. If the power plant is shut down permanently, than the service water pumps will not be operational and will not contribute to the impingement and entrainment of the power plant intake pump station. Therefore, this impingement and entrainment reduction analysis associated with the stand-alone operation of the desalination plant encompasses only the cooling water pumps and excludes the service pumps.

The volume of cooling water passing through the power plant intake power station at any given time is dependent upon the number of cooling water pumps (CWPs) and service water pumps that are in operation. With all of the pumps in operation, the maximum permitted power plant discharge volume is 857 MGD or about 595,000 gallons per minute (gpm) (Year 2006 NPDES Permit No. CA0001350). This discharge encompasses both the cooling water pumps (794.9 MGD) and the service water pumps (61.2 MGD).

TABLE 1-1

SUMMARY OF EPS POWER GENERATING CAPACITY AND FLOWS

Unit #	Date on Line*	Capacity (MW)	Number of Cooling Water Pumps	Cooling Water Flow (gpm)**	Service Pump Water Flow (gpm)**	Total (MGD)
1	1954	107	2	48,000	3,000	73
2	1956	104	2	48,000	3,000	73
3	1958	110	2	48,000	6,000	78
4	1973	287	2	200,000	13,000	307
5	1978	315	2	208,000	18,200	326
Gas turbine	1968	16	0	0	0	0
			Total:	**552,000**	**43,200**	**857**

* Encina Power Station NPDES Permit No. CA0001350, Order No. 2000-03, SDRWCB.
** Encina Power Station Supplemental 316(b) Report (EA Engineering, Science, and Technology 1997).

As electrical demand varies, the number of generating units in operation and the number of cooling water pumps needed to supply those units will also vary. Over the previous four years (2002 to 2005), the EPS has reported combined discharge flows ranging from 99.8 MGD to 794.9 MGD with a daily average of 600.4 MGD. Over the 20.5 year period of January 1980 to mid 2000 the average discharge flow was 550 MGD and ranged from 200–808 MGD.

1.3 DESALINATION PLANT INTAKE AND DISCHARGE FACILITIES

The seawater desalination plant intake and discharge facilities would be located adjacent to the Encina Power Plant. A key feature of the proposed design is the direct connection of the desalination plant intake and discharge facilities to the discharge canal of the power generation plant. This approach allows using the power plant cooling water as both source water for the seawater desalination plant and as a blending water to reduce the salinity of the desalination plant concentrate prior to the discharge to the ocean. Figure 1-2 illustrates the configuration of the desalination facility and EPS intake and discharge facilities.

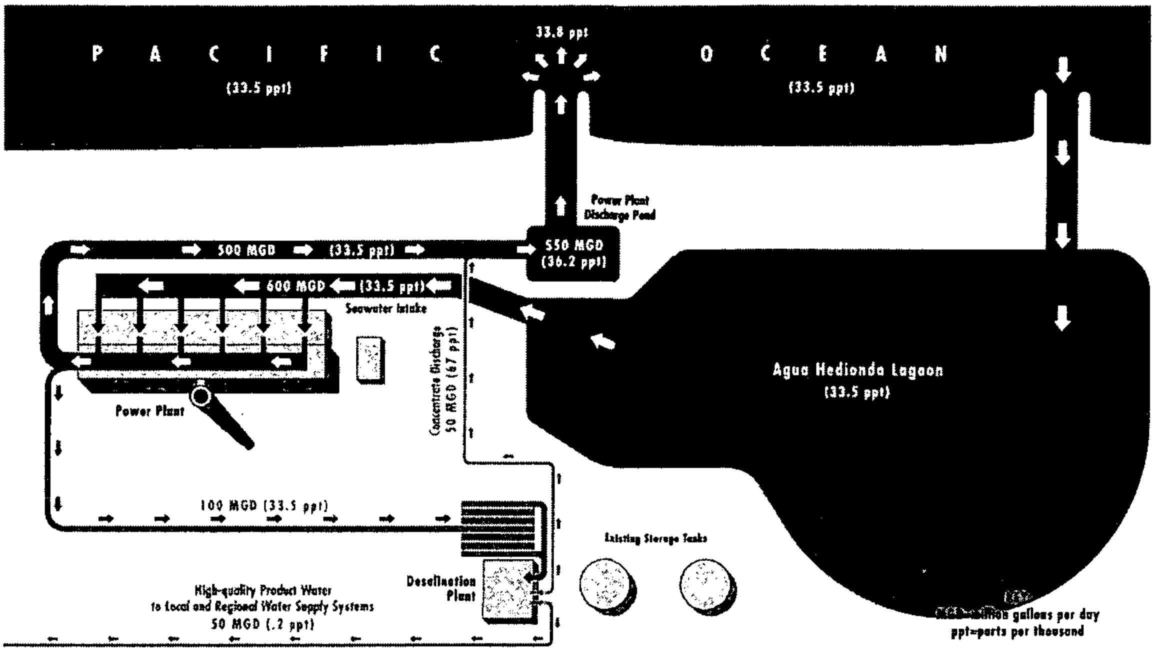


Figure 1-2 –Carlsbad Desalination Plant and Encina Power Station

As shown on Figure 1-2, under typical operational conditions when both the desalination facility and the power plant are operating, approximately 600 MGD of seawater enters the power plant intake facilities and after screening is pumped through the plant's condensers to cool them and thereby to remove the waste heat created during the electricity generation process. The Carlsbad desalination plant intake structure is connected to the end of this discharge canal and would divert an average of 104 MGD of the cooling water for production of fresh water.

Approximately 50 MGD of the seawater would be desalinated via reverse osmosis and conveyed for potable use. The remaining 50 MGD would have salinity approximately two times higher than that of the ocean water (67 ppt vs. 33.5 ppt). This seawater concentrate would be returned to the power plant discharge canal downstream of the point of intake for blending with the cooling water prior to conveyance to the Pacific Ocean. Under typical conditions, when both the desalination facility and the power plant are operating, the blend of 500 MGD of cooling water and 50 MGD of concentrate would have discharge salinity of 36.2 ppt, which is within the 10 percent natural fluctuation of the ocean water salinity (36.9 ppt) in the vicinity of the existing power plant discharge. Regional Board Order R9-2006-0065 establishes a salinity limit of 40/44 ppt (daily/hourly average).

The desalination plant intake pump station would be connected to the existing power plant discharge canal. This pump station would be equipped with vertical turbine pumps which would convey the source seawater from the power plant discharge canal to the desalination plant. The intake pump station will be equipped with a variable frequency drive, which would be operated to minimize intake flow and optimize plant performance and operations under varying water.

1.4 DESALINATION PLANT OPERATIONS DURING PERIODS OF CURTAILED POWER PLANT OPERATION

Under the conditions of temporary or permanent power plant shutdown, the desalination plant would run the power plant intake pumps to collect water for two purposes – (1) source water for the desalination facility and (2) dilution water for the concentrated seawater generated during the desalination process.

Under the intake and discharge limitations incorporated in the desalination plant NPDES permit, the desalination plant is permitted to collect between 100 MGD and 129 MGD (104 MGD average) of seawater in order to produce 48 to 54 MGD (average of 50 MGD) of drinking water. The power plant discharge needed to reduce 50 MGD of desalination plant concentrate to the average daily NPDES permit discharge salinity limitation of 40 ppt is 200 MGD. Thus, during average stand-along desalination plant operations, 304 MGD of seawater would need to be collected using the power plant intake pumps.

1.5 APPROACH FOR THE MINIMIZATION PLAN DEVELOPMENT

The Coastal Act and the Porter-Cologne Water Quality Control Act require the minimization of the potential adverse effects associated with the operation of water treatment plant intakes. Impingement and entrainment effects may be minimized via combination of operational measures, technological improvements and mitigation measures that are viable for the site specific conditions of the project.

The need for implementation of such minimization measures is intermittent in nature and is mainly driven by the mode of operation of the existing Encina Power Generation Station (EPS). If the EPS operates continuously, no impingement and entrainment mitigation measures will be required to be implemented by the seawater desalination plant because the plant operation does not have a significant contribution to the impingement and entrainment of marine organisms as indicated in the project Environmental Impact Report (EIR).

The only periods of time when the desalination plant operations cause additional impingement and entrainment of marine organisms, is when the power plant flow is less than 304 MGD. Between 2002 and 2006, this condition occurred less than 5 percent of the time.

The measures proposed to minimize the effect of the desalination plant operations are as follows:

- Operational Measures – The Discharger will operate a combination of power plant intake pumps that minimize the incremental impingement and entrainment effects attributed to desalination plant operations.

- Technological Measures – The Discharger will design, install and operate intake technologies that reduce the impingement and entrainment associated with the desalination plant operations.

- Mitigation Measures – The Discharger will fund habitat restoration projects to mitigate unavoidable entrainment and impingement impacts. The specific operational measures, technologies and mitigation measures are described in Chapters 2-5 of this Minimization Plan.

CHAPTER 2

ASSESMENT OF OPERATIONAL FLOW MINIMIZATION MEASURES

2.1 INTRODUCTION

The average intake flow needed for the normal operation of the 50 MGD Carlsbad seawater desalination plant is 304 MGD. Approximately 104 MGD of this flow would be required for water production and the reminder will be needed for dilution of the desalination plant concentrate. The intake flow needed for drinking water production varies. Therefore, this flow could be minimized by installing variable frequency drives on the desalination plant intake pumps. The minimum volume of water required for dilution is driven by two key limiting factors:

- The minimum volume needed to protect marine life. This volume is determined by the amount of water needed to blend with the 50 MGD of concentrate below level that could be harmful to the marine organisms in the vicinity of the discharge.

- The minimum volume needed to provide adequate mixing of the concentrate with the ambient seawater in the zone of initial dilution (ZID) of the discharge.

2.2 MINIMUM INTAKE FLOW NEEDED TO PROTECT MARINE LIFE

Regional Board Order R9-2000-0065 contains a California Ocean Plan-based performance goal for acute toxicity of the facility discharge of TUa = 0.765 (see Table 10, page 12, of NPDES Permit). In addition the permit has a daily average and average hourly total dissolved solids (salinity) limitations of 40 mg/L and 44 mg/L, respectively (see Table 9, page 12 of NPDES Permit).

The permit salinity limits were established based on a conservative analysis of the desalination plant discharge completed during the environmental impact report preparation phase of the project. In order to more accurately determine the salinity threshold at which the desalination plant concentrate can be discharged safely, Section VI.2.c.1 of the adopted NPDES Permit order requires the discharger to conduct a study using CDP pilot plant effluent to assess short-term exposure of test species to salinity concentrations that range from 36 to 60 parts per thousand (ppt). The goal of the salinity and acute toxicity special study is to assess compliance with the acute toxicity performance goal and to identify the maximum amount of salinity that can be discharged without causing acute toxicity. Recognizing that future EPS flows may be decreased, an additional goal is to identify the minimum seawater intake flows required to allow the CDP discharge to comply with salinity and acute toxicity requirements.

In conformance with the NPDES permit requirements, the Discharger completed the required "Salinity and Acute Toxicity Study". Attachment 1 of this report contains the study plan for the short-term toxicity threshold evaluation. Attachment 2 includes the results from the Acute Salinity Study.

Acute toxicity testing was performed in accordance with the Study Plan provided in Attachment 1 and in with the procedures established by the USEPA guidance manual, *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, 5th Edition, October 2002 (EPA-821-R-02-012). The bioassay was completed using Topsmelt test organisms.

The No Observed Effect Concentration (NOEC) of the test occurred at 42 ppt of concentrate salinity. The Lowest Observed Effect Concentration (LOEC) was found to be 44 ppt. The lethal concentration for 50 percent of the population (LC50) was 58.57 ppt. In addition, the No Observed Effect Time (NOET) for 60 ppt concentration was 2 hours, while the Lowest Observed Effect Time (LOET) for the 60 ppt concentration was 4 hours. The results of the Salinity and Acute Toxicity Study are summarized in Table 2-1.

TABLE 2-1

SALINITY AND ACUTE TOXICITY OF DESALINATION PLANT CONCENTRATE

Concentrate Salinity (ppt)	Test Species Survival (percent of total)	Acute Toxicity of Concentrate TUa[1,2]	Average and Maximum Total Desalination Plant Intake Flow Needed (MGD)
33.5 (Control)	100	0.00	NA
36	95	0.41	720 – 777.6
38	90	0.59	422 - 456
40	**95**	**0.41**	**307.7 – 332.3**
42	97.5	0.23	247.1 – 266.8
44	85	0.69	209.5 – 226.3
46	**87.5**	**0.65**	**184 – 198.7**
48	80	0.77	165.5 – 178.8
50	55	0.97	151.5 – 163.6
52	62.5	0.93	140.5 – 151.8

54	45	1.02	131.7 – 142.2
56	55	0.97	124.4 – 134.4
58	65	0.91	118.4 – 127.8
60	37.5	1.06	113.2 – 122.3

Notes: (1) TUa calculated as: log (100 percent survival)/1.7
(2) Desalination NPDES Permit TUa Performance Goal = 0.765

Analysis of the toxicity testing data presented in Table 2-1 indicates the following:

- The NPDES permit daily average salinity limitation of 40 ppt is conservative.
- The NPDES permit TUa Performance Goal of 0.765 is not exceeded until salinity reaches 48 ppt and is safely met at salinity of 46 ppt or less.
- Current NPDES permit average hourly salinity limitation of 44 ppt is also very conservative. The test data indicates that no mortality effect was observed for a period of 2 hours at discharge salinity of 60 ppt.
- Concentrate of salinity of 46 ppt and acute toxicity level TUa of 0.65 complies with a reasonable margin of safety with the NPDES acute toxicity TUa performance goal of 0.765. Therefore, this concentrate salinity level could be considered as an acceptable benchmark which could be used to determine the minimum intake flow needed to protect aquatic life.

2.3 MINIMUM INTAKE FLOW TO MAINTAIN ADEQUATE MIXING

As indicated previously, another key criterion to determine the minimum intake flow needed for environmentally safe plant operations is the rate of hydrodynamic mixing and dilution of the discharge with the ambient seawater in the ZID. The current NPDES permit has a specific requirement related to the minimum initial dilution of the discharge in the ZID of 15.5:1.

In order to determine discharge plume dissipation and mixing at increased concentrate discharge salinities/smaller dilution flows, the stand-alone desalination plant operations were modeled at several discharge flow rates corresponding to end-of-discharge canal salinity concentrations of 40.1 to 50.3 ppt. The flow scenarios were modeled for particular combinations of power plant intake pumps that could produce feed water flows that would yield closest to the target concentrate salinity levels in Table 2-1. The modeled scenarios are presented in Table 2-2. The results of the hydrodynamic modeling are summarized in Attachment 3 ("Near Shore Saline Effects due to Reduced Flow Rate Scenarios during Stand-Alone Operations of the Carlsbad Desalination Project at Encina Generation Station", Scott Jenkins & Joseph Wasyl, 12 January 2007).

TABLE 2-2

HYDRODYNAMIC MODELING OF DESALINATION PLANT DISCHARGE AT REDUCED INTAKE FLOW AND STAND-ALONE OPERATIONS

Scenario	Total Intake Flow (MGD)	Concentrate Salinity Discharge Conc. (ppt)	Intake Pumps in Operation	Minimum Pelagic Dilution @ ZID(1)	Maximum Bottom Salinity (ppt)(1)	Benthic Area Exposed To Salinity > 36.9 ppt (acres)(1)	Flow Reduction from Current Permit Requirement (percent)
1	149.8	50.3 ppt	One Pump of Unit 5	9.9:1	42.3	39.4	42.9
2	172.8	47.1 ppt	All Pumps Of Units 1 & 2 and One Pump of Unit 3	13.5:1	42.0	30.5	51
3	184.3	46 ppt	One Pump of Unit 5 And One Pump of Unit 1, 2 or 3	17.7:1	41.4	25.6	43
4	218.9	43.4 ppt	One Pump of Unit 5 And Two Pumps of Unit 1, 2 or 3	21.1:1	40.1	16.4	39
5	304.0	40.1 ppt	Two Pumps of Unit 4	28.2:1	38.1	8.3	0

(*) Note: (1) Historical Average Condition.

Review of Table 2-2 indicates the following key findings:

- Intake flows of less than 184.3 MGD (concentrate salinity > 46 ppt) will result in mixing ratio lower than the current NPDES Permit requirement of 15.5 to 1.

- At intake flow of 184.3 MGD and historical average discharge conditions the mixing ratio of 17.7 to 1, is compliant with the permit requirement of 15.5 to 1. As indicated in Table 2-1, the discharge will also be compliant with the permit's toxicity requirements.

- Intake flow of 218.9 MGD (concentrate salinity of 43.4 ppt) will satisfy the current NPDES permit's initial dilution ratio requirement of 15.5:1 for both historic average and extreme conditions and will be compliant with the acute toxicity requirement of the NPDES permit.

2.4 OPERATIONAL SCENARIOS OF POWER PLANT INTAKE PUMPS

The toxicity and hydrodynamic analysis of the desalination plant discharge presented in the previous two sections indicates that any intake flow at or over 304 MGD will allow it to meet all current desalination plant NPDES discharge permit requirements. As indicated previously, the existing power plant intake pumps can only deliver discrete flows via the operation of various combinations of individual pump units. When the power plant is operating at less than 304 MGD, the desalination facility and power plant operations will be coordinated to maintain an average flow of 304 MGD.

CHAPTER 3

ASSESSMENT OF IMPINGEMENT ASSOCIATED WITH DESALINATION PLANT OPERATIONS

3.1 METHODOLOGY FOR IMPINGEMENT ASSESSMENT

The impingement effect of any intake structure is caused by its screens and is associated with two parameters: the intake flow and the velocity of this flow through the screens. For the purposes of this analysis, the impingement effect is assumed proportional to the intake flow at velocities above 0.5 fps. If the intake through-screen velocity is below or equal to 0.5 fps, the impingement effect of the intake screens is zero.

The impingement assessment provided herein is based on the analysis of most recent data collected at the EPC intake facilities during the period June 1, 2004 to May 31, 2005. These data were collected and analyzed by Tenera Environmental in accordance with a sampling plan and methodology approved by the San Diego Regional Water Quality Control Board (see Attachments 4 & 5).

3.2 RELATIVE IMPINGMENT POTENTIAL OF EXISITNG INTAKE FACILITIES

The EPS has five power generation units, each of which is serviced by two constant speed seawater intake pumps. Therefore the total number of pump units is 10. The six (6) cooling water intake pumps of power generation Units 1, 2 and 3 convey their entire flow of 207.36 MGD through two common traveling screens with 3/8-inch openings. Unit 4 has two cooling pumps of total capacity of 288.02 MGD, which flow passes through two separate 3/8-inch traveling screens. Unit 5 is cooled by two cooling pumps of total capacity of 299.54 MGD which pass all of their flow through three traveling screens. These three screens have 5/8-inch openings.

Each of the seven (7) power plant intake screens are installed in a separate intake channel. The screens are conventional through-flow vertically rotating, single entry, band type units mounted in the intake channels. Each screen consists of series of baskets (screen panels) attached to a chain drive. Cooling water passes through the wire mesh screening surface and debris in the raw seawater are retained on the screens. The screens rotate automatically when the debris buildup causes a predetermined headloss through the screens. As the screens revolve, the collected debris is lifted from the intake water surface by the upward travel of the screen baskets. The screens travel at velocity of 3 feet per minute making one complete revolution in 20 minutes. A screen wash system washes the debris from the traveling screens into screen well baskets where it is accumulated for disposal. The removed debris is returned back to the ocean periodically. Table 3-1 presents the capacities of the individual pumps and the through-screen velocities at high and low tide conditions. All velocities indicated in this table are determined for all pumps in operation at their maximum flowrate.

TABLE 3-1

POWER PLANT INTAKE PUMP CAPACITY AND THROUGH-SCREEN VELOCITIES AT MAXIMUM COOLING PUMP FLOW (794.9 MGD)

Power Plant	Pump Capacity (MGD)	Maximum Through-Screen Velocity (fps) @ High Tide (4.83 of MSL)	Maximum Through-Screen Velocity (fps) @ Low Tide (-5.07 of MSL)	Note
Unit 1				
Pump 1 S	34.56	1.2	2.1	All pumps of Units 1, 2 & 3 share two common screens of identical size and capacity
Pump 1 N	34.56			
Total Capacity	**69.12**			
Unit 2				
Pump 2 S	34.56			
Pump 2 N	34.56			
Total Capacity	**69.12**			
Unit 3				
Pump 3 S	34.56			
Pump 3 N	34.56			
Total Capacity	**69.12**			
Unit 4				All flow pumped through two screens
Pump 4 E	144.01	1.8	2.8	
Pump 4 W	144.01			
Total Capacity	**288.02**			
Unit 5				
Pump 5 E	149.76	1.0	1.6	All flow pumped through three screens
Pump 5 W	149.76			
Total Capacity	**299.54**			

Note: MSL – mean sea level.

Because the through-screen velocity of all pump units is higher than 0.5 fps when operated at maximum flow, their relative contribution to the total impingement potential of the intake pump system will be proportional to the pump flow.

Assessment of Impingement Effect of Alternative Operational Conditions Based on Existing Studies

The abundance and biomass of fishes and invertebrates impinged on the EPS traveling screens were documented in an extensive study as part of the 316(b) Cooling Water Intake Demonstration (Attachment 4). Biological sampling was done over the period of June 1, 2004 to May 31, 2005. The sampling was completed in accordance with sampling procedures and plan approved by the Carlsbad Regional Water Quality Control Board.

The total amount of impinged organisms for the individual sampling events of the 2004/2005 study is presented in Table 3-2. The daily biomass of impinged fish during normal operations over the period of June 2004 to June 2005 was estimated at 0.96 kg/day (1.92 lbs/day) for an intake flow of 304 MGD. To put this figure in perspective, it is helpful to note that 1.92 lbs/day of impinged organisms represents 0.0000001 percent of the total volume of material flowing through the intake. The results of the June 2004 to June 2005 impingement study are summarized in Table 3-2 for the abundance and weight of sampled fish. This table presents impingement losses during both normal operations and heat treatment operations. Since the seawater desalination plant will be shutdown during heat treatment, the operation of this plant will not be associated with the impingement losses that occur during heat treatment.

TABLE 3-2

Number and weight of fishes, sharks, and rays impinged during normal operation and heat treatment surveys at EPS from June 2004 to June 2005.

			Normal Operations Sample Totals				Heat Treatment	
	Taxon	Common Name	Sample Count	Sample Weight (g)	Bar Rack Count	Bar Rack Weight (g)	Sample Count	Sample Weight (g)
1	*Atherinops affinis*	topsmelt	5,242	42,299	10	262	15,696	67,497
2	*Cymatogaster aggregata*	shiner surfperch	2,827	28,374	-	-	18,361	196,568
3	*Anchoa compressa*	deepbody anchovy	2,079	11,606	2	21	23,356	254,266
4	*Seriphus politus*	queenfish	1,304	7,499	2	17	929	21,390
5	*Xenistius californiensis*	salema	1,061	2,390	-	-	1,577	6,154
6	*Anchoa delicatissima*	slough anchovy	1,056	3,144	-	-	7	10
7	Atherinopsidae	silverside	999	4,454	-	-	2,105	8,661
8	*Hyperprosopon argenteum*	walleye surfperch	605	23,962	1	21	2,547	125,434
9	*Engraulis mordax*	northern anchovy	537	786	-	-	92	374
10	*Leuresthes tenuis*	California grunion	489	2,280	-	-	7,067	40,849
11	*Heterostichus rostratus*	giant kelpfish	344	2,612	-	-	908	9,088
12	*Paralabrax maculatofasciatus*	spotted sand bass	303	4,604	-	-	1,536	107,563
13	*Sardinops sagax*	Pacific sardine	268	1,480	-	-	6,578	26,266
14	*Roncador stearnsi*	spotfin croaker	182	8,354	2	3,000	106	17,160
15	*Paralabrax nebulifer*	barred sand bass	151	1,541	-	-	1,993	32,759
16	*Gymnura marmorata*	Calif. butterfly ray	146	60,629	1	390	70	36,821
17	*Phanerodon furcatus*	white surfperch	144	4,686	-	-	53	823
18	*Strongylura exilis*	California needlefish	135	6,025	-	-	158	11,899
19	*Paralabrax clathratus*	kelp bass	111	680	-	-	976	13,279
20	*Porichthys myriaster*	specklefin midshipman	103	28,189	-	-	218	66,860
21	unidentified chub	unidentified chub	96	877	-	-	7	44
22	*Paralichthys californicus*	California halibut	95	1,729	-	-	21	4,769
23	*Anisotremus davidsoni*	sargo	94	1,662	-	-	963	68,528
24	*Urolophus halleri*	round stingray	79	20,589	-	-	1,090	300,793
25	*Atractoscion nobilis*	white seabass	70	11,295	6	872	1,618	332,056

26	*Hypsopsetta guttulata*	diamond turbot	66	10,679	1	85	112	24,384
27	*Micrometrus minimus*	dwarf surfperch	57	562-	-	-	-	
28	*Syngnathus spp.*	pipefishes	55	161-	-		56	90
29	*Atherinopsis californiensis*	jacksmelt	54	1,152-	-		4,468	45,152
30	*Myliobatis californica*	bat ray	50	19,899	4	5,965	132	68,572
31	*Menticirrhus undulatus*	California corbina	43	1,906-	-		16	4,925
32	*Amphistichus argenteus*	barred surfperch	43	1,306-	-		34	2,528
33	*Fundulus parvipinnis*	California killifish	43	299-	-		16	41
34	unidentified fish, damaged	unid. damaged fish	36	1,060	1	70	8	262
35	Ictaluridae	catfish unid.	35	4,279-	-	-	-	
36	*Leptocottus armatus*	Pacific staghorn sculpin	32	280-	-		5	26
37	*Sphyraena argentea*	California barracuda	29	397-	-		46	1,667
38	*Lepomis cyanellus*	green sunfish	29	1,170-	-	-	-	
39	*Umbrina roncador*	yellowfin croaker	28	573-	-		127	22,399
40	*Lepomis macrochirus*	bluegill	20	670-	-	-	-	
41	*Ophichthus zophochir*	yellow snake eel	18	5,349-	-		51	17,303
42	*Citharichthys stigmaeus*	speckled sanddab	17	62-	-		1	30
43	*Brachyistius frenatus*	kelp surfperch	16	182-	-		17	598
44	*Cheilotrema saturnum*	black croaker	15	103-	-		288	9,029
45	*Embiotoca jacksoni*	black surfperch	14	1,240-	-		69	5,367
46	*Genyonemus lineatus*	white croaker	12	171-	-		9	79
47	*Platyrhinoidis triseriata*	thornback	11	4,731	1	1,500-	-	
48	*Chromis punctipinnis*	blacksmith	10	396-	-		151	4,431
49	unidentified fish	unidentified fish	10	811-	-	-	-	
50	*Porichthys notatus*	plainfin midshipman	9	1,792-	-	-	-	
51	*Hermosilla azurea*	zebra perch	9	1,097-	-		62	3,518
52	*Micropterus salmoides*	large mouth bass	9	27-	-	-	-	
53	*Trachurus symmetricus*	jack mackerel	7	7-	-		15	702
54	*Hypsoblennius gentilis*	bay blenny	7	37-	-		440	2,814
55	*Heterostichus* spp.	kelpfish	7	48-	-	-	-	
56	Engraulidae	anchovies	6	3-	-	-	-	
57	*Anchoa* spp.	anchovy	6	27-	-	-	-	
58	*Peprilus simillimus*	Pacific butterfish	5	91-	-		1	33
59	*Rhacochilus vacca*	pile surfperch	4	915-	-	-	-	
60	*Sebastes atrovirens*	kelp rockfish	4	40-	-	-	-	
61	*Pleuronichthys verticalis*	hornyhead turbot	4	190-	-		2	251
62	*Pylodictis olivaris*	flathead catfish	4	480-	-	-	-	
63	Pleuronectiformes unid.	flatfishes	4	62-	-	-	-	
64	*Syngnathus leptorhynchus*	bay pipefish	3	9-	-	-	-	
65	*Hypsoblennius gilberti*	rockpool blenny	3	16-	-		8	77
66	*Mustelus californicus*	gray smoothhound	3	1,850-	-		22	19,876
67	*Cheilopogon pinnatibarbatus*	smallhead flyingfish	3	604-	-	-	-	
68	*Ameiurus natalis*	yellow bullhead	3	220-	-	-	-	
69	*Lepomis* spp.	sunfishes	3	196-	-	-	-	
70	*Girella nigricans*	opaleye	2	346-	-		355	30,824
71	*Rhinobatos productus*	shovelnose guitarfish	2	461	2	6,200-	-	
72	*Acanthogobius flavimanus*	yellowfin goby	2	55-	-	-	-	
73	*Scomber japonicus*	Pacific mackerel	2	10-	-		15	880

74	*Hypsoblennius* spp.	blennies	2	11	-	-	113	489
75	*Hypsoblennius jenkinsi*	mussel blenny	2	17	-	-	175	946
76	*Paralabrax* spp.	sand bass	2	2	-	-	6	19
77	*Scorpaena guttata*	Calif. scorpionfish	2	76	-	-	-	-
78	*Hyporhamphus rosae*	California halfbeak	2	23	-	-	1	-
79	*Symphurus atricauda*	California tonguefish	2	15	-	-	-	-
80	*Tilapia* spp.	tilapias	2	7	-	-	-	-
81	*Sarda chiliensis*	Pacific bonito	2	1,010	-	-	2	540
82	*Albula vulpes*	bonefish	2	1,192	-	-	1	900
83	Sciaenidae unid.	croaker	2	3	-	-	17	1,212
84	*Oxylebius pictus*	painted greenling	1	5	-	-	-	-
85	*Lyopsetta exilis*	slender sole	1	26	-	-	-	-
86	*Citharichthys sordidus*	Pacific sanddab	1	1	-	-	-	-
87	*Gibbonsia montereyensis*	crevice kelpfish	1	8	-	-	-	-
88	*Pleuronichthys ritteri*	spotted turbot	1	7	-	-	13	2,745
89	*Gillichthys mirabilis*	longjaw mudsucker	1	34	-	-	-	-
90	*Dorosoma petenense*	threadfin shad	1	3	-	-	-	-
91	*Porichthys* spp.	midshipman	1	200	-	-	-	-
92	*Cynoscion parvipinnis*	shortfin corvina	1	900	-	-	-	-
93	*Mugil cephalus*	striped mullet	1	3	-	-	5	3,854
94	*Paraclinus integripinnis*	reef finspot	1	4	-	-	4	12
95	*Hyperprosopon* spp.	surfperch	1	115	-	-	7	552
96	*Ameiurus nebulosus*	brown bullhead	1	100	-	-	-	-
97	*Micropterus dolomieu*	smallmouth bass	1	150	-	-	-	-
98	*Citharichthys* spp.	sanddabs	-	-	-	-	1	3
99	*Triakis semifasciata*	leopard shark	-	-	-	-	2	688
100	*Medialuna californiensis*	halfmoon	-	-	-	-	53	1,864
101	*Torpedo californica*	Pacific electric ray	-	-	1	3,750	-	-
102	Scorpaenidae	scorpionfishes	-	-	-	-	2	64
103	*Halichoeres semicinctus*	rock wrasse	-	-	-	-	1	33
104	*Hypsypops rubicundus*	garibaldi	-	-	-	-	5	1,897
105	*Seriola lalandi*	yellowtail jack	-	-	-	-	21	978
106	*Dasyatis dipterura*	diamond stingray	-	-	-	-	2	1,468
107	*Heterodontus francisci*	horn shark	-	-	-	-	1	850
108	Zoarcidae	eelpouts	-	-	-	-	1	17
			19,408	**351,672**	**34**	**22,152**	**94,991**	**2,034,900**

Significance of Impingement Losses

To put this figure in perspective, the average daily fish consumption of an adult pelican is over 2.5 lbs. It is also helpful to note that 1.92 lbs/day of impinged organisms represents 0.0000001 percent of the total volume of material flowing through the intake.

CHAPTER 4

ASSESSMENT OF ENTRAINMENT ASSOCIATED WITH DESALINATION PLANT OPERATIONS

4.1 METHODOLOGY FOR ENTRAINMENT ASSESSMENT

As indicated previously, the desalination plant of seawater produces 50 MGD of drinking water. For the purpose of this analysis, we have assumed 100 percent mortality of the marine organisms entrained under the stand-alone operational condition of the desalination plant.

The entrainment assessment associated with the desalination plant operations is based on comprehensive data collection study completed at the existing intake of the Encina Power Generation Station following a San Diego Regional Water Quality Control Board (Regional Board) approved data collection protocol during the Period of June 01, 2004 and May 31, 2005. This is the most up-to-date entrainment assessment available for this facility.

We have estimated the proportional entrainment mortality of the most commonly entrained larval fish living in Agua Hedionda Lagoon by applying the Empirical Transport Model (ETM) to the complete data set from the period of June 01, 2004 and May 31, 2005. The potential entrainment contribution of the desalination facility operations was computed based on a total flow of 304 MGD (104 MGD flow to the desalination facility and 200 MGD for dilution of the concentrated seawater). Based on an average intake of 304 MGD, the proportional entrainment mortality computed was 12.2 percent. The ETM values for the species collected during the study period are summarized in Table 4-1.

Table 4-1

ETM VALUES FOR ENCINA POWER STATION LARVAL FISH ENTRAINMENT FOR THE PERIOD OF 01 JUN 2004 TO 31 MAY 2005 BASED ON STEADY ANNUAL INTAKE FLOW OF 304 MGD

	ETM Estimate	ETM Std.Err.	ETM + SE	ETM - SE
ETM Model Data for 3070 - Gobies	0.21599	0.30835	0.52434	-0.09236
ETM Model Data for 1495 - Blennies	0.08635	0.1347	0.22104	-0.04835
ETM Model Data for 1849 - Hypsopops	0.06484	0.13969	0.20452	-0.07485
AVERAGE	**0.122393**			
ETM Model Data for 3062 – White Croaker	0.00138	0.00281	0.00419	-0.00143
ETM Model Data for 1496 – Northern Anchovy	0.00165	0.00257	0.00422	-0.00092
ETM Model Data for 1219 – California Halibut	0.00151	0.00238	0.00389	-0.00087
ETM Model Data for 1471 - Queenfish	0.00365	0.00487	0.00852	-0.00123

ETM Model Data for 1494 – Spot Fin Croaker	0.00634	0.01531	0.02165	-0.00896
AVERAGE	**0.002906**			

The average ETM value of the entrained species of 0.1224 (12.2 percent) average of ETM results for the three most commonly entrained species living in Agua Hedionda Lagoon. This approach makes it possible to establish a definitive habitat value for the source water, and is consistent with the approach taken by the California Energy Commission and their independent consultants for the Morro Bay Power Plant (MBPP) in assessing and mitigating the entrainment effects of the proposed combined cycle project. The situation in Morro Bay is analogous to the proposed Carlsbad Project because both projects are drawing water from the enclosed bays.

4.2 ASSESSMENT OF THE AREA OF HABITAT PRODUCTION FOREGONE

In order to calculate the Area of Production Foregone (APF), the number of lagoon habitat acres used by the three most commonly entrained lagoon species was multiplied by the average Proportional Entrainment Mortality (PM) for the three lagoon species. The estimated acres of lagoon habitat for these species are based on a 2000 Coastal Conservancy Inventory of Agua Hedionda Lagoon habitat (see Table 4-2).

Table 4-2

Wetland Profile: Agua Hedionda Lagoon

Approximate Wetland Habitat Acreage - 330

Approximate Historic Acreage - 695

Habitat	Acres	Vegetation Source
Brackish/ Freshwater	3	Cattail, bulrush and spiny rush were dominant
Mudflat/Tidal Channel	49	Not specified
Open Water	253	Estuarine flats Eelgrass occurred in all basins
Riparian	11	Not specified
Salt Marsh	14	
Upland	61	
	391	(Riparian not included)

The areas that have potential to be impacted by the intake operations include the mudflat/tidal channel habitat (49 acres), the open water habitat (253 acres) for a total of 302 acres. The calculation of APF is based on the acres of the lagoon habitat that have the potential to be impacted by the intake operations (302 acres) and the average PM of 12.2 percent. APF = 0.122 x 302 acres = 36.8 acres.

Significance of Entrainment Losses

The loss of larval fish entrained by the Carlsbad Desalination Plant, whether the EPS is operating or not, represents a small fraction of marine organisms from the abundant and ubiquitous near shore source water populations. Using standard fisheries models for adult fishes, the loss of larvae (99 percent of which are lost to natural mortality) due to the desalination facility entrainment would have no effect on the species' ability to sustain their populations. Species with the highest mortality (i.e. the CIQ Gobies) are not substantially impacted because of their widespread distribution and high reproductive potential due to spawning several times a year, and are able to sustain conditional larval stage mortality rates of up to 60 percent without a decline in adult population level. This absence of potential population level effects is especially true for the species' early larval stages. The sheer numbers of larvae that are produced overwhelm population effects of both natural mortality and high levels of conditional mortality. California Department of Fish and Game in its Nearshore Fishery Management Plan provides for sustainable populations with harvests of up to 60 percent of unfished adult stocks.

Significance of Entrainment Losses
The magnitude of the entrainment losses for stand-alone operation is estimated for continuous operations (i.e., 24 hrs per day, 365 days per year). Taking into consideration that the power plant is not expected to discontinue operations any time soon, the actual entrainment effects will be even smaller. Additionally, entrainment mortality losses are not harvests in the common sense, because the larval fish are not removed from the ocean, but are returned to supply the ocean's food webs – the natural fate of at least 99 percent of larvae whether entrained or not. Generally, less than one percent of all fish larvae become reproductive adults. The small fraction of marine organisms lost to CDF entrainment would have no effect on the species' ability to sustain their populations because of their widespread distribution and reproductive potential. The most frequently entrained species are very abundant in the area of EPS intake, Agua Hedionda Lagoon, and the Southern California Bight, and therefore, the actual ecological effects due to entrainment from the Carlsbad Desalination Facility are insignificant. Species of direct recreational and commercial value constitute a very small fraction (less than 1 percent) of the entrained organisms and therefore, the operation of the Carlsbad Desalination Facility does not result in significant ecological impact. Additionally, none of the entrained organisms are listed as threatened or endangered species. Contrast this impact to that of the State Water Project. On May 31, 2007 State Water officials turned off the pumps that send water to southern California from the Sacramento-San Joaquin Delta to protect imperiled fish. This spring, both a federal and a state judge ruled that the water operations were illegally endangering the smelt and salmon.

CHAPTER 5

INTAKE IMPINGEMENT AND ENRTAINMENT MINIMIZATION PLAN

The Porter-Cologne Water Quality Control Act requires the minimization of the potential adverse effects associated with the operation of water treatment plant intakes. Based on the comprehensive analysis of a number of flow minimization, impingement and entrainment reduction alternatives, the Minimization Plan has identified the following combination of best available and feasible operational, technological and mitigation measures to maintain, restore and enhance the marine environment in the vicinity of the desalination plant intake.

5.1 OPERATIONAL MEASURES FOR IMACT MINIMIZATION

During power plant shutdowns the existing EPS intake system is proposed to be operated with a combination of screens and pumps that allow to reduce the total intake flow to 304 MGD. Acute toxicity testing and hydrodynamic modeling of the desalination plant will be environmentally safe.

Operational Procedures for Existing Power Plant Intake Pumps

The Encina power generation station and the Carlsbad seawater desalination plant will be staffed 24 hours per day and 365 days per year. During temporary shutdowns of the Encina power plant electricity generation facilities, power plant staff on duty will implement the following standard operational procedures:

1. Power plant staff will notify desalination plant staff regarding the time at which the power plant generation facilities is scheduled to be shutdown. This notification should be forwarded to the desalination plant staff as soon as possible but no later than two (2) hours before the time of the actual shut down of the power plant electricity generation units so the desalination plant staff has adequate time to prepare for the changed mode of power plant operation.

2. Preference would be given to operational scenarios resulting in lowest intake flow that can be achieved with the pumps available at the time this mode of operation has to be practiced.

3. Power plant staff on duty will modify the power plant intake pumps system operations in accordance with the specific directions for intake pumps and screens required to be in operation under the selected operational condition. Power plant staff will notify the desalination plant staff at the time of the switch to the selected operational condition.

4. During periods of power plant shutdown, the desalination plant staff will track the desalination plant operation more closely and will monitor the salinity/conductivity of the desalination plant discharge at the discharge pond monitoring point designated in the current NPDES permit. Desalination plant staff will adjust facility operations to maintain compliance with the average daily and daily maximum limits of salinity.

5. Power plant staff shall notify the desalination plant operational staff on duty at least two (2) hours before Encina power plant restart electricity generation which would allow desalination plant operators to adjust facility operations if needed.

6. Both power plant and desalination plant staff will work in close cooperation in order to assure facility compliance with all applicable regulatory requirements. Because the operation of the desalination plant intake pumps will be interlocked with that of the power plant pumps, a complete shutdown of all power plant intake pumps will trigger an automatic shutdown of the desalination plant intake pumps. This automatic pump operation interlocking provision would prevent a situation where the desalination plant intake pumps may run during times when all of the power plant pumps are shutdown.

5.2 TECHNOLOGY-BASED MEASURES FOR IMACT MINIMIZATION

Technology alternatives for reduction of impingement and entrainment of aquatic organisms in the source seawater were evaluated for both the desalination plant intake and the existing Encina Power Station (EPS) intake facilities (pumps and screens) under the condition of stand-alone desalination plant operations, when a limited number of the existing power plant intake pumps will operated to collect a total of up to 304 MGD needed for desalination plant operations. Please note that of the collected 304 MGD of intake flow only 104 MGD will enter the seawater desalination plant. The remaining flow of 200 MGD will be returned to the existing EPS discharge canal for blending with 50 MGD of concentrated seawater from the Carlsbad sweater desalination facility (CDF) prior to discharge to the ocean.

Alternative Desalination Plant Intake Technologies

Subsurface Intakes

The feasibility of using subsurface intakes (beach wells, slant wells, horizontal wells, filtration galleries) was evaluated in detail during the environmental impact review phase of this project. A thorough review of the site-specific applicability of subsurface intakes and a comprehensive hydrogeological study of the use of subsurface intakes in the vicinity of the proposed desalination plant site indicate that subsurface intakes are not viable due to limited production capacity of the subsurface geological formation, the potential to trigger subsidence in the vicinity of the site and the poor water quality of the collected source water. The geotechnical evaluation relied on drilling and testing information and near shore sediment surveys to assess the feasibility of using vertical, slant, and horizontal wells as seawater intake structures for the proposed project. The following is a summary of the findings for each of these alternative intake systems.

Vertical Intake Wells

Alternative Description: Vertical intake wells consist of water collection systems that are drilled vertically into a source water aquifer. A well yield of about 2000 gpm would be expected from a properly constructed, large diameter production well at the test well location in Agua Hedionda Lagoon. Modeling results indicate that up to nine vertical wells could be placed in the 700 foot wide alluvial channel, each pumping about 2100 gpm. Therefore, the maximum production from vertical wells placed under optimum conditions would be about 20,000 gpm. Given that the test well was place in the optimum location, this would represent the upper limit of expected well yields from the alluvial deposits in the coastal basins of San Diego County, which is consistent with historic observations. To meet the demands of the project, at least 10 similar wellfields would have to be constructed, as well as a conveyance system to transport the water to the proposed desalination facility. The project would therefore require 99 vertical wells to produce the volume of source water necessary to produce 50 mgd of product water.

Alternative Evaluation: Use of vertical intake wells is not viable for the site-specific conditions of this project due to the limited transmissivity and yield capacity of the wells which would require installation of very large number of wells for which beach property is not available.

Slant Wells

Alternative Description: Slant wells are subsurface intake wells drilled at an angle and extending under the ocean floor to maximize the collection of seawater and the beneficial effect of the filtration of the collected water through the ocean floor sediments.

Alternative Evaluation: The use of slant wells does not offer any advantage in this setting. The wellfield for which maximum production rates were calculated for vertical wells is located on a sandspit 100 ft from Agua Hedionda and 300 ft from the Pacific Ocean. Those constant head conditions were taken into account when assessing the yield of this type of subsurface intake. The use of slant wells increases the screened thickness of saturated sediment slightly (a 45 degree well would result in a 20% increase in screened thickness over a vertical well) and places the screened section more directly below the constant head lagoon or ocean boundary condition. The close proximity of the wellfield to the constant head condition already achieves this, with little increase in yield resulting from the slant well. Due to the site-specific hydrogeological conditions (low transmissivity of the ocean floor sediments and nearshore aquifer) the use of slant wells is also not viable for the Carlsbad Seawater Desalination project.

Horizontal Wells

Alternative Description: Horizontal wells are subsurface intakes which have a number of horizontal collection arms that extend into the coastal aquifer from a central collection cason in which the source water is collected. The water is pumped from the cason to the desalination plant intake pump station, which in turns pumps it through the plant pretreatment system.

Alternative Evaluation: The use of horizontal wells, if the alluvial channel can be tapped offshore and the well can be kept inside this alluvial channel, can theoretically produce greatly increased yields by markedly increasing the screened length of the well in contact with permeable sediments. However, the diameter of the collection arms of the horizontal wells is limited to 12 inches (and most are 8-inch or smaller), in turn limiting the production rate to 1,760 gpm per well. (Note, this conclusion was also confirmed by the Dana Point Ocean Desalination Project test well that documented a yield of 1,660 gpm from a 12 inch diameter well in that location.) Analysis of the sediment properties indicates that this would be achieved with a horizontal well extending approximately 200 ft below the Pacific Ocean or Agua Hedionda. Because of the constant head boundary at the ocean bottom or bottom of Agua Hedionda, there would be minimal interference between multiple horizontal wells, but the practicalities of drilling horizontal wells limit the space no less than about 50 ft. Given the limited width of the alluvial channel, only about 14 horizontal wells could be placed in the channel, for a total production rate of 28,000 gpm, still far below the project demand. This approach assumes that additional exploration work will prove that elevated TDS concentrations in groundwater in the most permeable strata can be overcome.

Water Quality Issues for Subsurface Intakes. Based on the results of actual intake well test completed in the vicinity of the EPS, a key fatal flaw of the beach well water quality was the high salinity of this water. The total dissolved solids (TDS) in the water were on the order of 60,000 mg/L, nearly twice that of typical seawater (33,500 mg/L). The water also had an elevated iron and suspended solids content. The pumping test was extended for nearly a month at 330 gpm (0.5 MGD) to determine if additional pumping would cause the TDS, iron and suspended solids to approach that of the nearby seawater. After 30 days of pumping, the quality of the water withdrawn from the well did not improve significantly.

Summary Evaluation of Subsurface Intake Feasibility

The site-specific hydrogeologic studies used to evaluate the feasibility of use of subsurface intakes for this project demonstrate that subsurface intakes can not provide sufficient seawater to support the proposed project. No subsurface intake system type (verticall wells, slant wells, or horizontal wells) can deliver seawater of 304 MGD needed for environmentally safe operation of the Carlsbad Seawater Desalination plant. In fact, due to site specific aquifer constraints, the subsurface intake cannot deliver even the 104 MGD of flow needed to produce 50 MGD of desalinated seawater. The maximum capacity that could be delivered using subsurface intakes is 28,000 gpm (40 MGD), which is less than 12 percent of the needed intake flow. Additionally, the quality of the water available from the subsurface intakes (salinity twice that of seawater, excessive iron and high suspended solids) would be untreatable. Therefore subsurface intakes were determined to be infeasible.

Installation of Variable Frequency Drives on Desalination Plant Intake Pumps

Since under worst-case conditions, the desalination plant entrainment effect would be proportional to the flow that enters the plant, the key approach analyzed and proposed to reduce entrainment is to install variable frequency drives (VFDs) on the intake pumps of the desalination plant intake pump station. These VFDs will allow the intake pumps to closely match the flow that enters into the desalination plant with the fluctuations of the drinking water demand. The technology is considered best technology available to minimize the effect of stand-alone operations of the desalination plant.

Alternative Power Plant Intake Technologies

A number of alternative technologies were evaluated to determine whether they offer a viable and cost-effective reduction of impingement and entrainment associated with the desalination plant operations under the conditions of a complete shutdown of EPS operations. As indicated previously, under these conditions, the EPS intake facilities (combination of screens and pumps) will be operated to collect a total flow of 304 MGD which is only 37.6 % of the installed EPS intake pump capacity.

It should be pointed out that because the existing power plant intake facilities will be operated at 37.6 % of their flow and fewer pumps will be collecting water through the same existing intake screening facilities, the maximum through screen velocities would be reduced significantly. This in turn will reduce the impingement associated with the desalination plant operations.

Technologies that have been evaluated based upon feasibility for implementation at the facility, biological effectiveness (i.e. ability to achieve significant reductions in both impingement and entrainment), and cost of implementation (including capital, installation, and annual operations and maintenance costs). Table 5-1 includes a list of evaluated technologies.

Table 5-1
Potential Impingement/Entrainment Reduction Technologies

Technology	**Impact Reduction Potential**	
	Impingement	**Entrainment**
Modified traveling screens with fish return	Yes	No
Replacement of existing traveling screens with fine mesh screens	Yes	Yes
New fine mesh screening structure	Yes	Yes
Cylindrical wedge-wire screens – fine slot width	Yes	Yes
Fish barrier net	Yes	No
Aquatic filter barrier (e.g. Gunderboom)	Yes	Yes
Fine mesh dual flow screens	Yes	Yes
Modular inclined screens	Yes	No
Angled screen system – fine mesh	Yes	Yes
Behavior barriers (e.g. light, sound, bubble curtain)	Maybe	No
Variable Speed Drives	Yes	Yes

The feasibility of the technologies listed in Table 5-1 is evaluated based on the following:

- Ability to achieve a significant reduction in impingement and entrainment (IM&E) for all species, taking into account variations in abundance of all life stages;
- Feasibility of implementation at the facility;
- Cost of implementation (including installed costs and annual O&M costs);
- Impact upon facility operations.

Fish Screens and Fish Handling and Return System

Alternative Description: This alternative would include the replacement of the existing traveling screens within the tunnel system with new traveling screens that have features that could enhance fish survival are designed with the latest fish removal features, including the Fletcher type buckets on the screen baskets (Ristroph-type screens), dual pressure spray systems (low pressure to remove fish, and high pressure to remove remaining debris), and separate sluicing systems for discarding trash and returning the impinged fish back to the Aqua Hedionda Lagoon (AHL) or the ocean.

Alternative Evaluation: The modified screening system could potentially improve impingement survival. This system however will have a negative effect in terms of entrainment reduction, because the intake pumps will need to collect approximately 1 % more source water (3 MGD) to service the dual pressure spray system of the new screens. In addition, a fish return system is required as part of this scenario to transport fish washed from the screens alive back to the water body to a location where they would not be subject to re-entrainment into the intake. Since the area of entrainment influence defined in the project Minimization Plan extends over the entire AHL, the collected fish would ultimately need to be pumped back to the open ocean, on a distance that extends over 3,000 feet from the point of capture. Survival of most species subject of impingement by the intake screens over such long transport distance is very unlikely. Currently, there are no existing operating fish retrieval and collection systems that convey the impinged marine species similar to these captured at the EPS intake (see Table 3-2) and therefore, there is no track record that allows to determine how effective this impingement reduction measure would be.

In addition, the capital and O&M costs associated with this impingement reduction alternative are very high. The construction costs to install new screens and fish retrieval, pumping, conveyance and ocean discharge system are estimated at: $5.7 million. For comparison, the total costs for complete mitigation of CDF operations is estimated at $1.84 million (see Section 5.3 of the Revised Minimization Plan, May 2007). The annual O&M costs for such system are estimated at $0.2 million over the costs of operation of the existing intake screening system. The additional O&M costs are associated mainly with the operation and upkeep of the pumping and conveyance system for 1% (3.0 MGD) of additional seawater needed to provide adequate amount of water to service the screen pressure spray system and the fish retrieval and conveyance system. Please note that under the current operations, no additional seawater or expenditures are required for collection and disposal of the intake screenings. In summary, the installation of modified screens with fish retrieval and return system is not viable because of the following key reasons:

- Uncertain impingement reduction and unlikely survival of a number of captured marine species due to the long transport distance from the point of impingement to a location that will prevent re-entrainment of the captured species.
- Very high construction costs for a limited and uncertain benefit ($5.7 million vs. $1.84 million);
- Measurable additional O&M Costs ($0.2 million/yr) for operation of the fish retrieval and return system;

- The implementation of this alternative will result in increased entrainment because three MGD (1 %) of additional seawater needs to be collected to operate the fish retrieval and return system.

New Power Plant Intake and Fine Mesh Screening Structure

Alternative Description: Application of fine mesh traveling water screen technology for EPS would require the construction of a complete new screen structure located at the south shore of the lagoon, including both coarse and fine mesh traveling screen systems and fish collection and return systems; and would replace the existing trash rack structure with a much larger screening structure. In order for the approach velocities to the new traveling screens to be reduced to 0.5 fps or less at all times, major modifications to the existing tunnel system will be required. Additionally, an appropriate and suitable location to return collected fish, shellfish, and their eggs and larvae would have to be constructed.

Alternative Evaluation: Fine mesh traveling water screens have been tested and found to retain and collect fish larvae alive with some success. Fine mesh traveling water screens have been installed at a few large-scale steam electric cooling intakes including marine applications at Big Bend Station in Tampa, Florida (EPRI, 1986), and at an operating nuclear generating station at Prairie Island on the Mississippi River (Kuhl, 1988). Results from field studies of fine-mesh traveling water screens generally show higher survival at lower approach velocities and with shorter impingement duration (EPRI, 1986). In addition, many regulatory agencies have in the past adopted an expectation that traveling water screen approach velocities should be 0.5 fps or less. The National Pollutant Discharge Elimination System – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Facilities in Section VII A states a maximum through screen design intake velocity of 0.5 fps as the acceptable design standard. This would require a screen approach velocity of 0.25 fps or less depending on the percent open area of the screen mesh used.

Since the use of fine mesh traveling water screen technology for EPS would require the construction of a new intake structure ($44 million), demolition of the existing intake structure ($0.3 million); removal of the existing screens ($0.1 million) and installation of new coarse screens ($3.2 million) and new fine mesh screens ($5.7 million) equipped with fish collection and return systems, would require a total construction expenditure of $53.3 million. The extremely high construction costs make this alternative financially infeasible. Similar to the previous technology, the implementation of this alternative will also require additional intake flow (4 MGD to 5 MGD) to be collected for the operation of the coarse and fine mesh screen organism retrieval and return systems. The additional O&M costs associated with the operation of this system are $0.3 million/year. In summary, the cost-benefit analysis of this alternative indicates that the alternative is not feasible for the following reasons:

- Uncertain impingement reduction and unlikely survival of a number of captured marine species due to the long transport distance from the point of impingement to a location that will prevent re-entrainment of the captured species.

- Cost prohibitive – construction costs for its implementation ($53.3 million) are an order of magnitude higher than the expenditures that would allow to completely mitigate the maximum intake effect of stand-alone desalination plant operations ($1.84 million).

- Significant additional O&M Costs ($0.3 million/yr) for operation of the fish retrieval and return system;

Cylindrical Wedge-Wire Screens – Fine Slot Width

Alternative Description: Wedge-wire screens are passive intake systems, which operate on the principle of achieving very low approach velocities at the screening media. Wedge-wire screens installed with small slot openings may enable a facility to meet performance standards for both IM&E. The wedge-wire screen is an EPA approved technology for compliance with the EPA 316(b) Phase II rule provided the following conditions exist:

- The cooling water intake structure is located in a freshwater river or stream;
- The cooling water intake structure is situated such that sufficient ambient counter currents exist to promote cleaning of the screen face;
- The through screen design intake velocity is 0.5 ft/s or less;
- The slot size is appropriate for the size of eggs, larvae, and juveniles of any fish and shellfish to be protected at the site; and
- The entire main condenser cooling water flow is directed through the technology.

Wedge-wire screens are designed to be placed in a water body where significant prevailing ambient cross flow current velocities (≥ 1 ft/s) exist. This cross flow allows organisms that would otherwise be impinged on the wedge-wire intake to be carried away with the flow. An integral part of a typical wedge-wire screen system is an air burst back-flush system, which directs a charge of compressed air to each screen unit to blow off debris and impinged organisms back into the water body where they would be carried away from the screen unit by the ambient cross flow currents.

Alternative Evaluation: The EPS CWIS, located on the tidal Agua Hedionda Lagoon would not meet the first two EPA criteria discussed above. The intake is not located on a freshwater river and there are no sufficient ambient crosscurrents in the lagoon to sweep organisms and debris away from the screen units. Debris and organisms back-flushed from the screens would immediately re-impinge on the screens following the back-flush cycle because the principal water current in the outer lagoon would be the station intake flow toward the screen units. For these reasons, wedge-wire screen technology is not considered feasible for application at the EPS.

Fish Net Barrier

Alternative Description: A fish net barrier, as it would be applied to the EPS intake system, is a mesh curtain installed in the source water body in front of the exiting intake structure such that all flow to the intake screens passes through the net, blocking entrance to the intake of all aquatic life forms large enough to be blocked by the net mesh. The net barrier is sized large enough to have very low approach and through net velocities to preclude impingement of juvenile fish with limited swimming ability. The mesh size must be large enough to preclude excessive fouling during normal station operation while at the same time small enough to effectively block entrainment of organisms into the intake system. These conditions typically limit the mesh size such that adult and a percentage of juvenile fish can be blocked. The mesh is not fine enough to block most larvae and eggs. The fish net barrier could potentially meet the performance requirements of the EPA Phase II Existing Facilities Rule for impingement; however, it would not meet the performance requirements for reduction of entrainment of eggs and larvae.

Alternative Evaluation: The fish net barrier technology is still experimental, with very few successful installations at power station intakes. Using a 20 gpm/ft^2 design loading rate, a net area of approximately 30,000 ft^2 would be required for EPS. Maintaining such a large net moored in the lagoon is not practical. In addition, the fish barrier is a passive screening device, which is subject to fouling and has no means for self-cleaning. This technology would be rapidly clogged due to fouling. The services of a diving contractor would be required to remove the net for cleaning onshore and to replace the fouled net with a clean net on each cleaning cycle. For these reasons, this technology is not practically feasible for implementation at EPS and further evaluation is not warranted.

Aquatic Filter Barrier

Alternative Description: An aquatic filter barrier system, such as the Gunderboom Marine Life Exclusion System (MLES)^{TM} (Gunderboom), is a moored water permeable barrier with fine mesh openings that is designed to prevent both impingement and entrainment of ichthyoplankton and juvenile aquatic life. An integral part of the MLES is an air-burst back flush system similar in concept to the air burst system used with wedge-wire screen systems to back flush impinged organisms and debris into the water body to be carried away by ambient cross currents.

Alternative Evaluation: A MLES has been installed and tested at the Lovett Station on the Hudson River. This test installation was applied to a cooling system of significantly smaller capacity than the EPS intake system and in a very different environment on the Hudson River, as opposed to the lagoon intake of the EPS. Although the MLES has much smaller mesh openings and would block fish eggs and larvae from being entrained into the intake, these smaller organisms would be impinged permanently on the barrier due to the lack of cross currents to carry them away. This system therefore, offers no significant advantage over other technologies such as the fish net barrier concept and would offer no biological improvement over the barrier net design. For these reasons, this technology is not practically feasible for implementation at the existing EPS intake and further evaluation is not warranted.

Fine Mesh Dual Flow Screens

Alternative Description: A modified dual flow traveling water screen is similar to the through flow design, but this type of screen would be turned 90 degrees to the direction of the flow so that its two faces would be parallel to the incoming water flow. When equipped with fine mesh screening media, the average 0.5 fps approach velocity to the screen face would have to be met by the dual flow screen design. Water flow enters the dual flow screen through both the ascending and the descending screen faces, and then flows out between the two faces. All of the fish handling features of the Ristroph screen design would be incorporated in the dual flow screen design.

Alternative Evaluation: The dual flow screen configuration has been shown to produce low survival rates for fish larvae. This is because of the longer impingement time endured by organisms impinged on the descending face of the screen. This longer impingement time is suspected to result in higher mortality rates than similar fine mesh screens with a flow through screen design.

The primary advantage of this screen configuration is the elimination of debris carryover into the circulating water system. Also, because both ascending and descending screen faces are utilized, there is greater screening area available for a given screen width than with the conventional through-flow configuration.

However, the dual flow screen can create adverse flow conditions in the approach flow to the circulating water pumps. The flow exiting the dual flow screens is turbulent with an exit velocity of greater than 3 fps. Modifications to the pump bays downstream of the screens, usually in the form of baffles to break up and laterally distribute the concentrated flow prior to reaching the circulating water pumps, would be required.

The implementation of this technology to the EPS CWIS would require an entirely new intake screen structure similar to the fine mesh through flow intake screen structure discussed previously. The dual flow fine mesh screen configuration offers no advantages in terms reduction of impingement and entrainment mortality as compared to through flow fine mesh traveling screens discussed above and in fact would probably not perform as well as the through flow design. The design concept for the dual flow screen structure would be similar to the through flow fine mesh screen structure with trash racks, coarse mesh traveling screens and fine mesh traveling screens in each screen train. The implementation cost and operation and maintenance costs for this facility would be of the same order of magnitude as for the through flow screen structure. Dual flow screen technology does not offer a significant performance or cost advantage as compared with through flow screen technology. Therefore, the use of this technology for the EPS is not recommended.

Modular Inclined Screens

Alternative Description: Modular Inclined Screen (MIS) is a fish protection technology for water intakes developed and tested by the Electric Power Research Institute (EPRI) (Amaral, 1994). This technology was developed specifically to bypass fish around turbines at hydro-electric stations. The MIS is a modular design including an inclined section of wedge-wire screen mounted on a pivot shaft and enclosed within a modular structure. The pivot shaft enables the screen to be tilted to back-flush debris from the screen. The screen is enclosed within a self-contained module, designed to provide a uniform velocity distribution along the length of the screen surface. Transition guide walls taper in along the downstream third of the screen, which guide fish to a bypass flume. A full size prototype module would be capable of screening up to 800 cfs (518 MGD) at an approach velocity of 10 ft/sec.

Alternative Evaluation: The MIS design underwent hydraulic model studies and biological effectiveness testing at Alden Research Laboratory to refine the hydraulic design and test its capability to divert fish alive. Eleven species of freshwater fish were tested including Atlantic salmon smolt, coho salmon, Chinook salmon, brown trout, rainbow trout, blueback herring, American shad and others. After some refinements in the design were made during this testing, the results showed that most of these species and sizes of fish can be safely diverted (Amaral, 1994).

Following laboratory testing, the MIS design was field tested at the Green Island Hydroelectric Project on the Hudson River in New York in the fall of 1995 (Shires, 1996). In addition to the MIS, the effectiveness of a strobe light system was also studied to determine its ability to divert blueback herring from the river to the MIS. Results for rainbow trout, golden shiner and blueback herring, which were released directly into the MIS module were similar to the laboratory test results in terms of fish survivability. The limited amount of naturally entrained blueback herring did not allow reliable evaluation of test results (Amaral, 1994).

The MIS technology, as tested, does not address entrainment of eggs and larvae. Also, this technology has never been tested for, or installed in, a power station with a seawater intake system. Further research would be required to evaluate the efficacy of this technology for application to a seawater intake system. MIS is not a suitable and proven technology, at this time, for retrofit to the EPS intake system. Therefore, this technology is not found viable for mitigation of the desalination plant intake impact.

Angled Screen System – Fine Mesh

Alternative Description: Angled screens are a special application of through-flow screens where the screen faces are arranged at an angle of approximately 25 degrees to the incoming flow. The conventional through-flow screen arrangement would place the screen faces normal or 90 degrees to the incoming flow. The objective of the angled-screen arrangement is to divert fish to a fish bypass system without impinging them on the screens. Most fish would not be lifted out of the water but would be diverted back to the receiving water by screw-type centrifugal or jet pumps.

Alternative Evaluation: Using fine screen mesh on the traveling screens minimizes entrainment, but increases potential for impingement of organisms that would have otherwise passed through the power plant condenser tubes. Application of this technology would require construction of new angled screen structure at the south shore of the lagoon similar to the new fine mesh screen intake structure discussed previously. The angled screen facility would not provide a significant performance advantage in terms of reducing IM&E as compared to the proposed fine mesh screen structure, and would be at least as large and a significantly more complex structure. This facility would be potentially more costly to implement and maintain than the fine mesh screen facility. Therefore, further evaluation of this technology for the EPS is not warranted.

Behavior Barriers

Alternative Description: A behavioral barrier relies on avoidance or attraction responses of the target aquatic organisms to a specific stimulus to reduce the potential of entrainment or impingement. Most of the stimuli tested to date are intended to repulse the organism from the vicinity of the intake structure.

Alternative Evaluation: Nearly all the behavioral barrier technologies are considered to be experimental or limited in effectiveness to a single target species. There are a large number of behavioral barriers that have been evaluated at other sites, and representative examples these are discussed separately below.

Offshore Intake Velocity Cap – This is a behavioral technology associated with a submerged offshore intake structure(s). The velocity cap redirects the area of water withdrawal for an offshore intake located at the bottom of the water body. The cap limits the vertical extent of the offshore intake area of withdrawal and avoids water withdrawals from the typically more productive aquatic habitat closer to the surface of the water body.

This technology operates by redirecting the water withdrawal laterally from the intake (rather than vertically from an intake on the bottom), and as a result, the water entering the intake is accelerated laterally and is more likely to provide horizontal velocity cues to fish and allow fish to respond and move away from the intake. Potentially entrainable fish that are able to identify these changes in water velocity as a result of their lateral line sensory system, are able to respond and actively avoid the highest velocity areas near the mouth of the intake structure.

This technology potentially reduces impingement of fish by stimulating a behavioral response. The technology does not necessarily reduce entrainment, except when the redirected withdrawal takes water from closer to the bottom of the water body and where that location has lower plankton abundance.

Application of this technology to the EPS CWIS, to be fully effective, would require development of an entirely new intake system with a submerged intake structure and connecting intake conduit system installed out into the Pacific Ocean similar to the offshore intake system at the El Segundo Generating Station (Weight, 1958). This is not a practically feasible consideration for the EPS. Therefore, this technology is not potentially applicable for the EPS CWIS and further evaluation of this technology is not warranted.

Air Bubble Curtain – Air bubble curtains have been tested alone and in combination with strobe lights to elicit and avoidance response in fish that might otherwise be drawn into the cooling water intake. Generally, results of testing the bubble curtain have been poor (EPRI, 1986). Tests have been conducted with smelt, alewife, striped bass, white perch, menhaden, spot, gizzard shad, crappie, freshwater drum, carp, yellow perch, and walleye. Many species exhibited some avoidance response to the air bubble courting or the combination air bubble and light emissions. However, there has been little if no testing of species common to the Agua Hedionda Lagoon.

This technology has some potential to enhance fish avoidance response in some species of fish. However, there is no reliable data for the species that are subject to impingement at the EPS and no way to estimate what type of reaction fish would have to the existing intake with the addition of a bubble curtain. Therefore, this technology is not suitable for the EPS.

Strobe Lights – There has been a great deal of research with this stimulus over the last 15 years to guide fish away from intake structures. The Electric Power Research Institute has co-funded a series of research projects (EPRI 1988, EPRI 1990, EPRI 1992) and reviewed the results of research in this field by others (EPRI 1986, EPRI 1999). In both laboratory studies and field applications, strobe lights were shown to effectively move selected species of fish away from the flashing lights. Most of the studies conducted to date have been with riverine fish species and for projects associated with hydroelectric generating facilities. One early study was conducted at the Roseton Generating Facility on the Hudson River in New York, another study was conducted on Lake Cayuga in New York, and others for migratory stages of Atlantic and Pacific salmon. Few species similar to those occurring in the Agua Hedionda Lagoon have been tested for avoidance response either in the lab or in actual field studies.

Laboratory testing was done for an application of strobe lights for the San Onofre Nuclear Generating Facility. Testing was conducted for white croaker, Pacific sardine and northern anchovy. Limited availability of test specimens and limited testing demonstrated no conclusive results and the California Coastal Commission (2000) found this device not useful at this station. Therefore, use of this technology for the EPS is not warranted.

Other Lighting – Incandescent and mercury vapor lights have also been tested as a behavioral stimulus to direct fish away from an intake structure. Mercury lights have generally been tested as a means of drawing fish to a safe bypass of the intake structure as generally the light has an attractive effect on fish. Tests have not demonstrated a uniform and clearly repeatable pattern of attraction for all fish species. The mercury lights have been somewhat effective in attracting European eel, Atlantic salmon, and Pacific salmon. But results with other species including American shad, blue back herring and alewife had more variable results. One test with different life stages of Coho salmon shows both attraction and repulsion from the mercury light for the different life stages of the coho. Testing with incandescent, sodium vapor and fluorescent lamps was more limited but also had variable and species specific results.

Other lighting systems, as with most all the behavioral barrier alternatives, have not been tested with the species of fish common in Agua Hedionda Lagoon. As a result there is no basis to recommend these lights systems as an enhancement to reduce impingement or entrainment at the EPS CWIS.

Sound – Sound has also been extensively tested in the last 15 years as a method to alter fish impingement rates at water intake structures. Three basic groups of sound systems including percussion devices (hammer, or poppers), transducers with a wide range of frequency output, and low frequency or infrasound generators, have all been tested on a variety of fish species.

Of all the recently studied behavioral devices the sound technology has demonstrated some success with at least one group of fish species. Clupeids, such as alewife, demonstrate a clear repulsion to a specific range of high frequency sound. A device has been installed in the Fitzpatrick Nuclear Generating station on Lake Ontario in New York State, which has been effective in reducing impingement of landlocked alewives. The results were repeated with alewife at a coastal site in New Jersey. Similar results with a high frequency generator also reported a strong avoidance response for another clupeid species, the blue back herring, in a reservoir in South Carolina.

Testing of this high frequency device on many other species including weakfish, spot, Atlantic croaker, bay anchovy, American shad, blue back herring, alewife, white perch, and striped bass demonstrated a similar and strong avoidance response by American shad and blue back herring. Alewife and sockeye salmon have also been reported to be repelled by a hammer percussion device at another facility. But testing of this same device at other facilities with alewife did not yield similar results.

Although high frequency sound has potential for eliciting an avoidance response by the Alosid family of fish species, there is no data to demonstrate a clear avoidance response for the species of fish common to the Agua Hedionda Lagoon. Therefore there is no basis to use sound as a viable method to reduce impingement of fish at the EPS CWIS.

Variable Speed Drives for EPS Circulating Water Intake Pumps

Alternative Description: Under this alternative, variable frequency drives would be installed on the EPS intake cooling water pumps to minimize the volume of water collected for the desalination plant operations. As indicated previously, the total volume of seawater that is required for the normal operation of the desalination plant is 304 MGD. Of this flow, 104 MGD will be collected for production of fresh water, while the remaining 200 MGD of seawater will be used to dilute the concentrated seawater from the desalination plant.

Alternative Evaluation: As indicated in Table 1-1, the EPS has 10 cooling water pumps of total capacity of 794.9 MGD. Based on year 2002-2006 pump operations track record, these pumps operated in a very wide flow range of 99.8 MGD to 794.9 MGD, which is + 32 % to – 600 % of the average power plant intake flow of 600.4 MGD recorded for the same period. Because of the significant diurnal and seasonal fluctuations of the power plant energy production capacity and associated cooling water needs, installation of variable frequency drives (VFDs) to accommodate power plant operations could be beneficial. The construction costs associated with the implementation of this alternative are estimated at $8.5 million.

Although the desalination plant fresh water production and therefore, intake flow are also projected to vary daily and seasonally, this variation will be within 3 to 5 % from the average flow of 304 MGD, which is an order to magnitude smaller than the variation range of the intake flow needed to accommodate EPS power production fluctuations. The main reason for this difference in seawater demand patterns as compared to electricity demand is that drinking water can be stored in reservoirs, electricity cannot. Therefore, the water production remains fairly constant while electricity production is highly variable. As a result, the installation of large-size VFDs on the existing power plant intake pumps to accommodate such a small flow variation is of limited benefit. A more beneficial and cost-effective approach to minimize entrainment and impingement associated with the desalination plant operations is to install VFDs on the intake pumps for the desalination plant. The cost of VFD installation for these pumps is only $0.9 million, which is an order of magnitude smaller than the construction costs associated with the installation of VFDs on the power plant intake pumps (i.e., $8.5 million). In summary, because of the limited benefit of the installation of VFDs on the EPS cooling water pumps to minimize the impingement and entrainment associated with desalination plant operations, this alternative is not considered economically viable, as compared to other options, such as the installation of VFDs on the desalination plant intake pumps and aquatic environment restoration.

Best Technology Available Proposed for Implementation
In order to minimize entrainment of marine organisms into the desalination plant, the Discharger will install variable frequency drives (VFDs) on the desalination plant intake pumps. These VFDs will allow to limit the intake flow processed through the desalination plant to the minimum flow necessary to meet fresh water demands at any given time, which in turn will minimize the entrainment of marine organisms into the desalination plant treatment facilities.

5.3 MITIGATION MEASURES FOR IMACT MINIMIZATION

Potential Mitigation Alternatives
The Discharger proposes to fund the implementation of environmental conservation, enhancement and restoration projects to offset the unavoidable impingement and entrainment (I&E) losses attributed to the desalination plant operations. The offsets for each of the potential mitigation alternatives listed below will be based on a comparison of impingement and entrainment losses resulting from the operation of the desalination plant, estimated based on the APF calculated in Section 4.2 of this Minimization Plan. The following examples of potential mitigation alternatives are for illustrative purposes only.

<u>Projects that Would Directly Restore or Enhance Estuarine or Marine Habitat in the Vicinity of Aqua Hedionda Lagoon</u>
Projects that would preserve, restore, or enhance the Aqua Hedionda Lagoon (AHL) watershed; and projects that restore and enhance the near-shore coastal environment in the vicinity of the proposed project include:

<u>Restoration or Enhancement of AHL</u>

- Invasive species removal and prevention;
- Restoration of historic sediment elevations to promote reestablishment of eelgrass beds;
- Marine fish hatchery enhancement;
- Community outreach soliciting public agency and landowner participation.

<u>Restoration or Enhancement of Agua Hedionda Watershed</u>

- Erosion control projects along upland watercourses;

- Construction of catchment basins, swales, and other sediment containment features;
- Land acquisition for purposes of creating conservation easements;
- Minimizing runoff from development activities;
- Restoration of floodplain habitat.

Restoration or Enhancement of Nearshore Coastal Areas

- Contribution to marine fish hatchery stocking program;
- Artificial reef development;
- Marine Protected Area establishment;
- Kelp bed enhancement.

The "value" of the ecological services or benefits that will result from implementation of any of these restoration projects will be assessed using various habitat models to demonstrate that the ecological "benefits" gained through restoration will outweigh the unavoidable entrainment and impingement losses.

Project Selection Criteria

The specific projects to which mitigation-related funds will be contributed will be selected with the approval of the RWQCB. The proposed restoration project selection criteria to aid in the evaluation of potential projects include:

- Location;
- Relevance to the nature of impingement and entrainment effects attributed to the desalination plant operations;
- Basic need and justification for project;
- Nature and extent of ecological benefits;
- Stakeholder acceptance;
- Consistency with ongoing resource agency work and environmental planning
- Administrative considerations;
- Implementation costs;

- Cost effectiveness;
- Ability to measure performance;
- Success of comparable projects;
- Length of time before benefits accrue;
- Technical feasibility;
- Opportunities for leveraging of funds/availability of matching funds;
- Legal requirements (e.g., permits, access);
- Likely duration of benefits;
- Project Cost.

Depending on the nature of a particular project, the relative importance and weighting of these criteria may vary. As a general proposition, however, projects will be selected so as to maximize the ecological benefits to AHL and adjacent nearshore areas. This process will ensure that the most effective projects are assigned the highest priority.

Monetary Assessment of the Proposed Mitigation Measures

As indicated in Section 4-2, the APF averages 36.8 acres and is estimated taking under the assumption that the power plant does not generate energy year-around and the exiting power plant cooling pumps are operated to deliver 304 MGD of seawater for the operation of the desalination plant. At a reasonable cost of restoration of in-kind habitat of $50,000/acre, the Discharger would fund up to $1.84 million of funds for mitigation measures (36.8 acres x $50,000/acre = $1.84 million). These funds will be contributed through a trust fund. The Discharger will deposit funds to this account annually at a value proportional to the amount of water used exclusively for seawater desalination plant operations. The Discharger will contribute 10 percent of the maximum amount (i.e., $184,000) to the account several months before the beginning of the first year of desalination plant operations.

The 10 percent value is based on the actual data from the power plant operation track record in 2006. During this year the total number of days the power plant used less than 304 MGD was 36. The volume of water collected by the power plant during these days was between 135.6 MGD and 293.8 MGD - although the power plant pumped less than 304 MGD it collected source seawater. The total volume of additional water that would have been collected during this year for the desalination plant operation only, would have been 3,331.8 MGD. This is 3 percent of the total amount of water that is needed for the desalination plant operations (3,331.8 MGD/ (304 MGD x 365 days) = 0.03). As indicated previously, we propose to deposit over three times more (i.e., 10 percent) of the mitigation funds that would have been determined based on the actual track record of the power plant during 2006. Since the impingement effects attributable to the desalination plant operations are significantly lower than these associated with entrainment, the 10 percent contribution would be sufficient to mitigate for both the impingement and entrainment effects of the desalination plant operations.

If during subsequent years, the additional amount of water collected to sustain desalination plant operations exceeds 10 percent of the total amount needed for stand alone operations, than we will contribute additional funds to provide mitigation for the difference. Ultimately, if and when the power plant operations is discontinued permanently, the Discharger will contribute the remaining difference between the funds already contributed to the mitigation amount and the maximum amount of $1.84 million.

5.4 MAINTEANCE OF LAGOON ENVIRONMENTAL HEALTH AND ABATEMENT OF BEACH ERROSION

Agua Hedionda Lagoon is connected to the Pacific Ocean by means of a manmade channel that is artificially maintained. Seawater circulation throughout the outer, middle and inner lagoons is sustained both by routine dredging of the manmade entrance to prevent its closure, which would occur naturally, and the Encina Power Station's cooling water withdrawals from the lower lagoon. Without the CDP or EPS need for water, fresh seawater flows into the lagoons would cease, and the entrance to the lagoons would be closed off by the natural long-shore transport of native beach sands. A comprehensive hydrodynamic study of the interaction between the lagoon and the ocean indicates that without the intake of seawater by the power plant cooling pumps, the entrance to the lagoon would be expected to close over time, and to remain closed most of the year (see Attachment 6). This in turn would have a detrimental effect on the environmental health of the lagoon, on its ecosystem and on its recreational value and beneficial uses.

The AHL provides a wide range of beneficial uses. Nearly all of these uses are directly or indirectly supported by seawater flow and exchange created by circulation of seawater in the lagoon. The existing tidal exchange, cooling water flows and/or future needs of the CDP provide for fresh ocean water that renew the Lagoon's water quality and flush nutrients and other watershed pollution, particularly from the Lagoon's upper reaches. In addition, the inflow of fresh supplies of ocean water induced by the pumping and tides carry waterborne supplies of planktonic organisms that nourish the many organisms and food chains of the Lagoon, including the White Sea Bass restoration program of the Hubbs Sea World Research Institute and the aquaculture operations in the outer Lagoon.

Tidal flows through the Lagoon also maintain water quality and support water related recreational activities, such as fishing, and water contact recreation. The name, Agua Hedionda, which means "stinking water" in Spanish, reflects a former stagnant condition that existed prior to the dredging of the mouth of the Lagoon.

To avoid this significant loss of highly productive marine habitat, in the absence of the ongoing operations of the EPS, the Discharger would maintain circulation of the seawater, continue routine dredging of the entrance to the lagoon to prevent its closure, and deposit the sand dredged from the lagoon on adjacent beaches so as to maintain, restore and enhance habitat for grunion spawning and to maintain, restore and enhance opportunities for public access and recreation along the shoreline and within the coastal zone.

5.5 EXTENT, TIMING AND EFFECT OF DREDGING AGUA HEDIONDA LAGOON

The Discharger commissioned studies to evaluate the extent, timing and effects of dredging that would be needed for the desalination facility to use the power plant intake if the power plant at some point in the future stops operating its cooling system. See Attachment 6, Coastal Processes Effects of Reduced Intake Flows at Agua Hedionda Lagoon (Jenkins 2006). The outer Agua Hedionda Lagoon (66 acres) was originally dredged in 1954 as part of the construction for the Encina Power Station and has been the subject of routine maintenance dredging since that time. The dredging is performed to remove sediment transported into the lagoon by tidal action through the existing jetty structure.

Attachment 6 includes a description of the effects of the dredging that would be required for the proposed desalination facility if the power plant stops operating its cooling system. If the flow rate is reduced to 304 MGD under stand-alone desalination plant operations, the average sand influx rate into Agua Hedionda Lagoon would be reduced by 42 percent relative to the present power generation operating scenario (i.e. 530 MGD). The reduction in sand influx rates reduces the interval for dredge maintenance from every other year to once every four to five years. Longer intervals between dredge cycles would not create any significant impacts either on the Lagoon environment or on the local beaches.

Attachment 6 concluded that the reduced flow rate operations of a stand-alone desalination plant will reduce the capture rates of littoral sediment that presently occur under higher flow rates associated with power generation, thereby reducing the environmental impacts associated with maintenance dredging. Reduced flow rate operations will not increase the magnitude of cyclical variations in habitat or residence time that presently occur throughout each maintenance dredge cycle, but will increase the length of time over which those variations occur. Lower flow rate operations will result in reductions of 8 percent to 10 percent in the fluxes of dissolved nutrients and oxygen into the lagoon through the ocean inlet, but this effect is relatively minor in comparison to the decline in nutrient flux that occurs in the latter stages of each dredge cycle. On balance, low flow operations do not appear to create any significant adverse impacts on either the lagoon environment or the local beaches, and the reduction in capture rates of sediment is a project benefit.

Attachment 6 used a combination of empirical data and hydrodynamic modeling to address the long term effects of reduced flow rate operations on sediment influx rates, dredging quantities and frequencies, variations in inter-tidal and sub-tidal habitat acreage, residence time and influx of dissolved nutrients and nutrients adsorbed on particulate. The empirical data used in Attachment 6 was taken from long-term dredge records and the tidal monitoring study of Elwany, et al (2005)[1]. Attachment 7, "Long-Term West Basin Water Level Analysis for Assessing

[1] Elwany, M. H. S., R. E. Flick, M. White, and K. Goodell, 2005, "Agua Hedionda Lagoon Hydrodynamic Studies," prepared for Tenera Environmental, 39 pp. + appens.

Threshold Impingement Effects of Reduced Intake Flows at Agua Hedionda Lagoon" (Jenkins 2007), re-interprets the hydrodynamic model analysis from Attachment 6 in terms of the persistence of water levels occurring higher than the threshold elevation for reduced flow rate operations. The analysis contained in Attachments 6 and 7 examines the full spectrum of potential effects that could conceivably result from operating at flow rates less than existing conditions. The flow rate of 304 MGD represents the lowest flow rate that keeps discharge salinity below 40 parts per thousand (ppt). And therefore, the worst case condition.

The spring tide hydraulic response was presented in Figure 8 of Attachment 6 to motivate the worst-case assessment of lagoon sedimentation impacts on wetland habitat and tidal prism in Figures 9 & 10. Spring tides represent the worst case scenario for these impacts because the lowest water levels occur at these times. Consequently, muting of the lagoon tidal range by inlet shoals will produce the largest loss of inter tidal wetland habitat and tidal prism during spring tides. However, the analysis of impacts on residence time in Figure 11 of Attachment 6 are based on the long term model simulations from Attachment 7 and are consistent with the empirical data of residence time found in Elwany, et al (2005) that was collected over several spring/neap cycles during a 5 week period.

Similarly, the discussion of impacts on dissolved and particulate nutrient fluxes found on pp 24-25 of Attachment 6 are also based on the Elwany et al (2005) data and long term model simulations of Attachment 7. The plant inflow rate has a smaller effect on nutrient flux during spring tides while the tidal prism losses are greatest. This is because the east and middle basins receive their nutrient fluxes by tidal exchange alone, and because the preponderance of tidal prism and lagoon habitat resides in those basins, the worst-case impacts on nutrient flux for the entire lagoon system occurs during spring tide. This is not to say that nutrient fluxes during other tidal phases were not studied for low flow conditions. Appendix-A of Attachment 7 presents 20 years of model simulations of the tidal variation in the west basin during low flow operations on which the average nutrient flux estimates into the lagoon system are based. The summary findings stated on p 25 of Attachment 6 are that low flow operations will reduce nutrient flux into the west basin of the lagoon by 10.1 percent when taking the average over many spring/neap cycles. During spring tides, the nutrient flux into the west basin is reduced by only 8 percent during low flow operations. However, both of these numbers are small relative to the 18.9 percent reduction of nutrient flux into the middle and inner basins that occur as a result of tidal prism losses during spring tide caused by inlet sedimentation. Since low flow rate operations slows the rate of inlet sedimentation by 42.5 percent, the net effect of those operations on nutrient flux must be considered as an improvement over existing conditions.

Attachments 6 and 7 isolate the worst case conditions for each potential impact (subject to a lower limit flow rate of 304 mgd), either by looking at an extreme event (e.g. spring tide impacts on wetland habitat and tidal prism) or by evaluating long term cyclical behavior (e.g. sedimentation rates, dredging, residence time or nutrient flux). Short term variations in dissolved oxygen during times of lower tidal exchanges (presumably neap tides) does not appear to lead to any additional impacts not already considered; since the longest residence times produced either by long term simulation (Figure 11, Attachment 7) or measured directly (Elwany, et. al., 2005) are still only 5 days or less. Residence times of this order are sufficiently brief to avoid hypoxic conditions in the lagoon, and hypoxia has never been observed in the lagoon flora and fauna of the lagoon despite dredge intervals as long as 3 years.

Impacts of Abandoning the Dredging Regime on Lagoon Biology. Another study, Potential Adverse Changes In Agua Hedionda Lagoon Resulting From Abandonment of the Lagoon Intake (Le Page 2007) (Attachment 8), analyzes the potential for adverse changes in Agua Hedionda water quality, ecology, and natural resources as a result of discontinued maintenance dredging of Agua Hedionda Lagoon. This study found that Agua Hedionda Lagoon provides 388 acres of nursery grounds and habitat for several fish, invertebrates, and avian species, which that are listed in the attachment. It also supports a number of valuable commercial, research, and coastal recreational uses that are described in the attachment. Because of the unique conditions attributable to the regular dredging that promotes the maximum tidal exchange and induced circulation of the lagoon, water quality, nutrient and dissolved oxygen levels in the lagoon support an environment that is unique to the west coast of the United States. In the absence of continued maintenance dredging the lagoon ceases to exist as a marine, estuarine, and wetland biological unit and the commercial, research and recreational uses would be lost.

Impacts of Abandoning the Dredging Regime on Commercial and Recreational Uses of Lagoon. The Agua Hedionda Lagoon has strong appeal for coastal recreation given the number of permits issued and the number of recreational anglers that use the lagoon. The city of Carlsbad issues about 400 recreational permits for Agua Hedionda Lagoon with about an even split between active and passive permits. In addition, recreational fishing is a popular pastime along the outer lagoon shore. The site is considered heavily used by the California Department of Fish and Game (CDFG). CDFG data on fishing pressure for the Carlsbad area shows that the Agua Hedionda Lagoon attracted 79% of the recreational fishing compared to other observed locations (Oceanside Jetty to Batiquitos Lagoon, 18%; Encinitas to Leucadia, 3%) from 2004-2005.

The lagoon offers a large area for both aquatic and land-based recreation and could be considered as high quality given the amount of wildlife that is found there as well as the number of people that use the area. Additionally, the lagoon supports an extensive aquaculture operation, the Hubbs Seaworld White Sea Bass Fish Hatchery, California Water Sports and a YMCA camp geared towards creating educational and recreational opportunities for youth in the marine environment. Each enterprise along the lagoon views the area as unique; and they would not be able to run their businesses or facilities without continued maintenance dredging. If the exchange with ocean water were to decrease or stop, a one-of-a-kind environment would be lost in southern California. The businesses that have become dependant upon the lagoon would be forced to shut down, opportunities for public access and recreation would be lost and nearly 400 acres of highly productive marine habitat would be destroyed.

Impacts of Discontinuing Flow from the Discharge Channel to Surfing Area. The discharge from the power plant has created a sand formation seaward of the outlet jetties on an otherwise simple plane beach profile that has created a popular surfing break. This surfing break is known as "Warm Water Jetties," because when the power plant is operating the water directly around the jetties is warmer than that of the neighboring beach.

By providing a source of sediment, the power plant discharge has created a relief in the bathymetry, or a delta that is essentially a ramp/focus configuration that produces high quality surfable waves (Scarfe, Elwany, Black, and Mead, 2003). The ramp acts to reduce the directional spread of waves approaching the shore and steepens them through the shoaling process. Surfing quality varies with tide, swell, and delta shape, and conditions are best when there is a large quantity of sand combined with a west or northwest swell.

In the absence of the operation of the power plant or the desalination plant, the quantity of sand available to maintain the sand bar seaward to the jetties will be substantially reduced. This significant change in conditions will have an adverse effect on the quality of the surf because it would move the sand shoreward as is the case immediately to the north and south of the Warm Water Jetties surfing break. Shoreward migration of the sand bar would not make for good surfing conditions as is evident by the lack of surfing activity for a quarter mile in either direction of the sand bar maintained by the power plant discharge.

REFERENCES

EPRI. 1986. Assessment of Downstream Migrant Fish Protection Technologies for Fish Protection. Prepared by Stone & Webster for EPRI. Report AP-4711. September 1986.

EPRI (Electric Power Research Institute). 1986. Assessment of Downstream Migrant Fish Protection Technologies for Hydroelectric Application. EPRI Report No. 2694-1.

EPRI 1988. Field Testing of Behavioral Barriers for Fish Exclusion at Cooling Water Intake

Systems. Central Hudson Gas & Electric Company – Roseton Generating Station. Prepared by Lawler, Matuskey & Skelly Engineers. Report CS-5995. September 1988.

EPRI 1990. Fish Protection Systems for Hydro Plants. Test Results. Prepared by Stone & Webster. EPRI Report GS-6712. February 1990.

EPRI 1992. Evaluation of Strobe Lights for Fish Diversion at the York Haven Hydroelectric Project. Prepared by Stone & Webster. Report TR-101703; November 1992.

EPRI 1999. Status Report on Fish Protection at Cooling Water Intakes. Prepared by Alden Research Laboratory. Report TR-114013. November 1999.

Kuhl, G.M., and K.N. Mueller. 1988. Prairie Island Nuclear Engineering Plant Environmental

Monitoring Program 1988 Annual Report: Fine-mesh Vertical Traveling Screens Impingement Survival Study. Prepared for Northern States Power Company.

Gunderboom Promotional Brochure.

National Pollutant Discharge Elimination System-Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Fedreal Register/Vol. 69, No. 131/Friday, July 9, 2004/ Rules And Regulations.

P. F. Shires, E. P. Taft; "Evaluation of the Modular Inclined Screen (MIS) at the Green Island Hydroelectric Project: 1995 Test Results"; Electric Power Research Institute (EPRI) Report TR-104498; May 1996.

Public Service Electric and Gas Company. 1993. Appendix I—Modeling. Permit No. NJ0005622. Prepared by Lawler, Matusky, and Skelly Engineers, Pearl River, NY. Comments on NJPDES Draft. 82 p.

San Diego Gas and Electric (SDG&E). 1980. *Encina Power Plant Cooling Water Intake System Demonstration.* Prepared for California Regional Water Quality Control Board, San Diego Region. December 1980.

S. V. Amaral, F. C. Winchell, T. C. Cook, E. P. Taft; "Biological Evaluation of a

Modular Inclined Screen for Protecting Fish at Water Intakes"; Electric Power Research Institute (EPRI) Report TR-104121; May 1994.

Tenera Environmental. 2000a. Diablo Canyon Power Plant: 316(b) Demonstration Report. Prepared for Pacific Gas and Elec. Co., San Francisco, CA. Doc. No. E9-055.0.

Tenera Environmental. 2000b. Moss Landing Power Plant Modernization Project: 316(b) Resource Assessment. Prepared for Duke Energy Moss Landing, L.L.C., Oakland, CA.

Weight, R.H. "Ocean Cooling Water System for 800 MW Power Station", Journal of the Power Division, Proceedings of the American Society of Civil Engineers, Dec 1958.

REFERENCES

EPRI. 1986. Assessment of Downstream Migrant Fish Protection Technologies for Fish Protection. Prepared by Stone & Webster for EPRI. Report AP-4711. September 1986.

EPRI (Electric Power Research Institute). 1986. Assessment of Downstream Migrant Fish Protection Technologies for Hydroelectric Application. EPRI Report No. 2694-1.

EPRI 1988. Field Testing of Behavioral Barriers for Fish Exclusion at Cooling Water Intake

Systems. Central Hudson Gas & Electric Company – Roseton Generating Station. Prepared by Lawler, Matuskey & Skelly Engineers. Report CS-5995. September 1988.

EPRI 1990. Fish Protection Systems for Hydro Plants. Test Results. Prepared by Stone & Webster. EPRI Report GS-6712. February 1990.

EPRI 1992. Evaluation of Strobe Lights for Fish Diversion at the York Haven Hydroelectric Project. Prepared by Stone & Webster. Report TR-101703; November 1992.

EPRI 1999. Status Report on Fish Protection at Cooling Water Intakes. Prepared by Alden Research Laboratory. Report TR-114013. November 1999.

Kuhl, G.M., and K.N. Mueller. 1988. Prairie Island Nuclear Engineering Plant Environmental

Monitoring Program 1988 Annual Report: Fine-mesh Vertical Traveling Screens Impingement Survival Study. Prepared for Northern States Power Company.

Gunderboom Promotional Brochure.

National Pollutant Discharge Elimination System-Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Fedreal Register/Vol. 69, No. 131/Friday, July 9, 2004/ Rules And Regulations.

P. F. Shires, E. P. Taft; "Evaluation of the Modular Inclined Screen (MIS) at the Green Island Hydroelectric Project: 1995 Test Results"; Electric Power Research Institute (EPRI) Report TR-104498; May 1996.

Public Service Electric and Gas Company. 1993. Appendix I—Modeling. Permit No. NJ0005622. Prepared by Lawler, Matusky, and Skelly Engineers, Pearl River, NY. Comments on NJPDES Draft. 82 p.

San Diego Gas and Electric (SDG&E). 1980. *Encina Power Plant Cooling Water Intake System Demonstration.* Prepared for California Regional Water Quality Control Board, San Diego Region. December 1980.

S. V. Amaral, F. C. Winchell, T. C. Cook, E. P. Taft; "Biological Evaluation of a

Modular Inclined Screen for Protecting Fish at Water Intakes"; Electric Power Research Institute (EPRI) Report TR-104121; May 1994.

Tenera Environmental. 2000a. Diablo Canyon Power Plant: 316(b) Demonstration Report. Prepared for Pacific Gas and Elec. Co., San Francisco, CA. Doc. No. E9-055.0.

Tenera Environmental. 2000b. Moss Landing Power Plant Modernization Project: 316(b) Resource Assessment. Prepared for Duke Energy Moss Landing, L.L.C., Oakland, CA.

Weight, R.H. "Ocean Cooling Water System for 800 MW Power Station", Journal of the Power Division, Proceedings of the American Society of Civil Engineers, Dec 1958.

ATTACHMENT 1

TOXICITY TESTING STUDY PLAN

CARLSBAD SEAWATER DESALINATION PLANT
NPDES NO. CA0109223

STUDY PLAN

FOR EVALUATION OF SALINITY-RELATED TOXICITY TRESHOLD FOR SHORT-TERM EXPOSURE TO DESALINATION PLANT DISCHARGE

STUDY PURPOSE

The purpose of this Short-Term Exposure Threshold (STET) Study is to determine the threshold concentration of total dissolved solids (TDS or salinity) of the discharge from the Carlsbad seawater desalination plant below which a short-term exposure (30 minutes to 24 hours) of standard test organisms to this discharge does not cause acute toxicity.

The study is proposed to fulfill Poseidon Resources Corporation's obligations under the requirements of Order No. R9-2006-0065 of August 16, 2006, of the San Diego Regional Water Quality Control Board, Section VI.C.2.c.1: "Salinity-Related Toxicity Threshold for Short-Term Exposure".

BACKGROUND

The Encina Power Generation Station (EPGS) has been selected as the site for the development of the Carlsbad Seawater Desalination Plant. The source water for the 50 MGD seawater reverse osmosis (SWRO) desalination plant will be collected from the existing cooling water discharge canal of the power plant. The power plant withdraws cooling water from the Pacific Ocean via the Agua Hedionda Lagoon. The concentrate and the treated waste filter backwash water from the desalination plant will be discharged into the existing cooling water discharge channel downstream of the point of interconnection for complete mixing with the cooling water discharge from the power plant prior to its ultimate disposal to the ocean.

Under normal operations the salinity concentration of the blended discharge of cooling water and desalination plant concentrate is projected to be less than or equal to 40 parts per thousand (ppt). The operation of the intake pumps of the desalination plant will be interlocked with the power plant intake pumps. As a result a power plant intake pump shutdown will automatically trigger desalination plant intake pump shutdown. After pump shutdown, however, it takes approximately 15 to 60 minutes to empty the desalination plant concentrate line and the power plant discharge canal. The instantaneous salinity concentration of the blended discharge may exceed 40 ppt during this short shut-down interval. To accommodate such short-term events when salinity of the blended concentrate may exceed the average daily TDS limit of 40 ppt during shut-down operations, the desalination plant NPDES permit establishes an average hourly salinity limit of 44 ppt.

Initial toxicity testing performed as part of Poseidon's NPDES application indicated that a short-term salinity of 44 ppt would not result in any harm to aquatic or benthic organisms. The purpose of STET Study is to confirm the validity of the 44 ppt salinity permit threshold and to assess the suitability of changing this threshold based on acute toxicity testing of the blended discharge for a salinity range between 36 and 60 ppt. The standard acute toxicity test was selected to establish the short-term salinity threshold, because this test will characterize effects of the short-term exposure of the blended discharge on aquatic life in the area of the discharge.

STUDY PROTOCOL

The proposed STET Study will consist of series of acute effluent toxicity bioassay tests of diluted desalination plant concentrate of salinity in a range of 36 ppt to 60 ppt and time of exposure of standard test organisms to the diluted concentrate in a range of 1 hour to 96 hours. As noted above, actual desalination shut-down operations may result in effluent salinities of up to 44 ppt for an hour or less. The proposed range of STET test salinities and exposure times thus represent a range of salinities and exposure times significantly in excess of actual discharge conditions.

Test Procedures

As per the requirements of the Carlsbad Seawater Desalination Plant NPDES Permit (Attachment E, Monitoring and Reporting Program, Section V. A.) the acute effluent toxicity bioassay tests will be performed in accordance with the standard test procedures established by the USEPA guidance manual, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th Edition, October 2002 (EPA-821-R-02-012).

Test Salinities

A 24-hour composite sample of seawater desalination plant concentrate will be collected at the Carlsbad seawater desalination pilot plant and be diluted to nominal test salinities of: 36 ppt, 38 ppt, 40 ppt, 42, ppt, 44 ppt, 46 ppt, 48 ppt, 50 ppt, 52 ppt, 54 ppt, 56 ppt, 58 ppt and 60 ppt. Filtered seawater from the Carlsbad pilot plant will be used to dilute the concentrate to the test salinity levels indicated above. In addition, a control sample of standard seawater salinity will be tested for comparison.

Test Organism

Topsmelt (*Atherinops affinis*) is planned to be used as a test organism. Topsmelt is proposed for this test because it is the only EPA-approved acute effluent toxicity test organism that may be present in the immediate vicinity of the desalination plant discharge. Since topsmelt is the marine organism also used to complete the EPGS acute effluent toxicity bioassay tests, the use of this organism for the STET test will facilitate continuity and comparability of the EPGS and desalination plant discharge toxicity test results.

The bioassay laboratory will be responsible for the supply, delivery and use of the test organisms. Each batch of test organisms will be subjected to salinity concentrations (see above) ranging from 36 ppt to 60 ppt. To simulate receiving water conditions under shut-down operations (in which salinity levels may temporarily gradually increase over a period of 15 to 45 minutes), salinity concentrations will be added to the text tanks over a period of short intervals (less than one hour) until the target salinity is reached.

Survival Count Times

Under the standard acute effluent toxicity bioassay test procedure, test organism survival counts are taken at the beginning of the test (0 hrs) and after 24, 48, 72 and 96 hours of effluent exposure. Additionally, in order to reflect the fact that elevated discharge salinity conditions are not expected to occur for longer than 60 minutes, the additional organism survival counts will be taken at 1 hour, 2 hours, 4 hours, and 12 hours after the initiation of the tests.

The tests will be completed by a certified laboratory specialized in such toxicity tests (Weston Solutions, Inc., Carlsbad office). This laboratory was selected because it is currently used by the EPGS staff to complete the power plant's cooling water effluent toxicity testing.

Source and Collection of Sample of Concentrate and Dilution Seawater

As indicated previously, for the purposes of the toxicity testing, the following samples are needed: (1) desalination plant concentrate; (2) dilution seawater not affected by/mixed with the EPGS cooling water discharge. Representative composite samples of the seawater desalination plant concentrate will be obtained from Poseidon's Carlsbad seawater desalination pilot plant.

The Carlsbad pilot plant is a 25 gpm seawater desalination facility located at the Encina power plant site. The plant consists of the same treatment facilities and uses the same chemicals as these planned to be used at the full-scale Carlsbad desalination plant. Under average conditions, the pilot desalination plant intake pump diverts up to 55 gpm of seawater from the Carlsbad power plant cooling water discharge. The intake seawater is treated using a pretreatment filtration system followed by cartridge filter and reverse osmosis (RO) seawater desalination system. The basic design criteria of the pilot plant are the same as these used for the full-scale facility. The pilot plant uses the same type of cartridge filters, and number and type of reverse osmosis membranes as the full-scale facility. Typically, the pilot project generates 70 to 80 gpm of filtered seawater of ambient ocean salinity (i.e., 32 to 34 ppt), and 35 to 40 gpm of concentrate that has salinity approximately two times higher than ambient salinity (i.e., 64 to 68 ppt).

For the purposes of this test one 24-hour composite sample of desalination plant concentrate and one 24-hour composite sample of filtered effluent will be collected from sampling ports at the pilot plant. The concentrate and filtered water composite samples will consist of minimum of 4 individual grab samples collected over every 8 hours over the same 24-hour period. Alternatively, the two composite samples may be collected using automatic grab samplers connected to the filter effluent and concentrate sampling ports.

TEST IMPLEMENTATION, RESULTS AND STUDY REPORT

The proposed STET Study will be implemented within six weeks from the approval of this Study Plan. The bioassay test results will be summarized in a report, which will be submitted for review to the San Diego RWQCB staff. This report will also contain an interpretation of the test results and recommendations regarding the average hourly salinity limitation included in the current permit.

ATTACHMENT 2

ACUTE TOXICITY TESTING STUDY

RESULTS

WESTON SOLUTIONS, INC.
2433 Impala Drive
Carlsbad, CA 92008
(760) 931-8081 / (760) 931-1580 FAX
www.westonsolutions.com

January 17, 2007

Poseidon Resources Corporation
1055 Washington Boulevard,
Stamford, CT 06901
Attn: Nikolay Voutchkov

RE: Toxicity Testing Results - Test Substance RO Concentrate Comp

Dear Mr. Voutchkov:

Attached please find the report for the Topsmelt acute test performed on test substance RO-Concentrate Comp, received on January 4, 2007.

All testing was performed consistent with our laboratory's quality assurance program. All results are to be considered in their entirety, and Weston Solutions is not responsible for use of less than the complete report. Results apply only to the sample tested.

If you have any questions regarding the attached report, or require additional testing, please call me at (760) 931-8081 or email at Chris.Osuch@westonsolutions.com. Thank you for using the aquatic testing services of Weston Solutions, Inc.

Sincerely,

Chris Osuch

Chris Osuch
Carlsbad Bioassay Laboratory

Weston Solutions, Inc.

Analytical Report

Client	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

96 Hour Acute Effluent Toxicity Bioassay
Weston Testing Protocol No. BIO 062C
EPA-821-R-02-012

Test Organism: ***Atherinops affinis***
Age: 15 days old

Study Design: Sample RO Concentrate Comp was diluted with filtered seawater from the desalination plant (UF Filtrate) to 13 different test salinities. A UF Filtrate Control was also tested to confirm that the dilution water did not cause toxicity. Final salinities of 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58 and 60 ppt were tested following EPA-821-R-02-012. To simulate what would occur if the power plant shuts down, the fish were acclimated to final salinities over the first 24 hours of the test. The fish were initially exposed to half of the salinity increase to start the test. The salinity was adjusted during the water renewal at 24 hours to final concentrations. In addition to the normal survival counts, additional counts were performed at 30 minutes, 1 hour, 2 hours, 4 hours and 12 hours. Standard test procedures were followed.

Concentration (ppt)	Number of Test Organisms at Start of Test	Number of Test Organisms at End of Test	Percent Survival	TUa
Control	40	40	100	N/A
UF Filtrate Control	40	40	100	N/A
36	40	38	95	0.41
38	40	36	90	0.59
40	40	38	95	0.41
42	40	39	97.5	0.23
44	40	34	85	0.69
46	40	35	87.5	0.65
48	40	32	80	0.77
50	40	22	55	0.97
52	40	25	62.5	0.93
54	40	18	45	1.02
56	40	22	55	0.97
58	40	26	65	0.91
60	40	15	37.5	1.06

Amy Menge — QA Officer — Date: 1/16/07
Chris Osuch — Approved — Date: 1/17/07

Weston Solutions, Inc.

Analytical Report

Client	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

96 Hour Acute Effluent Toxicity Bioassay
Weston Testing Protocol No. BIO 062C
EPA-821-R-02-012

Test Organism: ***Atherinops affinis***

Acute Toxicity Statement for Sample RO Concentrate Comp

Distribution Method	Result	Variance Method	Result
Kolmogorov D Test	Non-normal; $p \leq 0.01$	N/A	could not be confirmed

Hypothesis Method	NOEC	LOEC	Point Estimation Method	LC_{50}
Wilcoxon Rank Sum Test	42 ppt	44 ppt	Linear Interpolation	58.57 ppt

Acute Toxicity Statement: Test substance RO Concentrate Comp produced 37.5 percent survival in the 60 ppt concentration at 96 hours. The LC50 at 96 hours was estimated to be 58.57 ppt.

Control and UF Filtrate Control means were not significantly different ($p = 1.00$).

Weston Solutions, Inc.

Analytical Report

Client	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

96 Hour Acute Effluent Toxicity Bioassay
Weston Testing Protocol No. BIO 062C
EPA-821-R-02-012

Test Organism: ***Atherinops affinis***

Additional statistics were performed on each concentration to determine the No Observed Effect Time (NOET), the Lowest Observed Effect Time (LOET), and the Lethal Time for 50% of the population (LT_{50}). The results are presented in the table below.

Concentration (ppt)	NOET (Hours)	LOET (Hours)	LT_{50} (Hours)
36	96	>96	>96
38	96	>96	>96
40	96	>96	>96
42	96	>96	>96
44	4	12	>96
46	96	>96	>96
48	96	>96	>96
50	4	12	>96
52	96	>96	>96
54	1	2	11
56	96	>96	>96
58	4	12	>96
60	2	4	8.67

Weston Solutions, Inc.

Analytical Report

Client	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

96 Hour Acute Effluent Toxicity Bioassay
Weston Testing Protocol No.: BIO 062C
EPA-821-R-02-012

Test Organism: *Atherinops affinis*

Test Solution Physical and Chemical Data

Total Chlorine (mg/L)			
Concentration (ppt)	Initial	Renewal	Final
Control	0.00	*	*
60	0.00	*	*

*Chlorine not detected in initial measurement of sample

Concentration (ppt)	Statistic	D.O. (mg/L)	Temp (°C)	Salinity (ppt)	pH
Control	Mean	6.6	21.1	33.5	8.0
	Minimum	5.6	20.4	33.1	7.8
	Maximum	7.4	21.7	33.7	8.1
UF Filtrate	Mean	7.2	20.8	33.3	7.9
	Minimum	5.6	20.0	32.9	7.8
	Maximum	8.8	21.7	33.7	8.0
36	Mean	6.4	20.7	36.1	7.9
	Minimum	5.6	19.8	34.3	7.8
	Maximum	8.8	21.3	37.5	8.0
38	Mean	7.0	20.8	37.9	7.9
	Minimum	5.4	20.0	35.3	7.8
	Maximum	8.7	21.6	40.2	8.0
40	Mean	7.0	20.7	39.8	7.9
	Minimum	5.4	19.9	36.3	7.8
	Maximum	8.9	21.6	43.4	8.0
42	Mean	7.0	20.6	41.6	7.9
	Minimum	5.3	19.7	37.3	7.8
	Maximum	8.8	21.6	46.2	8.0
44	Mean	7.0	20.7	43.4	7.9
	Minimum	5.4	19.8	38.2	7.8
	Maximum	8.8	21.7	49.1	8.0

Weston Solutions, Inc.

Analytical Report

Client	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

96 Hour Acute Effluent Toxicity Bioassay
Weston Testing Protocol No.: BIO 062C
EPA-821-R-02-012

Test Organism: *Atherinops affinis*

Test Solution Physical and Chemical Data

Concentration (ppt)	Statistic	D.O. (mg/L)	Temp. (°C)	Salinity (ppt)	pH
46	Mean	7.0	20.7	45.2	7.9
	Minimum	5.3	19.7	39.2	7.8
	Maximum	8.8	21.7	52.1	8.0
48	Mean	6.9	20.7	47.2	7.9
	Minimum	5.1	20.1	40.5	7.8
	Maximum	8.8	21.3	55.0	8.0
50	Mean	6.9	20.7	48.9	7.9
	Minimum	5.4	19.9	41.2	7.8
	Maximum	8.8	21.6	57.9	8.0
52	Mean	7.0	20.8	50.8	7.9
	Minimum	5.4	20.1	41.9	7.8
	Maximum	8.8	21.8	61.0	8.0
54	Mean	7.1	20.8	52.7	7.9
	Minimum	5.5	20.2	43.1	7.8
	Maximum	8.8	21.8	63.9	8.0
56	Mean	7.0	20.9	54.4	7.9
	Minimum	5.2	20.3	44.1	7.8
	Maximum	8.7	21.8	65.9	8.0
58	Mean	7.0	21.0	55.7	7.9
	Minimum	5.6	20.3	44.9	7.8
	Maximum	8.6	21.8	65.8	8.0
60	Mean	7.1	20.9	57.2	7.9
	Minimum	5.6	20.0	45.7	7.8
	Maximum	8.7	21.7	65.8	8.0

Protocol Deviations: The test was initially started on December 19, 2006, but did not meet control survival acceptability criteria. The test was re-run on January 5, 2007 and the results are presented in this report.

Weston Solutions, Inc.

Analytical Report

Client:	Poseidon	Date Received:	04 Jan 07
Project:	Desal Pilot Topsmelt Toxicity Study	Date Test Started:	05 Jan 07
Client Sample ID:	RO Concentrate Comp	Date Test Ended:	09 Jan 07
Weston Test ID:	C070105.0262	Matrix:	Liquid

TEST: 96 Hour Acute Effluent Toxicity Bioassay, Weston Protocol No. BIO 062C, EPA-821-R-02-012

LAB CONTROL WATER: Filtered Seawater from Desalination Plant.

Dissolved Oxygen	7.4 mg/L
Temperature	21.7 °C
pH	8.1

TEST ORGANISM: Topsmelt, *Atherinops affinis* Age: 15 days old
Supplier: Aquatic BioSystems
Feeding: Fed *Artemia* nauplii *ad libitum* daily prior to testing.

TEST CHAMBER: Half liter containers, 4 replicate samples, 13 test salinities, and 4 replicate controls, brought to a 250mL final volume.

EXPERIMENTAL DESIGN:

1. Poseidon Resources personnel collected two 12 hour composite samples of both RO Concentrate and UF Filtrate ending at 1600 hours on January 3 and 0800 hours on January 4, 2007, respectively. Each sample was delivered to Weston in two 20L containers at 1020 hours on January 4. Temperatures upon arrival were 14.1 and 16.4° C for RO Concentrate, and 14.9 and 15.3°C for UF Filtrate, respectively. To create a 24 hour composite sample, the two 12 hour composites of each sample were composited at the Weston laboratory at 1040 hours on January 5, 2007. The composite samples were named RO Concentrate Comp and UF Filtrate Comp.
2. The temperature of the effluent was adjusted to 21± 1°C.
3. 10 test organisms were placed in each test container.
4. Test chambers were held at 21± 1°C for 96 hours with a photoperiod of 16 hours light: 8 hours darkness.
5. Test chambers were renewed daily.
6. Each test chamber was fed 1000 freshly hatched *Artemia* nauplii daily for the duration of the test.

MORTALITY CRITERIA: Lack of respiratory movement and lack of reaction to gentle prodding

ACCEPTIBILITY CRITERIA:

$\geq$ 90% survival in controls. Evaluation of the concentration-response relationship indicated that the data presented in this report are reliable.

REFERENCE TOXICITY: (Control Chart Included)

Toxicant: $CuSO_4$, Lot No.: 1605565, Received: 5/25/06, Opened: 6/6/06, Expires: 5/25/08.

96 Hour LC_{50}:	105.62 ppb	
Laboratory Mean:	159.08 ppb	
Test Date:	1/5/2007	Within 95 % Confidence Limits

STUDY DIRECTOR: K. Skrivseth

INVESTIGATORS: K. Skrivseth, E. Batliner, D. Weiss, A. Margolis, D. Sowersby, A. Lovell, J. Hansen

WESTON SOLUTIONS

Topsmelt 96-Hour Acute Toxicity Test

BIO062

Client	Poseidon
Project	Desal Pilot Topsmelt Toxicity Study
Client Sample ID:	RO Concentrate Comp
Weston Test ID:	C070105.0262
Species	Atherinops affinis

Date Received:	1/4/07
Date Test Started:	1/5/07
Date Test Ended:	1/9/07
Study Director:	K. Stenvseth
Organisms/Chamber:	10

	Conc.	Meter	D.O. (mg/L)	Meter	Temp (°C)	Meter	Salinity (ppt)	Meter	pH	Total Chlorine (mg/L)
Day 0 (0 Hours)	Control	7	7.4	7	21.7	6	33.1	11	8.1	0.00
Date: 1/5/06	UF Ø		8.0		21.7		32.9		8.0	
Sample ID: C070105.01 C070105.02	36		8.1		21.3		34.3		8.0	
Dilutions (Tech): KS	38		7.7		21.6		35.3		8.0	
WQ Time: 1415 Rep: stock	40		7.7		21.6		36.3		8.0	
Technician: [illegible]	42		7.7		21.6		37.3		8.0	
	44		7.8		21.7		38.2		8.0	~~0.00~~ ③
24 Hours (OLD)	Control	7	5.7	7	20.9	6	33.7	10	7.9	
	UF Ø		5.8		21.1		33.6		7.8	
Date: 1/6/07	36		5.8		21.2		35.0		7.8	
WQ Time: 1355 Rep: 1	38		5.4		20.8		36.4		7.8	
Technician: KS	40		5.4		20.6		37.1		7.8	
	42		5.3		20.5		37.9		7.8	
	44		5.7		20.8		38.4		7.8	
24 Hours (Renewal Water)	Control	7	7.2	7	21.6	6	① 33.1	10	8.1	
Date: 1/6/07	UF Ø		8.2		21.3		32.9		8.0	
Sample ID: C070105.01 C070105.02	36		8.4		21.0		37.5		8.0	
Dilutions (Tech): KS	38		8.3		21.1		40.2		7.9	
WQ Time: 1435 Rep: stock	40		8.3		21.2		43.4		7.9	
Technician: KS	42		8.1		21.3		46.2		7.9	
	44		8.1		21.3		49.1		7.9	
48 Hours (OLD)	Control	6	5.6	6	21.0	5	33.7	10	7.9	
	UF Ø		5.6		20.5		33.7		7.9	
Date: 1/7/07	36		5.6		20.4		36.5		7.9	
WQ Time: 1420 Rep: 2	38		5.8		20.4		38.6		7.9	
Technician: KS	40		5.5		20.5		40.2		7.9	
	42		6.0		20.3		42.5		7.9	
	44		5.4		20.6		44.4		7.9	
48 Hours (Renewal Water)	Control	6	7.3	6	20.9	5	33.5	10	8.1	[illegible]
Date: 1/7/07	UF Ø		8.8		20.0		33.2		8.0	
Sample ID: C070105.01 C070105.02	36		8.8		19.8		36.5		8.0	
Dilutions (Tech): KS	38		8.7		20.0		38.0		8.0	
WQ Time: 1445 Rep: stock	40		8.9		19.9		40.0		8.0	
Technician: KS	42		8.8		19.7		42.5		8.0	
	44		8.8		19.8		43.9		8.0	—
72 Hours (OLD)	Control	6	6.1	6	20.7	5	33.6	10	7.9	
	UF Ø		6.2		20.6		33.4		7.9	
Date: 1/8/07	36		6.2		20.5		36.1		7.9	
WQ Time: 1106 Rep: 3	38		6.1		20.4		38.3		7.9	
Technician: KS	40		5.9		20.6		40.2		7.9	
	42		6.0		20.5		42.2		7.9	
	44		6.0		20.4		44.2		7.9	
72 Hours (Renewal Water)	Control	6	7.3	6	21.2	5	33.6	10	8.1	
Date: 1/8/07	UF Ø		8.7		21.2		33.2		8.0	
Sample ID: C070105.01 C070105.02	36		8.7		21.2		36.2		8.0	
Dilutions (Tech): KS	38		8.6		21.2		38.0		7.9	
WQ Time: 1140 Rep: stock	40		8.7		21.0		40.9		7.9	
Technician: KS	42		8.6		21.0		42.1		7.9	
	44		8.7		20.8		44.4		7.9	
96 Hours	Control	6	6.0	6	20.4	5	33.7	10	7.8	[illegible]
	UF Ø		6.0		20.3		33.4		7.8	
Date: 1/9/07	36		6.0		20.4		36.5		7.8	
WQ Time: 1020 Rep: 4	38		5.7		20.6		38.4		7.8	
Technician: AM	40		5.5		20.2		40.1		7.8	
	42		5.6		20.1		42.3		7.8	
	44		5.6		20.3		44.4		7.8	—

① WC 1/6/07 KS

② WC 1/5/07 [initials]

③ No Chlorine detected at test initiation. 1/5/07 [initials]

Client	Poseidon
Project:	Desal Pilot Topsmelt Toxicity Study
Client Sample ID:	RO Concentrate Comp
Weston Test ID:	C070105.0262
Species	*Atherinops affinis*

Date Received:	1/4/07
Date Test Started:	1/5/07
Date Test Ended:	1/9/07
Study Director:	K.Skrivseth
Organisms/Chamber:	10

	Conc.	Meter	D.O. (mg/L)	Meter	Temp (°C)	Meter	Salinity (ppt)	Meter	pH	Total Chlorine (mg/L)
Day 0 (0 Hours)	46	7	7.7	7	21.7	6	39.2	11	8.0	0.0②
Date: 1/5/07	48		7.5		21.8		40.5		8.0	
Sample ID: C070105.01 C070105.02	50		7.4		21.6		41.2		8.0	
Dilutions (Tech): KS	52		7.5		21.8		42.1		8.0	
WQ Time: 1415 Rep: Stock	54		7.5		21.8		43.1		8.0	
Technician: EB	56		7.5		21.8		44.1		8.0	
	58		7.4		21.8		45.1		8.0	—
24 Hours (OLD)	46	7	5.3	7	20.7	6	39.5	10	7.8	
	48		5.1		20.7		41.2		7.8	
Date: 1/6/07	50		5.6		20.6		41.3		7.8	
WQ Time: 1355 Rep: 1	52		5.4		20.7		41.9		7.8	
Technician: KS	54		5.5		20.6		43.2		7.9	
	56		5.2		20.3		44.2		7.9	
	58		5.6		20.8		44.9		7.9	
24 Hours (Renewal Water)	46	7	8.2	7	21.3	6	52.1	10	7.9	
Date: 1/6/07	48		8.2		21.3		55.0		7.9	
Sample ID: C070105.01 C070105.02	50		8.2		21.2		57.9		7.9	
Dilutions (Tech): KS	52		8.2		21.3		61.0		7.8	
WQ Time: 1435 Rep: Stock	54		8.0		21.4		63.9		7.8	
Technician: KS	56		8.1		21.5		65.9		7.8	
	58		8.1		21.6		65.8		7.8	
48 Hours (OLD)	46	6	5.5	6	21.3	5	46.0	10	7.8	
	48		5.3		20.7		48.2		7.9	
Date: 1/7/07	50		5.7		20.8		50.1		7.9	
WQ Time: 1420 Rep: 2	52		5.6		20.6		52.6		7.9	
Technician: KS	54		5.8		20.2		54.3		8.0	
	56		5.4		20.8		56.2		8.0	
	58		5.6		20.8		57.5		8.0	
48 Hours (Renewal Water)	46	6	8.8	6	19.7	5	46.0	10	8.0	—
Date: 1/7/07	48		8.8		20.1		48.0		8.0	
Sample ID: C070105.01 C070105.02	50		8.8		19.9		50.0		8.0	
Dilutions (Tech): KS	52		8.8		20.4		51.9		8.0	
WQ Time: 1445 Rep: Stock	54		8.8		20.5		53.9		7.9	
Technician: KS	56		8.7		20.5		56.0		8.0	
	58		8.6		20.6		57.9		7.9	—
72 Hours (OLD)	46	6	6.0	6	20.4	5	46.3	10	7.9	
	48		6.2		20.4		48.2		7.9	
Date: 1/8/07	50		6.0		20.6		50.2		7.9	
WQ Time: 1106 Rep: 3	52		6.3		20.7		52.3		8.0	
Technician: KS	54		6.2		20.4		54.2		8.0	
	56		6.4		20.4		56.1		8.0	
	58		6.3		20.6		DKS ~~60.~~ 58.3		8.0	
72 Hours (Renewal Water)	46	6	8.6	6	20.9	5	46.4	10	7.9	
Date: 1/8/07	48		8.5		21.0		47.9		7.9	
Sample ID: C070105.01 C070105.02	50		8.3		21.0		50.2		7.9	
Dilutions (Tech): KS	52		8.5		21.0		51.9		7.9	
WQ Time: 1140 Rep: Stock	54		8.6		21.1		53.9		7.9	
Technician: KS	56		8.5		21.2		55.9		7.9	
	58		8.5		21.2		57.9		7.8	
96 Hours	46	6	5.5	6	20.8	5	46.4	10	7.8	—
	48		5.2		20.4		48.2		7.8	
Date: 1/9/07	50		5.4		20.2		50.3		7.8	
WQ Time: 1020 Rep: 4	52		6.0		20.1		52.3		7.9	
Technician: AM	54		6.1		20.5		54.7		7.9	
	56		5.9		20.6		56.4		7.9	
	58		5.8		20.3		58.0		7.9	—

① WC 1/8/07

② WC 1/9/07

WESTON SOLUTIONS

Topsmelt 96-Hour Acute Toxicity Test

Client	Posidon
Project:	Desal Pilot Topsmelt Toxicity Study
Client Sample ID:	RO Concentrate Comp
Weston Test ID:	C070105.0262
Species	Atherinops affinis

Date Received:	1/4/07
Date Test Started:	1/5/07
Date Test Ended:	1/9/07
Study Director:	K. Stringfellow
Organisms/Chamber:	10

	Conc.	Meter	D.O. (mg/L)	Meter	Temp (°C)	Meter	Salinity (ppt)	Meter	pH	Total Chlorine (mg/L)
Day 0 (0 Hours) Date: 1/5/07 Sample ID: C070105.01 C070105.02 Dilutions (Tech): KS WQ Time: 1415 Rep: Stock Technician: EB	60	7	7.5	7	21.7	6	46.1	11	8.0	0.00
24 Hours (OLD) Date: 1/6/07 WQ Time: 1355 Rep: 1 Technician: KS	60	7	5.6	7	21.2	6	45.7	10	8.0	
24 Hours (Renewal Water) Date: 1/6/07 Sample ID: C070105.01 C070105.02 Dilutions (Tech): KS WQ Time: 1435 Rep: Stock Technician: KS	60	7	8.1	7	21.5	6	65.8	10	7.9	
48 Hours (OLD) Date: 1/7/07 WQ Time: 1420 Rep: 2 Technician: KS	60	6	5.9	6	20.6	5	59.9	10	8.0	
48 Hours (Renewal Water) Date: 1/7/07 Sample ID: C070105.01 C070105.02 Dilutions (Tech): KS WQ Time: 1445 Rep: Stock Technician: KS	60	6	8.7	6	20.6	5	60.0	10	7.9	③
72 Hours (OLD) Date: 1/8/07 WQ Time: 1106 Rep: 3 Technician: KS	60	6	6.5	6	20.6	5	60.3	10	8.0	
72 Hours (Renewal Water) Date: 1/8/07 Sample ID: C070105.01 C070105.02 Dilutions (Tech): KS WQ Time: 1140 Rep: Stock Technician: KS	60	6	8.4	6	21.2	5	59.9	10	7.8	
96 Hours Date: 1/9/07 WQ Time: 1020 Rep: 4 Technician: JWM	60	6	5.7	6	20.0	5	60.2	10	7.9	③

① WD 1/5/07 EB
② IE 1/5/07 EB
③ No chlorine detected at test initiation. 1/9/07

BIO062

Topsmelt 96-Hour Acute Toxicity Test

Weston Test ID:	Client:	Client Sample ID:
C070105.0262	Poseidon	RO Concentrate Comp

Survival Data

Conc.	Rep	30 min		1 Hour		2 Hours		4 Hours		12 Hours		24 Hours		48 Hours		72 Hours		96 Hours	
		Date: 1.5.07		Date: 1.5.07		Date: 1.5.07		Date: 1.5.07		Date: 1.6.07		Date: 1/6/07		Date: 1/7/07		Date: 1/8/07		Date: 1/9/07	
		Time: 1838		Time: 1910		Time: 2010		Time: 2205		Time: 0008		Renewal Time: 1629		Renewal Time: 1528		Renewal Time: 1400		End Time: 1610	
		Technician: BA		Technician: BA		Technician: BA		Technician: BA		Technician: DW		Technician: VS		Technician: VS		Technician: BA		Technician: AMM	
		# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead
Control	1	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
UF Ø	1	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
36	1	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	9	1	9	Ø	9	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	9	1	9	Ø	9	Ø	9	Ø	9	Ø
38	1	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	9	1	9	Ø	8	1	8	Ø	8	Ø	8	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	9	1	9	Ø	8	1	8	Ø	8	Ø	8	Ø	8	Ø
40	1	10	Ø	10	Ø	9	1	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	9	1	9	Ø	9	Ø	9	Ø	9	Ø

Feeding Information	Day 0	24 Hours	48 Hours	72 Hours
Feed Time*:	1810	1300	1245	1055
Technician:	BA	VS	VS	VS

*Topsmelt should be fed at test initiation and approximately 2 hours before renewal at 24, 48, and 72 hours.

Start Time:	1805 BA, DW		
End Time:	1610 AMM		
Supplier:	ABS		
Organism Batch:	ABS 3444	Age:	15 days

Dilution Water Batch:	C070105.01
Hobo Temp. No.:	543494
Test Location:	Rm 3
Test Acceptability:	X ≥ 90% Survival in Control

Weston Test ID:	Client:	Client Sample ID:
C070105.0262	Poseidon	RO Concentrate Comp

Survival Data

Conc.	Rep	30 min.		1 Hour		2 Hours		4 Hours	
		Date: 1.5.07		Date: 1.5.07		Date: 1.5.07		Date: 1.5.07	
		Time: 1838		Time: 1910		Time: 2010		Time: 2205	
		Technician: DA		Technician: DA		Technician: DA		Technician: DA	
		# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead
42	1	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	9	1	9	Ø
44	1	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	9	1
	3	10	Ø	10	Ø	10	Ø	9	1
	4	10	Ø	10	Ø	10	Ø	10	Ø
46	1	9	1	9	[illegible] Ø	9	Ø	7 [illegible]	2
	2	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	9	1	9	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø
48	1	10	Ø	10	Ø	8	2	8	Ø
	2	10	Ø	10	Ø	10	Ø	9	1
	3	10	Ø	10	Ø	10	Ø	10	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø
56	1	10	Ø	10	Ø	9	1	6	3
	2	10	Ø	10	Ø	10	Ø	9	1
	3	10	Ø	10	Ø	10	Ø	9	1
	4	10	Ø	10	Ø	8 [illegible]	2	8	Ø

Conc.	Rep	12 Hours		24 Hours		48 Hours		72 Hours		96 Hours	
		Date: 1.6.07		Date: 1/6/07		Date: 1/7/07		Date: 1/8/07		Date: 1/9/07	
		Time: 0608		Renewal Time: 1629		Renewal Time: 1528		Renewal Time: 1400		End Time: 1610	
		Technician: DW		Technician: YS		Technician: YS		Technician: DA		Technician: [illegible]	
		# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead
42	1	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	2	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	3	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
	4	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
44	1	9	1 NB	9	Ø	9	Ø	9	Ø	9	Ø
	2	7	2	7	Ø	7	Ø	7	Ø	7	Ø
	3	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
	4	9	1	9	Ø	9	Ø	9	Ø	9	Ø
46	1	7	Ø	7	Ø	7	Ø	7 6 [illegible]	Ø 1 [illegible]	7	Ø
	2	9	1	9	Ø	9	Ø	9	Ø	9	Ø
	3	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
48	1	7	1	7	Ø	7	Ø	6	1	6	Ø
	2	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
	3	7	3	7	Ø	7	Ø	7	Ø	7	Ø
	4	10	Ø	10	Ø	10	Ø	10	Ø	10	Ø
56	1	3	3	3	Ø	2	1	2	Ø	2	Ø
	2	9	Ø	9	Ø	9	Ø	9	Ø	9	Ø
	3	6	3	5	1	5	Ø	5	Ø	5	Ø
	4	7	1	7	Ø	6	1	6	Ø	6	Ø

Feeding Information	Day 0	24 Hours	48 Hours	72 Hours
Feed Time*:	1810	1300	1245	1055
Technician:	DA	YS	YS	YS

*Topsmelt should be fed at test initiation and approximately 2 hours before renewal at 24, 48, and 72 hours.

① IE. 1.5.07 DA
② WS. 1.8.07 DA

Start Time:	1805 DA, DW.		
End Time:	1610		
Supplier:	ABS		
Organism Batch:	ABS 3444	Age:	15 days

Dilution Water Batch	C070105.01
Hobo Temp. No.:	543494
Test Location:	Rm 3
Test Acceptability:	X ≥ 90% Survival in Control

Topsmelt 96-Hour Acute Toxicity Test

Weston Test ID:	Client:	Client Sample ID:
C070105.0262	Posidon	RO Concentrate Comp

Survival Data

Conc.	Rep	30 min.		1 Hour		2 Hours		4 Hours		12 Hours		24 Hours		48 Hours		72 Hours		96 Hours	
		Date: 1-5-07		Date: 1-5-07		Date: 1-5-07		Date: 1-5-07		Date: 01-06-07		Date: 1/6/07		Date: 1/7/07		Date: 1/8/07		Date: 1/9/07	
		Time: 1838		Time: 1910		Time: 2010		Time: 2205		Time: 0608		Renewal Time: 1629		Renewal Time: 1528		Renewal Time: 1400		End Time: 1610	
		Technician: DA		Technician: DA		Technician: DA		Technician: DA		Technician: DW		Technician: VS		Technician: VS		Technician: DA		Technician: DM	
		# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead	# Alive	#Dead
52	1	10	0	10	0	10	0	10	0	10	0	9	1	9	0	9	0	9	0
	2	10	0	10	0	10	0	8	2	8	0	8	0	8	0	8	0	8	0
	3	10	0	7	3	6	1	5	1	4	1	4	0	4	0	4	0	4	0
	4	10	0	10	0	8	2	6	2	5	1	4	1	4	0	4	0	4	0
54	1	10	0	8	2	7	1	7	0	6	1	6	0	6	0	5	1	5	0
	2	10	0	9	1	8	1	8	0	5	3	5	0	5	0	5	0	5	0
	3	9	1	7	2	5	2	5	0	4	1	4	0	4	0	4	0	4	0
	4	10	0	10	0	9	1	7	2	4	3	4	0	4	0	4	0	4	0
56	1	10	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0
	2	10	0	10	0	9	1	7	2	7	0	7	0	7	0	7	0	7	0
	3	9	1	7	2	6	1	2	4	2	0	2	0	2	0	2	0	2	0
	4	10	0	10	0	10	0	7	3	4	3	3	1	3	0	3	0	3	0
58	1	10	0	10	0	9	1	9	0	8	1	8	0	8	0	8	0	8	0
	2	10	0	10	0	9	1	8	1	8	0	8	0	8	0	8	0	8	0
	3	8	2	5	3	5	0	5	0	5	0	5	0	5	0	5	0	5	0
	4	10	0	10	0	10	0	7	3	5	2	5	0	5	0	5	0	5	0
60	1	10	0	10	0	9	1	5	4	3	2	3	0	3	0	3	0	3	0
	2	10	0	10	0	9	1	8	1	3	5	3	0	3	0	3	0	3	0
	3	10	0	10	0	8	2	7	1	4	3	4	0	4	0	4	0	4	0
	4	10	0	10	0	10	0	7	3	5	2	5	0	5	0	5	0	5	0

Feeding Information	Day 0	24 Hours	48 Hours	72 Hours
Feed Time*:	1810	1300	1245	1055
Technician:	DA	VS	VS	VS

*Topsmelt should be fed at test initiation and approximately 2 hours before renewal at 24, 48, and 72 hours.

Start Time:	1805 DA, DW		
End Time:	1610		
Supplier:	ABS		
Organism Batch:	ABS 3444	Age:	15 days

Dilution Water Batch:	C070105.01
Hobo Temp. No.:	543494
Test Location:	Rm3
Test Acceptability:	X ≥ 90% Survival in Control

Acute Fish Test-96 Hr Survival

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Sample time is last sample taken of 24 hour composite, not the time the composite was created in the lab.

Conc-ppt	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
UF Filtrate Control	1.0000	1.0000	1.0000	1.0000
36	1.0000	1.0000	0.9000	0.9000
38	1.0000	0.8000	1.0000	0.8000
40	0.9000	1.0000	1.0000	0.9000
42	1.0000	1.0000	1.0000	0.9000
44	0.9000	0.7000	0.9000	0.9000
46	0.7000	0.9000	0.9000	1.0000
48	0.6000	0.9000	0.7000	1.0000
50	0.2000	0.9000	0.5000	0.6000
52	0.9000	0.8000	0.4000	0.4000
54	0.5000	0.5000	0.4000	0.4000
56	1.0000	0.7000	0.2000	0.3000
58	0.8000	0.8000	0.5000	0.5000
60	0.3000	0.3000	0.4000	0.5000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-ppt	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
Control	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4			1.0000	1.0000
UF Filtrate Control	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				
36	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	14.00	12.00	0.9500	0.9500
38	0.9000	0.9000	0.9000	0.8000	1.0000	12.830	4	14.00	12.00	0.9417	0.9417
40	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	14.00	12.00	0.9417	0.9417
42	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	16.00	12.00	0.9417	0.9417
*44	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	10.00	12.00	0.8625	0.8625
*46	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	12.00	12.00	0.8625	0.8625
*48	0.8000	0.8000	0.8000	0.6000	1.0000	22.822	4	12.00	12.00	0.8000	0.8000
*50	0.5500	0.5500	0.5500	0.2000	0.9000	52.486	4	10.00	12.00	0.5875	0.5875
*52	0.6250	0.6250	0.6250	0.4000	0.9000	42.079	4	10.00	12.00	0.5875	0.5875
*54	0.4500	0.4500	0.4500	0.4000	0.5000	12.830	4	10.00	12.00	0.5500	0.5500
*56	0.5500	0.5500	0.5500	0.2000	1.0000	67.215	4	12.00	12.00	0.5500	0.5500
*58	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	10.00	12.00	0.5500	0.5500
*60	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.00	12.00	0.3750	0.3750

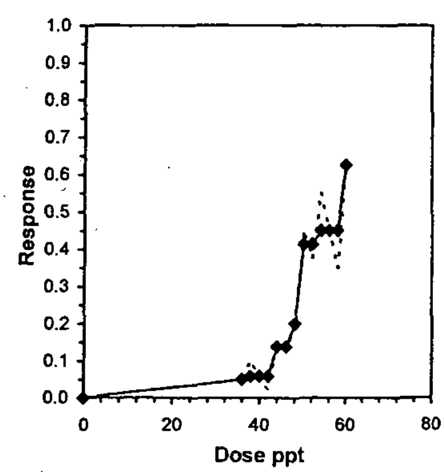
TUa 0.41 0.59 0.41 0.23 0.69 0.65 0.77 0.97 0.93 1.02 0.97 0.91 1

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.04263	1.035	0.18798	1.22476
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	42	44	42.9884	

Linear Interpolation (200 Resamples)

Point	ppt	SD	95% CL(Exp)		Skew
IC05	36.000	5.725	16.800	46.478	-0.9648
IC10	43.053	1.446	41.368	50.968	1.0565
IC15	46.400	1.683	41.358	49.543	-0.4398
IC20	48.000	1.108	41.600	49.686	-1.2139
IC25	48.471	0.931	46.118	51.988	0.9231
IC40	49.882	2.730	48.645	63.329	1.1803
IC50	58.571				



 ToxCalc v5.0.23 Reviewed by: [signature]

Test: AC-Acute Fish Test | Test ID: C070105.0262
Species: AA-Atherinops affinis | Protocol: EPAA 02-EPA Acute
Sample ID: RO Concentrate Comp | Sample Type: DMR-Discharge Monitoring Report
Start Date: 1/5/2007 18:05 | End Date: 1/9/2007 16:10 | Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	Control	10				10	
	2	2	Control	10				10	
	3	3	Control	10				10	
	4	4	Control	10				10	
	5	1	UF Filtrate Control	10				10	
	6	2	UF Filtrate Control	10				10	
	7	3	UF Filtrate Control	10				10	
	8	4	UF Filtrate Control	10				10	
	9	1	36.000	10				10	
	10	2	36.000	10				10	
	11	3	36.000	10				9	
	12	4	36.000	10				9	
	13	1	38.000	10				10	
	14	2	38.000	10				8	
	15	3	38.000	10				10	
	16	4	38.000	10				8	
	17	1	40.000	10				9	
	18	2	40.000	10				10	
	19	3	40.000	10				10	
	20	4	40.000	10				9	
	21	1	42.000	10				10	
	22	2	42.000	10				10	
	23	3	42.000	10				10	
	24	4	42.000	10				9	
	25	1	44.000	10				9	
	26	2	44.000	10				7	
	27	3	44.000	10				9	
	28	4	44.000	10				9	
	29	1	46.000	10				7	
	30	2	46.000	10				9	
	31	3	46.000	10				9	
	32	4	46.000	10				10	
	33	1	48.000	10				6	
	34	2	48.000	10				9	
	35	3	48.000	10				7	
	36	4	48.000	10				10	
	37	1	50.000	10				2	
	38	2	50.000	10				9	
	39	3	50.000	10				5	
	40	4	50.000	10				6	
	41	1	52.000	10				9	
	42	2	52.000	10				8	
	43	3	52.000	10				4	
	44	4	52.000	10				4	
	45	1	54.000	10				5	
	46	2	54.000	10				5	
	47	3	54.000	10				4	
	48	4	54.000	10				4	
	49	1	56.000	10				10	
	50	2	56.000	10				7	
	51	3	56.000	10				2	
	52	4	56.000	10				3	
	53	1	58.000	10				8	

Test: AC-Acute Fish Test		Test ID: C070105.0262
Species: AA-Atherinops affinis		Protocol: EPAA 02-EPA Acute
Sample ID: RO Concentrate Comp		Sample Type: DMR-Discharge Monitoring Report
Start Date: 1/5/2007 18:05	End Date: 1/9/2007 16:10	Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	54	2	58.000	10				8	
	55	3	58.000	10				5	
	56	4	58.000	10				5	
	57	1	60.000	10				3	
	58	2	60.000	10				3	
	59	3	60.000	10				4	
	60	4	60.000	10				5	

Comments: Sample time is last sample taken of 24 hour composite, not the time the composite was created in the lab.

 ToxCalc 5.0 Reviewed by: [signature]

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	36 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 36 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	0.9000
24	1.0000	1.0000	1.0000	0.9000
48	1.0000	1.0000	0.9000	0.9000
72	1.0000	1.0000	0.9000	0.9000
96	1.0000	1.0000	0.9000	0.9000

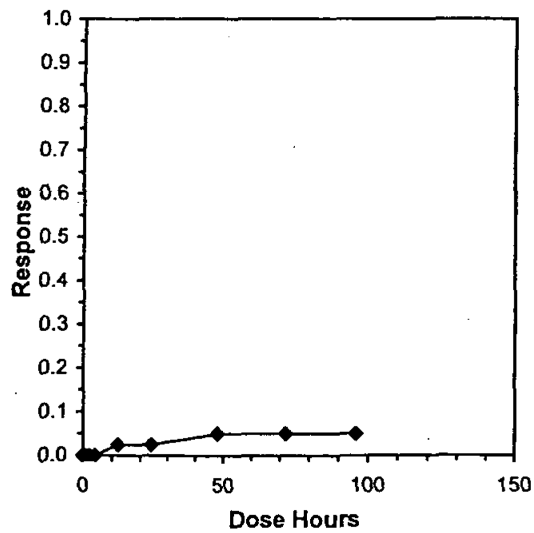
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0696	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0696	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0696	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0696	1.0000	1.0000
12	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.913	2.540	0.0696	0.9750	0.9750
24	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.913	2.540	0.0696	0.9750	0.9750
48	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.826	2.540	0.0696	0.9500	0.9500
72	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.826	2.540	0.0696	0.9500	0.9500
96	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.826	2.540	0.0696	0.9500	0.9500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.857002	0.919	-0.51648	-0.0863
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.069561	0.069561	0.002111	0.0015	0.228996	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)	Skew
IT05	>96			
IT10	>96			
IT15	>96			
IT20	>96			
IT25	>96			
IT40	>96			
IT50	>96			



Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 36 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	10	
	17	1	4.000	10	10	
	18	2	4.000	10	10	
	19	3	4.000	10	10	
	20	4	4.000	10	10	
	21	1	12.000	10	10	
	22	2	12.000	10	10	
	23	3	12.000	10	10	
	24	4	12.000	10	9	
	25	1	24.000	10	10	
	26	2	24.000	10	10	
	27	3	24.000	10	10	
	28	4	24.000	10	9	
	29	1	48.000	10	10	
	30	2	48.000	10	10	
	31	3	48.000	10	9	
	32	4	48.000	10	9	
	33	1	72.000	10	10	
	34	2	72.000	10	10	
	35	3	72.000	10	9	
	36	4	72.000	10	9	
	37	1	96.000	10	10	
	38	2	96.000	10	10	
	39	3	96.000	10	9	
	40	4	96.000	10	9	

Comments: Used to compare survival of fish to time exposed to 36 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	38 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 38 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	0.9000
4	1.0000	0.9000	1.0000	0.9000
12	1.0000	0.9000	1.0000	0.8000
24	1.0000	0.8000	1.0000	0.8000
48	1.0000	0.8000	1.0000	0.8000
72	1.0000	0.8000	1.0000	0.8000
96	1.0000	0.8000	1.0000	0.8000

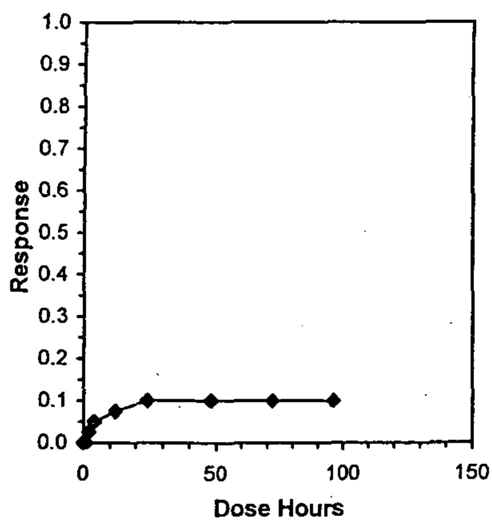
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1485	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1485	1.0000	1.0000
2	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.428	2.540	0.1485	0.9750	0.9750
4	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	0.855	2.540	0.1485	0.9500	0.9500
12	0.9250	0.9250	0.9250	0.8000	1.0000	10.351	4	1.283	2.540	0.1485	0.9250	0.9250
24	0.9000	0.9000	0.9000	0.8000	1.0000	12.830	4	1.711	2.540	0.1485	0.9000	0.9000
48	0.9000	0.9000	0.9000	0.8000	1.0000	12.830	4	1.711	2.540	0.1485	0.9000	0.9000
72	0.9000	0.9000	0.9000	0.8000	1.0000	12.830	4	1.711	2.540	0.1485	0.9000	0.9000
96	0.9000	0.9000	0.9000	0.8000	1.0000	12.830	4	1.711	2.540	0.1485	0.9000	0.9000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.88643	0.919	-0.1062	-1.1176
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.14847	0.14847	0.00822	0.00683	0.32927	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)	Skew
IT05	4.000			
IT10	24.000			
IT15	>96			
IT20	>96			
IT25	>96			
IT40	>96			
IT50	>96			



ToxCalc v5.0.23

Reviewed by: JM

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 38 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	9	
	17	1	4.000	10	10	
	18	2	4.000	10	9	
	19	3	4.000	10	10	
	20	4	4.000	10	9	
	21	1	12.000	10	10	
	22	2	12.000	10	9	
	23	3	12.000	10	10	
	24	4	12.000	10	8	
	25	1	24.000	10	10	
	26	2	24.000	10	8	
	27	3	24.000	10	10	
	28	4	24.000	10	8	
	29	1	48.000	10	10	
	30	2	48.000	10	8	
	31	3	48.000	10	10	
	32	4	48.000	10	8	
	33	1	72.000	10	10	
	34	2	72.000	10	8	
	35	3	72.000	10	10	
	36	4	72.000	10	8	
	37	1	96.000	10	10	
	38	2	96.000	10	8	
	39	3	96.000	10	10	
	40	4	96.000	10	8	

Comments: Used to compare survival of fish to time exposed to 38 ppt concentration.

 Reviewed by: JJM

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	40 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 40 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	0.9000	1.0000	1.0000	1.0000
4	0.9000	1.0000	1.0000	1.0000
12	0.9000	1.0000	1.0000	0.9000
24	0.9000	1.0000	1.0000	0.9000
48	0.9000	1.0000	1.0000	0.9000
72	0.9000	1.0000	1.0000	0.9000
96	0.9000	1.0000	1.0000	0.9000

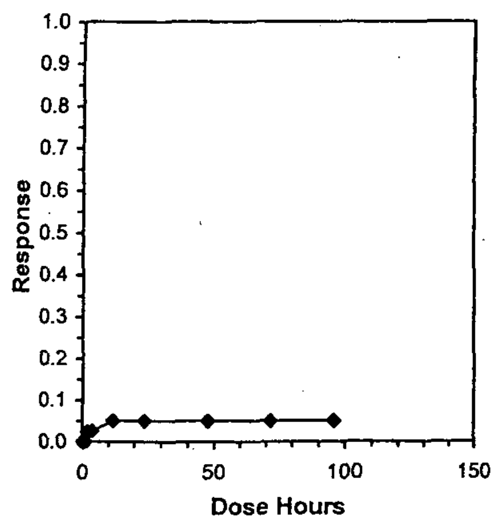
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0836	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0836	1.0000	1.0000
2	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.760	2.540	0.0836	0.9750	0.9750
4	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.760	2.540	0.0836	0.9750	0.9750
12	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.519	2.540	0.0836	0.9500	0.9500
24	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.519	2.540	0.0836	0.9500	0.9500
48	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.519	2.540	0.0836	0.9500	0.9500
72	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.519	2.540	0.0836	0.9500	0.9500
96	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	1.519	2.540	0.0836	0.9500	0.9500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.86051	0.919	-0.2975	-1.1929
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.0836	0.0836	0.00211	0.00217	0.48013	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)	Skew
IT05	>96			
IT10	>96			
IT15	>96			
IT20	>96			
IT25	>96			
IT40	>96			
IT50	>96			



ToxCalc v5.0.23

Reviewed by: UM

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 40 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	9	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	10	
	17	1	4.000	10	9	
	18	2	4.000	10	10	
	19	3	4.000	10	10	
	20	4	4.000	10	10	
	21	1	12.000	10	9	
	22	2	12.000	10	10	
	23	3	12.000	10	10	
	24	4	12.000	10	9	
	25	1	24.000	10	9	
	26	2	24.000	10	10	
	27	3	24.000	10	10	
	28	4	24.000	10	9	
	29	1	48.000	10	9	
	30	2	48.000	10	10	
	31	3	48.000	10	10	
	32	4	48.000	10	9	
	33	1	72.000	10	9	
	34	2	72.000	10	10	
	35	3	72.000	10	10	
	36	4	72.000	10	9	
	37	1	96.000	10	9	
	38	2	96.000	10	10	
	39	3	96.000	10	10	
	40	4	96.000	10	9	

Comments: Used to compare survival of fish to time exposed to 40 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.026	Sample ID:	42 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute-	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 42 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	0.9000
4	1.0000	1.0000	1.0000	0.9000
12	1.0000	1.0000	1.0000	0.9000
24	1.0000	1.0000	1.0000	0.9000
48	1.0000	1.0000	1.0000	0.9000
72	1.0000	1.0000	1.0000	0.9000
96	1.0000	1.0000	1.0000	0.9000

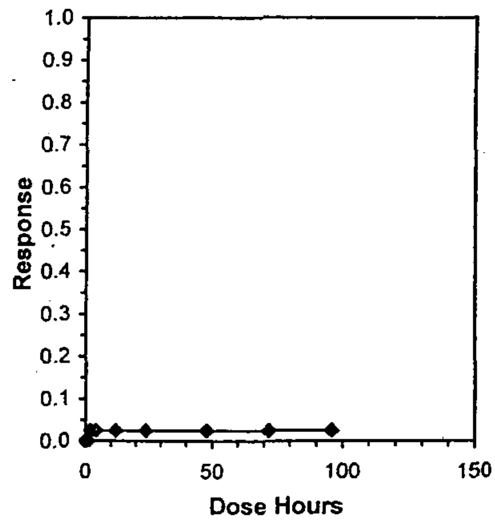
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0751	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.0751	1.0000	1.0000
2	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
4	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
12	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
24	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
48	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
72	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750
96	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.845	2.540	0.0751	0.9750	0.9750

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.64765	0.919	-1.4345	0.54552
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.07513	0.07513	0.00058	0.00175	0.95668	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)	Skew
IT05	>96			
IT10	>96			
IT15	>96			
IT20	>96			
IT25	>96			
IT40	>96			
IT50	>96			



 ToxCalc v5.0.23 Reviewed by

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 42 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	9	
	17	1	4.000	10	10	
	18	2	4.000	10	10	
	19	3	4.000	10	10	
	20	4	4.000	10	9	
	21	1	12.000	10	10	
	22	2	12.000	10	10	
	23	3	12.000	10	10	
	24	4	12.000	10	9	
	25	1	24.000	10	10	
	26	2	24.000	10	10	
	27	3	24.000	10	10	
	28	4	24.000	10	9	
	29	1	48.000	10	10	
	30	2	48.000	10	10	
	31	3	48.000	10	10	
	32	4	48.000	10	9	
	33	1	72.000	10	10	
	34	2	72.000	10	10	
	35	3	72.000	10	10	
	36	4	72.000	10	9	
	37	1	96.000	10	10	
	38	2	96.000	10	10	
	39	3	96.000	10	10	
	40	4	96.000	10	9	

Comments: Used to compare survival of fish to time exposed to 42 ppt concentration.

 ToxCalc 5.0 Reviewed by: [signature]

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	44 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 44 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000
4	1.0000	0.9000	0.9000	1.0000
12	0.9000	0.7000	0.9000	0.9000
24	0.9000	0.7000	0.9000	0.9000
48	0.9000	0.7000	0.9000	0.9000
72	0.9000	0.7000	0.9000	0.9000
96	0.9000	0.7000	0.9000	0.9000

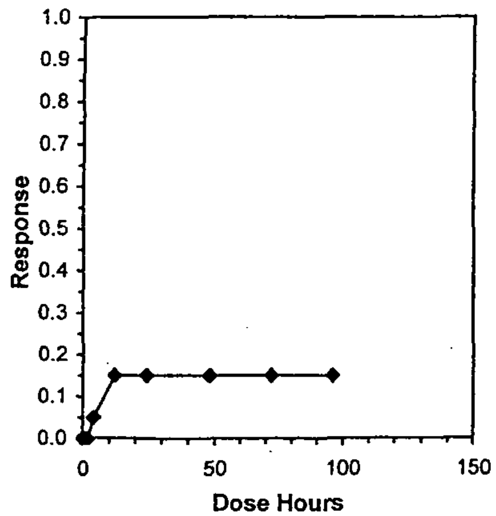
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1312	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1312	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1312	1.0000	1.0000
4	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	0.968	2.540	0.1312	0.9500	0.9500
*12	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	2.905	2.540	0.1312	0.8500	0.8500
*24	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	2.905	2.540	0.1312	0.8500	0.8500
*48	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	2.905	2.540	0.1312	0.8500	0.8500
*72	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	2.905	2.540	0.1312	0.8500	0.8500
*96	0.8500	0.8500	0.8500	0.7000	0.9000	11.765	4	2.905	2.540	0.1312	0.8500	0.8500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.70003	0.919	-1.5407	1.46363
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	4	12	6.9282		0.13117	0.13117	0.02267	0.00533	0.00127	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	4.0000	1.3395	2.4000	10.4000	0.8155
IT10	8.0000	10.0399	1.6000	72.0000	3.8051
IT15	>96				
IT20	>96				
IT25	>96				
IT40	>96				
IT50	>96				



Test: AC-Acute Fish Test	Test ID: C070105.0262
Species: AA-Atherinops affinis	Protocol: EPAA 02-EPA Acute
Sample ID: 44 ppt RO Concentrate Comp	Sample Type: DMR-Discharge Monitoring Report
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10	Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	10	
	17	1	4.000	10	10	
	18	2	4.000	10	9	
	19	3	4.000	10	9	
	20	4	4.000	10	10	
	21	1	12.000	10	9	
	22	2	12.000	10	7	
	23	3	12.000	10	9	
	24	4	12.000	10	9	
	25	1	24.000	10	9	
	26	2	24.000	10	7	
	27	3	24.000	10	9	
	28	4	24.000	10	9	
	29	1	48.000	10	9	
	30	2	48.000	10	7	
	31	3	48.000	10	9	
	32	4	48.000	10	9	
	33	1	72.000	10	9	
	34	2	72.000	10	7	
	35	3	72.000	10	9	
	36	4	72.000	10	9	
	37	1	96.000	10	9	
	38	2	96.000	10	7	
	39	3	96.000	10	9	
	40	4	96.000	10	9	

Comments: Used to compare survival of fish to time exposed to 44 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	46 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 46 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	0.9000	1.0000	1.0000	1.0000
1	0.9000	1.0000	1.0000	1.0000
2	0.9000	1.0000	0.9000	1.0000
4	0.7000	1.0000	0.9000	1.0000
12	0.7000	0.9000	0.9000	1.0000
24	0.7000	0.9000	0.9000	1.0000
48	0.7000	0.9000	0.9000	1.0000
72	0.7000	0.9000	0.9000	1.0000
96	0.7000	0.9000	0.9000	1.0000

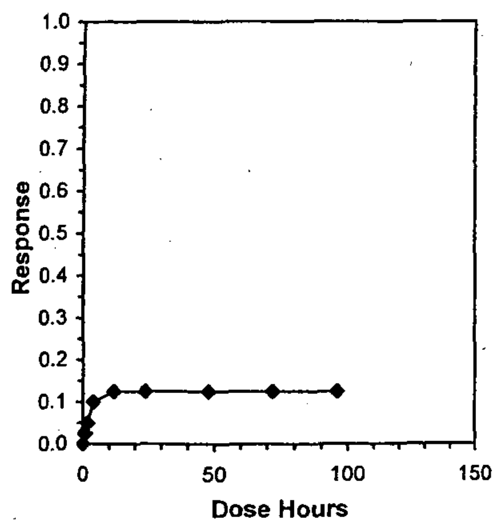
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.341	2.540	0.1862	0.9750	0.9750
1	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.341	2.540	0.1862	0.9750	0.9750
2	0.9500	0.9500	0.9500	0.9000	1.0000	6.077	4	0.682	2.540	0.1862	0.9500	0.9500
4	0.9000	0.9000	0.9000	0.7000	1.0000	15.713	4	1.364	2.540	0.1862	0.9000	0.9000
12	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	1.705	2.540	0.1862	0.8750	0.8750
24	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	1.705	2.540	0.1862	0.8750	0.8750
48	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	1.705	2.540	0.1862	0.8750	0.8750
72	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	1.705	2.540	0.1862	0.8750	0.8750
96	0.8750	0.8750	0.8750	0.7000	1.0000	14.381	4	1.705	2.540	0.1862	0.8750	0.8750

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.84452	0.919	-0.848	0.16827
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.18622	0.18622	0.01058	0.01075	0.47261	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	2.0000	2.9127	0.0000	11.6686	5.4444
IT10	4.0000				
IT15	>96				
IT20	>96				
IT25	>96				
IT40	>96				
IT50	>96				



ToxCalc v5.0.23

Reviewed by

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 46 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.02
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	9	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	9	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	9	
	14	2	2.000	10	10	
	15	3	2.000	10	9	
	16	4	2.000	10	10	
	17	1	4.000	10	7	
	18	2	4.000	10	10	
	19	3	4.000	10	9	
	20	4	4.000	10	10	
	21	1	12.000	10	7	
	22	2	12.000	10	9	
	23	3	12.000	10	9	
	24	4	12.000	10	10	
	25	1	24.000	10	7	
	26	2	24.000	10	9	
	27	3	24.000	10	9	
	28	4	24.000	10	10	
	29	1	48.000	10	7	
	30	2	48.000	10	9	
	31	3	48.000	10	9	
	32	4	48.000	10	10	
	33	1	72.000	10	7	
	34	2	72.000	10	9	
	35	3	72.000	10	9	
	36	4	72.000	10	10	
	37	1	96.000	10	7	
	38	2	96.000	10	9	
	39	3	96.000	10	9	
	40	4	96.000	10	10	

Comments: Used to compare survival of fish to time exposed to 46 ppt concentration

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	48 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 48 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	0.8000	1.0000	1.0000	1.0000
4	0.8000	0.9000	1.0000	1.0000
12	0.7000	0.9000	0.7000	1.0000
24	0.7000	0.9000	0.7000	1.0000
48	0.7000	0.9000	0.7000	1.0000
72	0.6000	0.9000	0.7000	1.0000
96	0.6000	0.9000	0.7000	1.0000

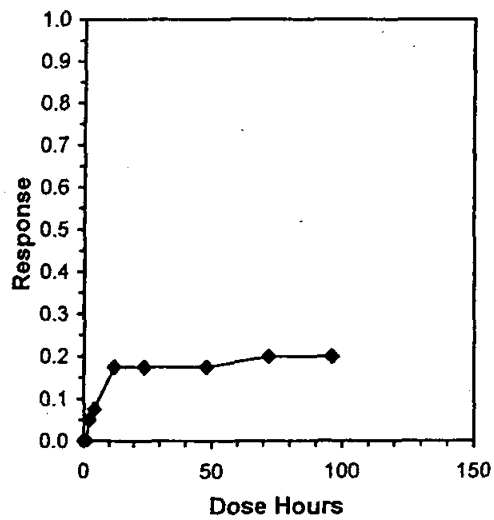
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.2224	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.2224	1.0000	1.0000
2	0.9500	0.9500	0.9500	0.8000	1.0000	10.526	4	0.571	2.540	0.2224	0.9500	0.9500
4	0.9250	0.9250	0.9250	0.8000	1.0000	10.351	4	0.857	2.540	0.2224	0.9250	0.9250
12	0.8250	0.8250	0.8250	0.7000	1.0000	18.182	4	1.999	2.540	0.2224	0.8250	0.8250
24	0.8250	0.8250	0.8250	0.7000	1.0000	18.182	4	1.999	2.540	0.2224	0.8250	0.8250
48	0.8250	0.8250	0.8250	0.7000	1.0000	18.182	4	1.999	2.540	0.2224	0.8250	0.8250
72	0.8000	0.8000	0.8000	0.6000	1.0000	22.822	4	2.284	2.540	0.2224	0.8000	0.8000
96	0.8000	0.8000	0.8000	0.6000	1.0000	22.822	4	2.284	2.540	0.2224	0.8000	0.8000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93335	0.919	0.03161	-0.6642
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.2224	0.2224	0.031	0.01533	0.07183	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	2.000	2.318	1.111	9.467	6.1902
IT10	6.000	7.141	0.000	34.966	4.8581
IT15	10.000				
IT20	>96				
IT25	>96				
IT40	>96				
IT50	>96				



ToxCalc v5.0.23

Reviewed by: [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 48 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	8	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	10	
	17	1	4.000	10	8	
	18	2	4.000	10	9	
	19	3	4.000	10	10	
	20	4	4.000	10	10	
	21	1	12.000	10	7	
	22	2	12.000	10	9	
	23	3	12.000	10	7	
	24	4	12.000	10	10	
	25	1	24.000	10	7	
	26	2	24.000	10	9	
	27	3	24.000	10	7	
	28	4	24.000	10	10	
	29	1	48.000	10	7	
	30	2	48.000	10	9	
	31	3	48.000	10	7	
	32	4	48.000	10	10	
	33	1	72.000	10	6	
	34	2	72.000	10	9	
	35	3	72.000	10	7	
	36	4	72.000	10	10	
	37	1	96.000	10	6	
	38	2	96.000	10	9	
	39	3	96.000	10	7	
	40	4	96.000	10	10	

Comments: Used to compare survival of fish to time exposed to 48 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	50 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute-	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 50 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	0.9000	1.0000	1.0000	0.8000
4	0.6000	0.9000	0.9000	0.8000
12	0.3000	0.9000	0.6000	0.7000
24	0.3000	0.9000	0.5000	0.7000
48	0.2000	0.9000	0.5000	0.6000
72	0.2000	0.9000	0.5000	0.6000
96	0.2000	0.9000	0.5000	0.6000

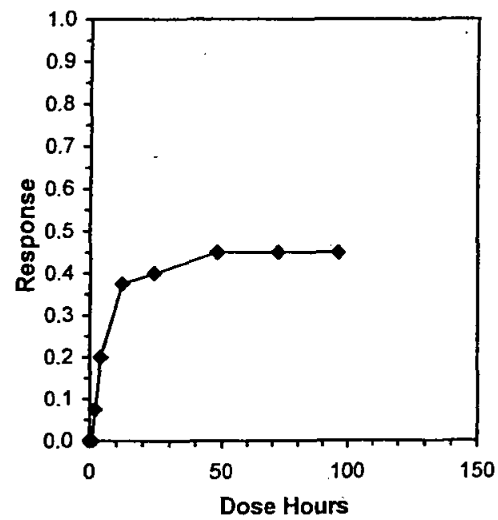
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.3629	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.3629	1.0000	1.0000
2	0.9250	0.9250	0.9250	0.8000	1.0000	10.351	4	0.525	2.540	0.3629	0.9250	0.9250
4	0.8000	0.8000	0.8000	0.6000	0.9000	17.678	4	1.400	2.540	0.3629	0.8000	0.8000
*12	0.6250	0.6250	0.6250	0.3000	0.9000	40.000	4	2.624	2.540	0.3629	0.6250	0.6250
*24	0.6000	0.6000	0.6000	0.3000	0.9000	43.033	4	2.799	2.540	0.3629	0.6000	0.6000
*48	0.5500	0.5500	0.5500	0.2000	0.9000	52.486	4	3.149	2.540	0.3629	0.5500	0.5500
*72	0.5500	0.5500	0.5500	0.2000	0.9000	52.486	4	3.149	2.540	0.3629	0.5500	0.5500
*96	0.5500	0.5500	0.5500	0.2000	0.9000	52.486	4	3.149	2.540	0.3629	0.5500	0.5500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.88912	0.919	-0.0982	0.55881
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	4	12	6.9282		0.36293	0.36293	0.16789	0.04083	0.00159	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	1.667	0.349	1.133	3.003	0.8992
IT10	2.400	0.646	1.227	4.960	0.7743
IT15	3.200	1.085	1.280	7.496	1.2255
IT20	4.000	2.362	2.167	12.640	3.9069
IT25	6.286	4.978	1.755	34.629	4.0462
IT40	24.000				
IT50	>96				



ToxCalc v5.0.23

Reviewed by: [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 50 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	9	
	14	2	2.000	10	10	
	15	3	2.000	10	10	
	16	4	2.000	10	8	
	17	1	4.000	10	6	
	18	2	4.000	10	9	
	19	3	4.000	10	9	
	20	4	4.000	10	8	
	21	1	12.000	10	3	
	22	2	12.000	10	9	
	23	3	12.000	10	6	
	24	4	12.000	10	7	
	25	1	24.000	10	3	
	26	2	24.000	10	9	
	27	3	24.000	10	5	
	28	4	24.000	10	7	
	29	1	48.000	10	2	
	30	2	48.000	10	9	
	31	3	48.000	10	5	
	32	4	48.000	10	6	
	33	1	72.000	10	2	
	34	2	72.000	10	9	
	35	3	72.000	10	5	
	36	4	72.000	10	6	
	37	1	96.000	10	2	
	38	2	96.000	10	9	
	39	3	96.000	10	5	
	40	4	96.000	10	6	

Comments: Used to compare survival of fish to time exposed to 50 ppt concentration.

 Reviewed by: [signature]

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	52 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 52 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	0.7000	1.0000
2	1.0000	1.0000	0.6000	0.8000
4	1.0000	0.8000	0.5000	0.6000
12	1.0000	0.8000	0.4000	0.5000
24	0.9000	0.8000	0.4000	0.4000
48	0.9000	0.8000	0.4000	0.4000
72	0.9000	0.8000	0.4000	0.4000
96	0.9000	0.8000	0.4000	0.4000

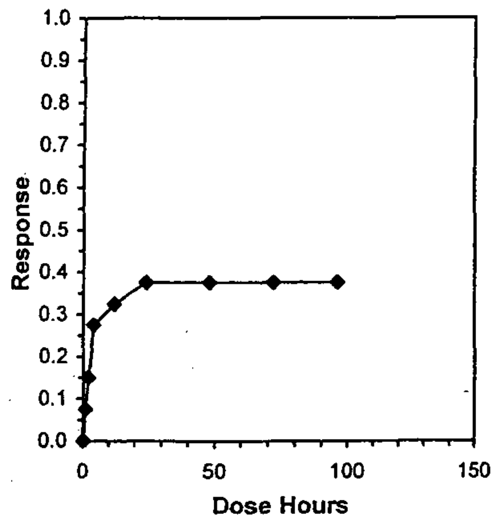
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.3856	1.0000	1.0000
1	0.9250	0.9250	0.9250	0.7000	1.0000	16.216	4	0.494	2.540	0.3856	0.9250	0.9250
2	0.8500	0.8500	0.8500	0.6000	1.0000	22.528	4	0.988	2.540	0.3856	0.8500	0.8500
4	0.7250	0.7250	0.7250	0.5000	1.0000	30.584	4	1.812	2.540	0.3856	0.7250	0.7250
12	0.6750	0.6750	0.6750	0.4000	1.0000	40.797	4	2.141	2.540	0.3856	0.6750	0.6750
24	0.6250	0.6250	0.6250	0.4000	0.9000	42.079	4	2.470	2.540	0.3856	0.6250	0.6250
48	0.6250	0.6250	0.6250	0.4000	0.9000	42.079	4	2.470	2.540	0.3856	0.6250	0.6250
72	0.6250	0.6250	0.6250	0.4000	0.9000	42.079	4	2.470	2.540	0.3856	0.6250	0.6250
96	0.6250	0.6250	0.6250	0.4000	0.9000	42.079	4	2.470	2.540	0.3856	0.6250	0.6250

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.89327	0.919	0.05004	-1.3097
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.38556	0.38556	0.10281	0.04608	0.04811	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	0.8333	0.4189	0.5206	2.8602	1.3821
IT10	1.3333	0.7443	0.4413	4.3520	1.7363
IT15	2.0000	2.2555	0.2619	18.0000	3.7135
IT20	2.8000	3.5646	0.7171	22.6814	2.3143
IT25	3.6000	12.3323	1.0400	76.4869	3.0286
IT40	>96				
IT50	>96				



 ToxCalc v5.0.23 Reviewed by: [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 52 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	7	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	10	
	15	3	2.000	10	6	
	16	4	2.000	10	8	
	17	1	4.000	10	10	
	18	2	4.000	10	8	
	19	3	4.000	10	5	
	20	4	4.000	10	6	
	21	1	12.000	10	10	
	22	2	12.000	10	8	
	23	3	12.000	10	4	
	24	4	12.000	10	5	
	25	1	24.000	10	9	
	26	2	24.000	10	8	
	27	3	24.000	10	4	
	28	4	24.000	10	4	
	29	1	48.000	10	9	
	30	2	48.000	10	8	
	31	3	48.000	10	4	
	32	4	48.000	10	4	
	33	1	72.000	10	9	
	34	2	72.000	10	8	
	35	3	72.000	10	4	
	36	4	72.000	10	4	
	37	1	96.000	10	9	
	38	2	96.000	10	8	
	39	3	96.000	10	4	
	40	4	96.000	10	4	

Comments: Used to compare survival of fish to time exposed to 52 ppt concentration.

Acute Fish Test-24 Hr Survival

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	54 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 54 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	0.9000	1.0000
1	0.8000	0.9000	0.7000	1.0000
2	0.7000	0.8000	0.5000	0.9000
4	0.7000	0.8000	0.5000	0.7000
12	0.6000	0.5000	0.4000	0.4000
24	0.6000	0.5000	0.4000	0.4000
48	0.6000	0.5000	0.4000	0.4000
72	0.5000	0.5000	0.4000	0.4000
96	0.5000	0.5000	0.4000	0.4000

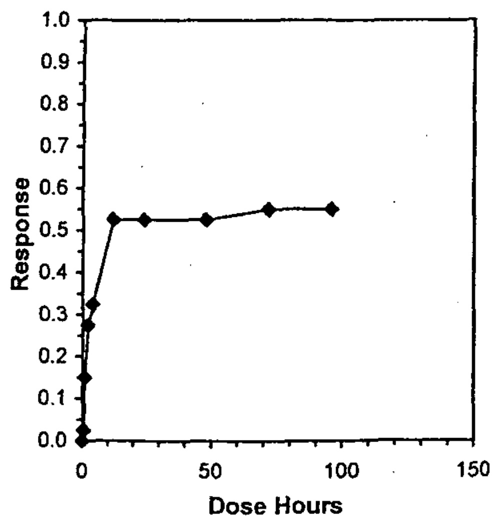
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.357	2.540	0.1781	0.9750	0.9750
1	0.8500	0.8500	0.8500	0.7000	1.0000	15.188	4	2.139	2.540	0.1781	0.8500	0.8500
*2	0.7250	0.7250	0.7250	0.5000	0.9000	23.556	4	3.922	2.540	0.1781	0.7250	0.7250
*4	0.6750	0.6750	0.6750	0.5000	0.8000	18.642	4	4.635	2.540	0.1781	0.6750	0.6750
*12	0.4750	0.4750	0.4750	0.4000	0.6000	20.156	4	7.487	2.540	0.1781	0.4750	0.4750
*24	0.4750	0.4750	0.4750	0.4000	0.6000	20.156	4	7.487	2.540	0.1781	0.4750	0.4750
*48	0.4750	0.4750	0.4750	0.4000	0.6000	20.156	4	7.487	2.540	0.1781	0.4750	0.4750
*72	0.4500	0.4500	0.4500	0.4000	0.5000	12.830	4	7.844	2.540	0.1781	0.4500	0.4500
*96	0.4500	0.4500	0.4500	0.4000	0.5000	12.830	4	7.844	2.540	0.1781	0.4500	0.4500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96222	0.919	-0.2462	0.28143
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	1	2	1.41421		0.1781	0.1781	0.19822	0.00983	2.1E-10	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	0.600	0.157	0.173	1.240	0.9174
IT10	0.800	0.186	0.480	1.579	1.2044
IT15	1.000	0.352	0.600	2.607	1.4602
IT20	1.400	0.534	0.582	3.562	0.7827
IT25	1.800	0.823	0.760	5.320	0.7784
IT40	7.000	1.757	1.799	11.800	-0.5099
IT50	11.000	14.147	8.835	85.560	1.6031



 ToxCalc v5.0.23 Reviewed by: [signature]

Test: AC-Acute Fish Test | Test ID: C070105.0262
Species: AA-Atherinops affinis | Protocol: EPAA 02-EPA Acute
Sample ID: 54 ppt RO Concentrate Comp | Sample Type: DMR-Discharge Monitoring Report
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10 | Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	9	
	8	4	0.500	10	10	
	9	1	1.000	10	8	
	10	2	1.000	10	9	
	11	3	1.000	10	7	
	12	4	1.000	10	10	
	13	1	2.000	10	7	
	14	2	2.000	10	8	
	15	3	2.000	10	5	
	16	4	2.000	10	9	
	17	1	4.000	10	7	
	18	2	4.000	10	8	
	19	3	4.000	10	5	
	20	4	4.000	10	7	
	21	1	12.000	10	6	
	22	2	12.000	10	5	
	23	3	12.000	10	4	
	24	4	12.000	10	4	
	25	1	24.000	10	6	
	26	2	24.000	10	5	
	27	3	24.000	10	4	
	28	4	24.000	10	4	
	29	1	48.000	10	6	
	30	2	48.000	10	5	
	31	3	48.000	10	4	
	32	4	48.000	10	4	
	33	1	72.000	10	5	
	34	2	72.000	10	5	
	35	3	72.000	10	4	
	36	4	72.000	10	4	
	37	1	96.000	10	5	
	38	2	96.000	10	5	
	39	3	96.000	10	4	
	40	4	96.000	10	4	

Comments: Used to compare survival of fish to time exposed to 54 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	56 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 56 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	0.9000	1.0000
1	1.0000	1.0000	0.7000	1.0000
2	1.0000	0.9000	0.6000	1.0000
4	1.0000	0.7000	0.2000	0.7000
12	1.0000	0.7000	0.2000	0.4000
24	1.0000	0.7000	0.2000	0.3000
48	1.0000	0.7000	0.2000	0.3000
72	1.0000	0.7000	0.2000	0.3000
96	1.0000	0.7000	0.2000	0.3000

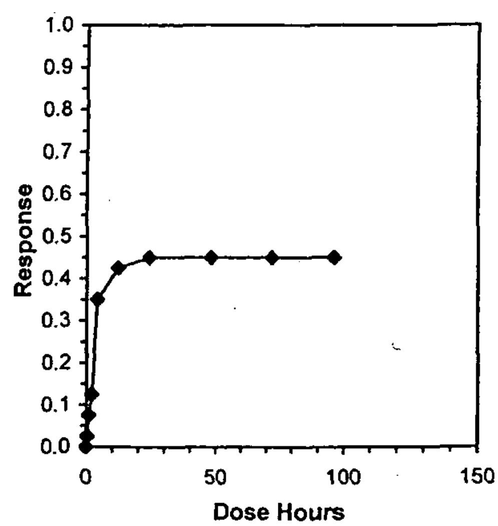
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	0.9750	0.9750	0.9750	0.9000	1.0000	5.128	4	0.122	2.540	0.5205	0.9750	0.9750
1	0.9250	0.9250	0.9250	0.7000	1.0000	16.216	4	0.366	2.540	0.5205	0.9250	0.9250
2	0.8750	0.8750	0.8750	0.6000	1.0000	21.634	4	0.610	2.540	0.5205	0.8750	0.8750
4	0.6500	0.6500	0.6500	0.2000	1.0000	51.025	4	1.708	2.540	0.5205	0.6500	0.6500
12	0.5750	0.5750	0.5750	0.2000	1.0000	60.870	4	2.074	2.540	0.5205	0.5750	0.5750
24	0.5500	0.5500	0.5500	0.2000	1.0000	67.215	4	2.196	2.540	0.5205	0.5500	0.5500
48	0.5500	0.5500	0.5500	0.2000	1.0000	67.215	4	2.196	2.540	0.5205	0.5500	0.5500
72	0.5500	0.5500	0.5500	0.2000	1.0000	67.215	4	2.196	2.540	0.5205	0.5500	0.5500
96	0.5500	0.5500	0.5500	0.2000	1.0000	67.215	4	2.196	2.540	0.5205	0.5500	0.5500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.92623	0.919	0.14666	-0.6651
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	96	>96			0.52055	0.52055	0.156	0.084	0.09845	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	0.7500	0.6153	0.0833	3.2646	0.7859
IT10	1.5000	0.8438	0.2989	4.7096	1.6439
IT15	2.2222	1.7731	0.1720	8.5770	4.3444
IT20	2.6667	2.7816	0.9950	18.0505	3.9266
IT25	3.1111	9.2279	1.2243	41.6843	5.0088
IT40	9.3333				
IT50	>96				



 ToxCalc v5.0.23 Reviewed by: [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 56 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	9	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	7	
	12	4	1.000	10	10	
	13	1	2.000	10	10	
	14	2	2.000	10	9	
	15	3	2.000	10	6	
	16	4	2.000	10	10	
	17	1	4.000	10	10	
	18	2	4.000	10	7	
	19	3	4.000	10	2	
	20	4	4.000	10	7	
	21	1	12.000	10	10	
	22	2	12.000	10	7	
	23	3	12.000	10	2	
	24	4	12.000	10	4	
	25	1	24.000	10	10	
	26	2	24.000	10	7	
	27	3	24.000	10	2	
	28	4	24.000	10	3	
	29	1	48.000	10	10	
	30	2	48.000	10	7	
	31	3	48.000	10	2	
	32	4	48.000	10	3	
	33	1	72.000	10	10	
	34	2	72.000	10	7	
	35	3	72.000	10	2	
	36	4	72.000	10	3	
	37	1	96.000	10	10	
	38	2	96.000	10	7	
	39	3	96.000	10	2	
	40	4	96.000	10	3	

Comments: Used to compare survival of fish to time exposed to 56 ppt concentration.

 Reviewed by: [signature]

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262 -	Sample ID:	58 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 58 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	0.8000	1.0000
1	1.0000	1.0000	0.5000	1.0000
2	0.9000	0.9000	0.5000	1.0000
4	0.9000	0.8000	0.5000	0.7000
12	0.8000	0.8000	0.5000	0.5000
24	0.8000	0.8000	0.5000	0.5000
48	0.8000	0.8000	0.5000	0.5000
72	0.8000	0.8000	0.5000	0.5000
96	0.8000	0.8000	0.5000	0.5000

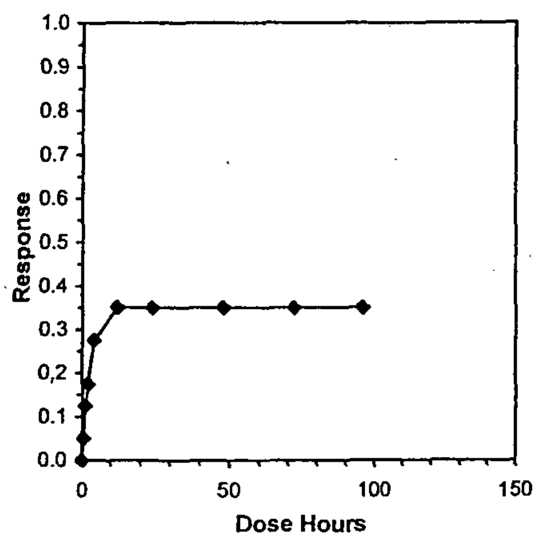
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	0.9500	0.9500	0.9500	0.8000	1.0000	10.526	4	0.408	2.540	0.3115	0.9500	0.9500
1	0.8750	0.8750	0.8750	0.5000	1.0000	28.571	4	1.019	2.540	0.3115	0.8750	0.8750
2	0.8250	0.8250	0.8250	0.5000	1.0000	26.877	4	1.427	2.540	0.3115	0.8250	0.8250
4	0.7250	0.7250	0.7250	0.5000	0.9000	23.556	4	2.242	2.540	0.3115	0.7250	0.7250
*12	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	2.854	2.540	0.3115	0.6500	0.6500
*24	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	2.854	2.540	0.3115	0.6500	0.6500
*48	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	2.854	2.540	0.3115	0.6500	0.6500
*72	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	2.854	2.540	0.3115	0.6500	0.6500
*96	0.6500	0.6500	0.6500	0.5000	0.8000	26.647	4	2.854	2.540	0.3115	0.6500	0.6500

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.862352	0.919	-0.64117	-0.62886
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	4	12	6.928203		0.311517	0.311517	0.076806	0.030083	0.026038	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	0.5000	0.5035	0.0000	2.9000	1.2106
IT10	0.8333	0.6940	0.0333	3.7667	0.7702
IT15	1.5000	0.8912	0.0950	4.8067	0.7341
IT20	2.5000	1.7351	0.0000	8.8600	2.6173
IT25	3.5000	3.8666	0.0000	23.5000	2.1085
IT40	>96				
IT50	>96				



 ToxCalc v5.0.23 Reviewed by: [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 58 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	8	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	5	
	12	4	1.000	10	10	
	13	1	2.000	10	9	
	14	2	2.000	10	9	
	15	3	2.000	10	5	
	16	4	2.000	10	10	
	17	1	4.000	10	9	
	18	2	4.000	10	8	
	19	3	4.000	10	5	
	20	4	4.000	10	7	
	21	1	12.000	10	8	
	22	2	12.000	10	8	
	23	3	12.000	10	5	
	24	4	12.000	10	5	
	25	1	24.000	10	8	
	26	2	24.000	10	8	
	27	3	24.000	10	5	
	28	4	24.000	10	5	
	29	1	48.000	10	8	
	30	2	48.000	10	8	
	31	3	48.000	10	5	
	32	4	48.000	10	5	
	33	1	72.000	10	8	
	34	2	72.000	10	8	
	35	3	72.000	10	5	
	36	4	72.000	10	5	
	37	1	96.000	10	8	
	38	2	96.000	10	8	
	39	3	96.000	10	5	
	40	4	96.000	10	5	

Comments: Used to compare survival of fish to time expossed to 58 ppt concentration.

Acute Fish Test

Start Date:	1/5/2007 18:05	Test ID:	C070105.0262	Sample ID:	60 ppt RO Concentrate Comp
End Date:	1/9/2007 16:10	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	DMR-Discharge Monitoring Report
Sample Date:	1/4/2007 08:00	Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis

Comments: Used to compare survival of fish to time exposed to 60 ppt concentration.

Conc-Hours	1	2	3	4
0	1.0000	1.0000	1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
2	0.9000	0.9000	0.8000	1.0000
4	0.5000	0.8000	0.7000	0.7000
12	0.3000	0.3000	0.4000	0.5000
24	0.3000	0.3000	0.4000	0.5000
48	0.3000	0.3000	0.4000	0.5000
72	0.3000	0.3000	0.4000	0.5000
96	0.3000	0.3000	0.4000	0.5000

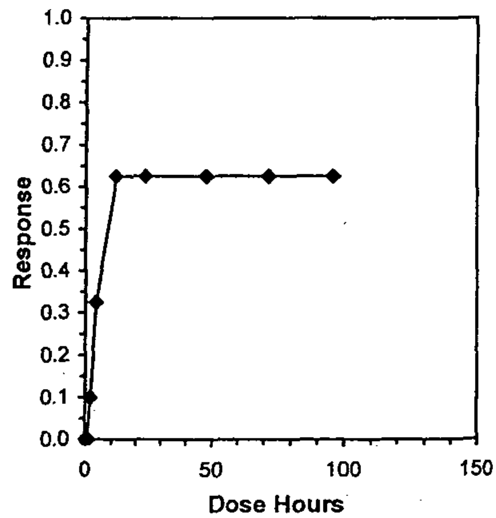
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-Hours	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
0	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4				1.0000	1.0000
0.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1485	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	0.000	4	0.000	2.540	0.1485	1.0000	1.0000
2	0.9000	0.9000	0.9000	0.8000	1.0000	9.072	4	1.711	2.540	0.1485	0.9000	0.9000
*4	0.6750	0.6750	0.6750	0.5000	0.8000	18.642	4	5.560	2.540	0.1485	0.6750	0.6750
*12	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.692	2.540	0.1485	0.3750	0.3750
*24	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.692	2.540	0.1485	0.3750	0.3750
*48	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.692	2.540	0.1485	0.3750	0.3750
*72	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.692	2.540	0.1485	0.3750	0.3750
*96	0.3750	0.3750	0.3750	0.3000	0.5000	25.531	4	10.692	2.540	0.1485	0.3750	0.3750

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.89025	0.919	0.15935	-0.0825
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOET	LOET	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	2	4	2.82843		0.14847	0.14847	0.35933	0.00683	6.4E-16	9, 30

Linear Interpolation (200 Resamples)

Point	Hours	SD	95% CL(Exp)		Skew
IT05	1.5000	0.2499	1.1571	2.5680	0.9107
IT10	2.0000	0.2547	1.3143	2.8013	0.1212
IT15	2.4444	0.2663	1.5048	3.3333	-0.2839
IT20	2.8889	0.3003	2.1067	4.0267	0.0375
IT25	3.3333	0.4021	2.5329	5.2171	0.5887
IT40	6.0000	1.2092	2.5293	8.8632	-0.5447
IT50	8.6667	0.9805	5.9891	11.4507	-1.4042



ToxCalc v5.0.23

Reviewed by: [signature]

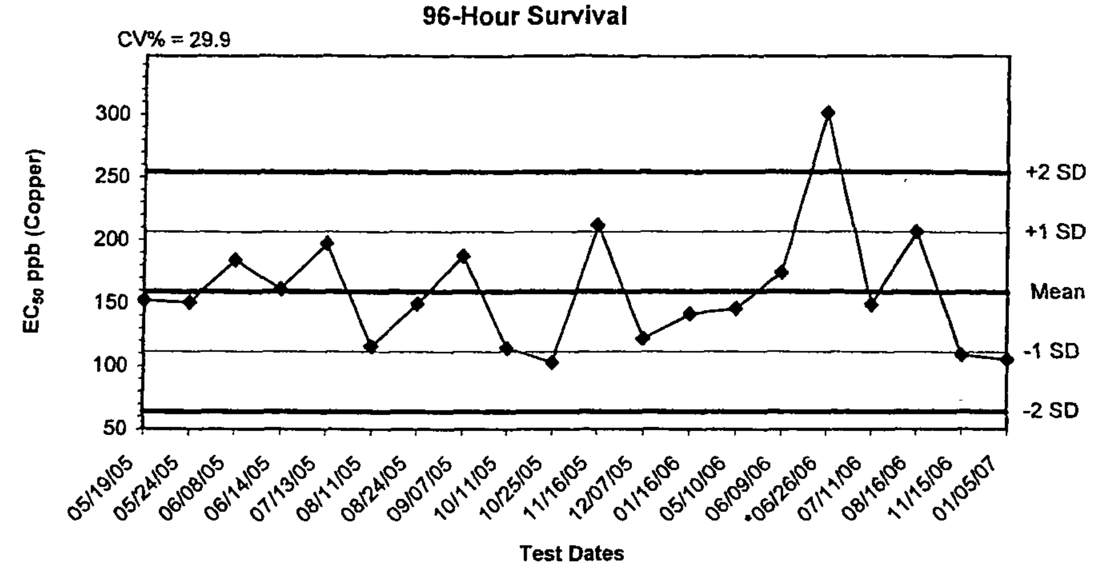
Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: 60 ppt RO Concentrate Comp
Start Date: 1/5/2007 18:05 End Date: 1/9/2007 16:10

Test ID: C070105.0262
Protocol: EPAA 02-EPA Acute
Sample Type: DMR-Discharge Monitoring Report
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Hour	Start	# Alive	Notes
	1	1	0.000	10	10	
	2	2	0.000	10	10	
	3	3	0.000	10	10	
	4	4	0.000	10	10	
	5	1	0.500	10	10	
	6	2	0.500	10	10	
	7	3	0.500	10	10	
	8	4	0.500	10	10	
	9	1	1.000	10	10	
	10	2	1.000	10	10	
	11	3	1.000	10	10	
	12	4	1.000	10	10	
	13	1	2.000	10	9	
	14	2	2.000	10	9	
	15	3	2.000	10	8	
	16	4	2.000	10	10	
	17	1	4.000	10	5	
	18	2	4.000	10	8	
	19	3	4.000	10	7	
	20	4	4.000	10	7	
	21	1	12.000	10	3	
	22	2	12.000	10	3	
	23	3	12.000	10	4	
	24	4	12.000	10	5	
	25	1	24.000	10	3	
	26	2	24.000	10	3	
	27	3	24.000	10	4	
	28	4	24.000	10	5	
	29	1	48.000	10	3	
	30	2	48.000	10	3	
	31	3	48.000	10	4	
	32	4	48.000	10	5	
	33	1	72.000	10	3	
	34	2	72.000	10	3	
	35	3	72.000	10	4	
	36	4	72.000	10	5	
	37	1	96.000	10	3	
	38	2	96.000	10	3	
	39	3	96.000	10	4	
	40	4	96.000	10	5	

Comments: Used to compare survival of fish to time exposed to 60 ppt concentration.

Atherinops affinis Reference Toxicant Control Chart: 96-Hour Survival



Dates	Values	Mean	-1 SD	-2 SD	+1 SD	+2 SD
05/19/05	152.2400	159.0758	111.5070	63.9382	206.6446	254.2134
05/24/05	150.3620	159.0758	111.5070	63.9382	206.6446	254.2134
06/08/05	184.3200	159.0758	111.5070	63.9382	206.6446	254.2134
06/14/05	160.9600	159.0758	111.5070	63.9382	206.6446	254.2134
07/13/05	197.3020	159.0758	111.5070	63.9382	206.6446	254.2134
08/11/05	115.8480	159.0758	111.5070	63.9382	206.6446	254.2134
08/24/05	149.5050	159.0758	111.5070	63.9382	206.6446	254.2134
09/07/05	187.2600	159.0758	111.5070	63.9382	206.6446	254.2134
10/11/05	114.3980	159.0758	111.5070	63.9382	206.6446	254.2134
10/25/05	103.1990	159.0758	111.5070	63.9382	206.6446	254.2134
11/16/05	211.7200	159.0758	111.5070	63.9382	206.6446	254.2134
12/07/05	121.6290	159.0758	111.5070	63.9382	206.6446	254.2134
01/16/06	141.4220	159.0758	111.5070	63.9382	206.6446	254.2134
05/10/06	145.3200	159.0758	111.5070	63.9382	206.6446	254.2134
06/09/06	174.0000	159.0758	111.5070	63.9382	206.6446	254.2134
*06/26/06	301.4970	159.0758	111.5070	63.9382	206.6446	254.2134
07/11/06	148.8500	159.0758	111.5070	63.9382	206.6446	254.2134
08/16/06	206.7660	159.0758	111.5070	63.9382	206.6446	254.2134
11/15/06	109.2980	159.0758	111.5070	63.9382	206.6446	254.2134
01/05/07	105.6200	159.0758	111.5070	63.9382	206.6446	254.2134

*Value out of 95% CI range.
Updated 1/12/07 EB

Acute Fish Test-96 Hr Survival

Start Date:	1/5/2007 16:40	Test ID:	C060525.74	Sample ID:	REF-Ref Toxicant
End Date:	1/9/2007 14:50	Lab ID:	CCA-Weston Solutions Carls	Sample Type:	CUSO-Copper sulfate
Sample Date:		Protocol:	EPAA 02-EPA Acute	Test Species:	AA-Atherinops affinis
Comments:					

Conc-ppb	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
25	0.9000	1.0000	1.0000	1.0000
50	1.0000	0.9000	0.9000	1.0000
100	0.7000	0.6000	0.6000	0.5000
200	0.0000	0.0000	0.0000	0.1000
400	0.0000	0.0000	0.0000	0.0000

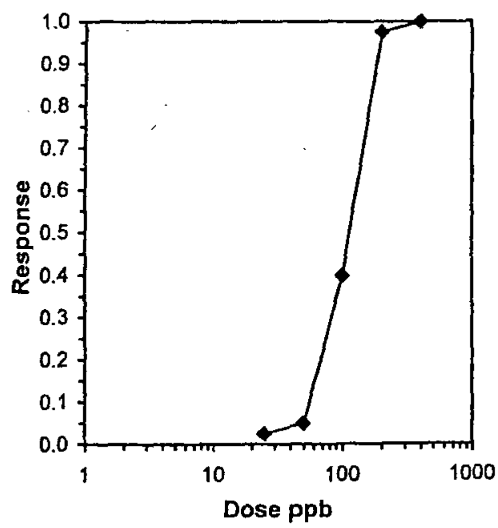
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ppb	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	4			0	40
25	0.9750	0.9750	1.3713	1.2490	1.4120	5.942	4	16.00	10.00	1	40
50	0.9500	0.9500	1.3305	1.2490	1.4120	7.072	4	14.00	10.00	2	40
*100	0.6000	0.6000	0.8872	0.7854	0.9912	9.469	4	10.00	10.00	16	40
*200	0.0250	0.0250	0.1995	0.1588	0.3218	40.840	4	10.00	10.00	39	40
*400	0.0000	0.0000	0.1588	0.1588	0.1588	0.000	4	10.00	10.00	40	40

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94414	0.884	0.0141	-0.0718
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	50	100	70.7107	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%			
5.0%	107.02	94.60	121.07
10.0%	108.00	94.15	123.88
20.0%	109.93	91.09	132.68
Auto-2.5%	105.62	93.09	119.85



 ToxCalc v5.0.23 Reviewed by [signature]

Test: AC-Acute Fish Test
Species: AA-Atherinops affinis
Sample ID: REF-Ref Toxicant
Start Date: 1/5/2007 16:40 End Date: 1/9/2007 14:50

Test ID: C060525.74
Protocol: EPAA 02-EPA Acute
Sample Type: CUSO-Copper sulfate
Lab ID: CCA-Weston Solutions Carlsbad, CA

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	Control	10				10	
	2	2	Control	10				10	
	3	3	Control	10				10	
	4	4	Control	10				10	
	5	1	25.000	10				9	
	6	2	25.000	10				10	
	7	3	25.000	10				10	
	8	4	25.000	10				10	
	9	1	50.000	10				10	
	10	2	50.000	10				9	
	11	3	50.000	10				9	
	12	4	50.000	10				10	
	13	1	100.000	10				7	
	14	2	100.000	10				6	
	15	3	100.000	10				6	
	16	4	100.000	10				5	
	17	1	200.000	10				0	
	18	2	200.000	10				0	
	19	3	200.000	10				0	
	20	4	200.000	10				1	
	21	1	400.000	10				0	
	22	2	400.000	10				0	
	23	3	400.000	10				0	
	24	4	400.000	10				0	

Comments:

WESTON SOLUTIONS

96 Hour Topsmelt
Reference Toxicant Test

Test ID: 060525.74	Replicates: 4	Study Director: E. Bathker	Location: Rm 3
Dilution Water Batch: S10122906	Organism Batch: ABS 7444	Associated Test(s): Poseidon	No. of Organisms: 10

Toxicant: Copper Sulfate (0.509gCu/LCuSO4	Lot #: 1605565	Date Prepared: (stock) 11/28/06	Initials: VS

Target Concentrations: 400 ppb	Quantity of Stock: Target: 1.572 mL	Quantity of Diluent: Target: 2000 mL
400 ppb	Actual: 1.5720	Actual: 2000.0

Serial Dilute by ½ to obtain concentrations of 200, 100, 50, and 25 ppb.

0 Hours Date: 1/5/07 WQ Time: 1540 EB Start Time: 1640 Initials: AL

STOCK

	Control	25	50	100	200	400
D.O. (mg/L)	7.4	7.3	7.3	7.2	7.2	7.2
Temperature	21.6	21.6	21.5	21.5	21.4	21.4
Salinity	33.1	33.1	33.1	33.1	33.1	33.1
pH	8.0	8.2	8.2	8.2	8.2	8.2

24 Hours Date: 1/6/07 Time: 1530 Initials: VS

Renewal Information Toxicant Amount: 1.5728 Diluent Amount: 2000.4 Initials: VS

	Control	25	50	100	200	400
No. Alive Rep 1	10	9(1)	10	8(2)	2(8)	Ø(10)
No. Alive Rep 2	10	10	9(1)	8(2)	Ø(10)	Ø(10)
No. Alive Rep 3	10	10	9(1)	8(2)	1(9)	Ø(10)
No. Alive Rep 4	10	10	10	8(2)	3(7)	Ø(10)

48 Hours Date: 1/7/07 Time: 1507 Initials: VS

Renewal Information Toxicant Amount: 0.7860 Diluent Amount: 2000.0 Initials: VS

	Control	25	50	100	200	400
No. Alive Rep 1	10	9	10	8	1(1)	—
No. Alive Rep 2	10	10	9	7(1)	—	—
No. Alive Rep 3	10	10	9	6(2)	Ø(1)	—
No. Alive Rep 4	10	10	10	7(1)	1(2)	—

WESTON SOLUTIONS

96 Hour Topsmelt Reference Toxicant Test

C06052574

72 Hours	Date: 1/8/07		Time: 1250		Initials: KS	
Renewal Information	Toxicant Amount: 0.7863		Diluent Amount: 2000.8		Initials: KS	
	Control	25	50	100	200	400
No. Alive Rep 1	10	9	10	7(1)	Ø(1)	—
No. Alive Rep 2	10	10	9	6(1)	—	—
No. Alive Rep 3	10	10	9	6	—	—
No. Alive Rep 4	10	10	10	5(2)	1	—

96 Hours	Date: 1/9/07	WQ Time: 1035 am	Replicate: 4 STOCK		Initials: AM
	Control	25	50	100	200	400
D.O. (mg/L)	6.1	6.2	6.1	6.8	7.1	
Temperature	20.8	20.7	20.8	20.7	20.6	
Salinity	33.7	33.7	33.7	33.7	33.6	
pH	7.9	7.9	7.9	7.9	8.0	

96 Hour Survival Data		End Time: 1450			Initials: BA	
	Control	25	50	100	200	400
No. Alive Rep 1	10	9	10	7	—	—
No. Alive Rep 2	10	10	9	6	—	—
No. Alive Rep 3	10	10	9	6	—	—
No. Alive Rep 4	10	10	10	5	1	—

☒ Pass ☐ Fail

Notes:

WESTON SOLUTIONS

BIOASSAY SAMPLE RECEIPT

Client: Poseidon	Project: Desal Pilot Topsmelt Toxicity Study		
Weston Sample ID:	C070104.01	C070104.02	C070104.03
Client Sample ID:	UF Filtrate	RO Concentrate	UF Filtrate
Renewal Sample (Y/N):	N	N	N
Date/Time Received:	1/4/07 1020	1/4/07 1020	1/4/07 1020
Airbill #:	N/A	N/A	N/A
Sample Tracking Information Kept for Records: (Y/N)	N/A	N/A	N/A
Collection Date/Time:	1/3/07 composite at 0800 + 1600	1/3/07 composite at 0800 + 1600	1/4/07 composite at 0000 + 0800
Condition of Shipping Container:	good	good	good
Type and Capacity of Sample Container:	20L cubi	20L cubi	20L cubi
Total Sample Volume (L):	20L	20L	20L
Condition of Sampling Container:	good	good	good
Sample Container Appropriate: (Y/N)	Y	Y	Y
Custody Seals Intact: (Y/N)	N/A	N/A	N/A
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)	Y	Y	Y
Sampler's Name Present on COC Form: (Y/N)	Y	Y	Y

TAKE THE FOLLOWING MEASUREMENTS UPON ARRIVAL

WESTON ID	Temp. (°C) (0-6°C) *	Dissolved Oxygen (mg/L)	pH	Conductivity (mS/cm) or Salinity (ppt)	Hardness (mg $CaCO_3$/L)	Alkalinity (mg $CaCO_3$/L)	Total Chlorine (mg/L)	Total Ammonia (mg NH_3/L)	Tech
C070104.01	14.9	7.9	7.9	33.0	—	—	0.00	<0.5	EB/JH
C070104.02	14.1	7.2	7.8	66.6	—	—	0.00	<0.5	EB/JH
C070104.03	15.3	7.8	8.1	33.3	—	—	0.01	<0.5	EB/JH

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:

Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

WESTON SOLUTIONS

BIOASSAY SAMPLE RECEIPT

Client: Poseidon	Project: Desal Pilot Topsmelt Toxicity Study		
Weston Sample ID:	070104.04		
Client Sample ID:	RO Concentrate		
Renewal Sample (Y/N):	N		
Date/Time Received:	1/4/07 1020		
Airbill #:	N/A		
Sample Tracking Information Kept for Records: (Y/N)	N/A		
Collection Date/Time:	1/4/07 composite 0000 / 0800		
Condition of Shipping Container:	good		
Type and Capacity of Sample Container:	20L cubi		
Total Sample Volume (L):	20L		
Condition of Sampling Container:	good		
Sample Container Appropriate: (Y/N)	Y		
Custody Seals Intact: (Y/N)	Y		
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)	Y		
Sampler's Name Present on COC Form: (Y/N)	Y		

TAKE THE FOLLOWING MEASUREMENTS UPON ARRIVAL

WESTON ID	Temp. (°C) (0-6°C) *	Dissolved Oxygen (mg/L)	pH	Conductivity (mS/cm) or Salinity (ppt)	Hardness (mg $CaCO_3$/L)	Alkalinity (mg $CaCO_3$/L)	Total Chlorine (mg/L)	Total Ammonia (mg NH_3/L)	Tech
070104.04	16.4	7.1	7.8	66.3	—	—	0.01	<0.5	QB/JH

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:

Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

WESTON SOLUTIONS

BIOASSAY SAMPLE RECEIPT

Client: Poseidon	Project: Desal Pilot Topsmelt Toxicity Study	
Weston Sample ID:	C070105.01	C070105.02	
Client Sample ID:	UF Filtrate-Comp	RO-Concentrate-Comp	
Renewal Sample (Y/N):	N	N	
Date/Time Received:	1/5/07 1040	1/5/07 1040	
Airbill #:	N/A	N/A	
Sample Tracking Information Kept for Records: (Y/N)	N/A	N/A	
Collection Date/Time:	1/5/07 (04) 1040	1/5/07 (04) 1040	
Condition of Shipping Container:	good	good	
Type and Capacity of Sample Container:	20 L x 2	20 L x 2	
Total Sample Volume (L):	40 L	40 L	
Condition of Sampling Container:	good	good	
Sample Container Appropriate: (Y/N)	Y	Y	
Custody Seals Intact: (Y/N)	N/A	N/A	
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)	Y	Y	
Sampler's Name Present on COC Form: (Y/N)	Y	Y	

TAKE THE FOLLOWING MEASUREMENTS UPON ARRIVAL

WESTON ID	Temp. (°C) (0-6°C) *	Dissolved Oxygen (mg/L)	pH	Conductivity (mS/cm) or Salinity (ppt)	Hardness (mg $CaCO_3$/L)	Alkalinity (mg $CaCO_3$/L)	Total Chlorine (mg/L)	Total Ammonia (mg NH_3/L)	Tech
C070105.01	7.4	9.3	8.2	32.9	—	—	0.01		KS
C070105.02	6.9	8.3	8.0	66.4	—	—	0.00		KS

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:

Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

① Time that Comp was created. 1/10/07 C

O:\BLANK FORMS\Bioassay\Forms with Weston Logo\SAMPLE RECEIPT Form- Weston temp.doc
Last printed 1/25/2006 10:55:00 AM

WESTON SOLUTIONS

☒ 2433 Impala Drive • Carlsbad, CA 9[illegible] • (760) 931-8081, FAX 931-1580
☐ 98 Main St., Ste. #428 • Tiburon, CA 94920 • (415) 435-1847, FAX 435-0479
☐ 1440 Broadway, Ste. 908 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710
☐ 152 Sunset View Lane • Sequim, WA 98382 • (360) 582-1758, FAX 582-1679
☐ 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

CHAIN OF CUSTODY

13576

DATE 1-4-07 PAGE 1 OF 1

PROJECT NAME / SURVEY / PROJECT NUMBER: DESAL PILOT TOPSMELT TOXICITY STUDY

PROJECT MANAGER:

COMPANY: POSEIDON

ADDRESS: 4600 CARLSBAD BLVD

PHONE/~~FAX~~: 760-438-4843

	SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
②0	UF FILTRATE	1/3	16:00	RSW	DM	1						N/A	14.9	C070104.01
①0	RO CONCENTRATE	1/3	16:00	RSW	DM	1							14.1	C070104.02
②	UF FILTRATE	1/4	8:00	RSW	DM	1							15.3	C070104.03
①0	RO CONCENTRATE	1/4	8:00	RSW	DM	1							16.4	C070104.04

SPECIAL INSTRUCTIONS/COMMENTS: 1/3 COMPOSITE SAMPLE TAKEN AT 0800 & 1600
(EACH UF & RO) 1/4 " " " 0000 & 0800

SHIPPING:

Shipping VIA: Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	Daniel J. Maron	Elizabeth M. Bottin	Elizabeth M. Bottin	Yasemin Serivsek		
Firm	POSEIDON	Weston Solutions	Weston Solutions	Weston Solutions		
Date/Time	1-4-07	1/4/07 0950	1/4/07 1020	1/4/07 1020		

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

① Both RO Concentrate samples composited in Lab to create 24 hr. composite. New sample name RO Concentrate Comp. 1/5/07 [illegible]
② Both UF Filtrate samples composited in Lab to create 24 hr [illegible]

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

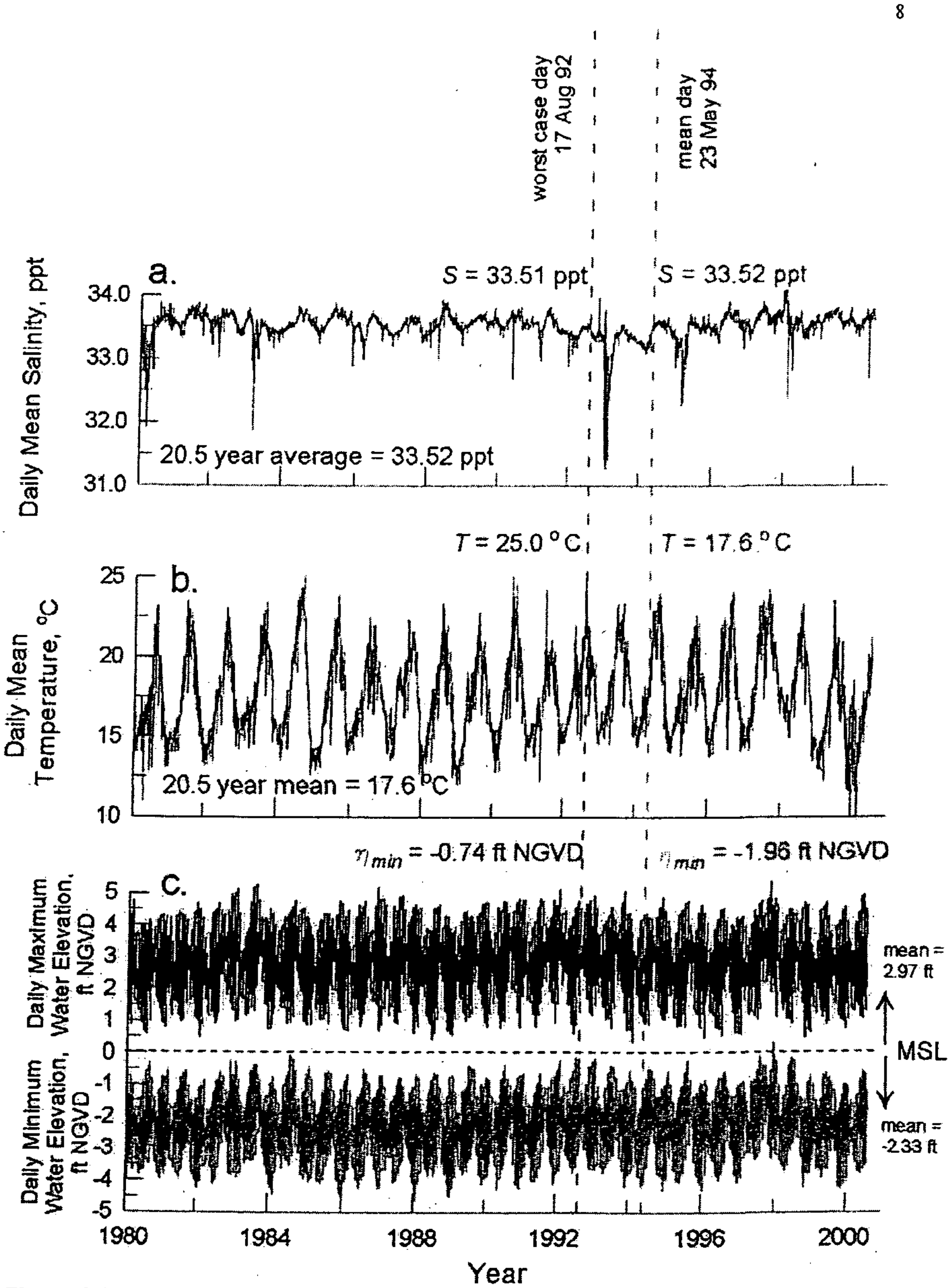


Figure 1. Period of record of boundary conditions, Encina Power Plant, 1980-2000.5: a) daily mea salinity, b) daily mean temperature, and c) daily high and low ocean water level elevati

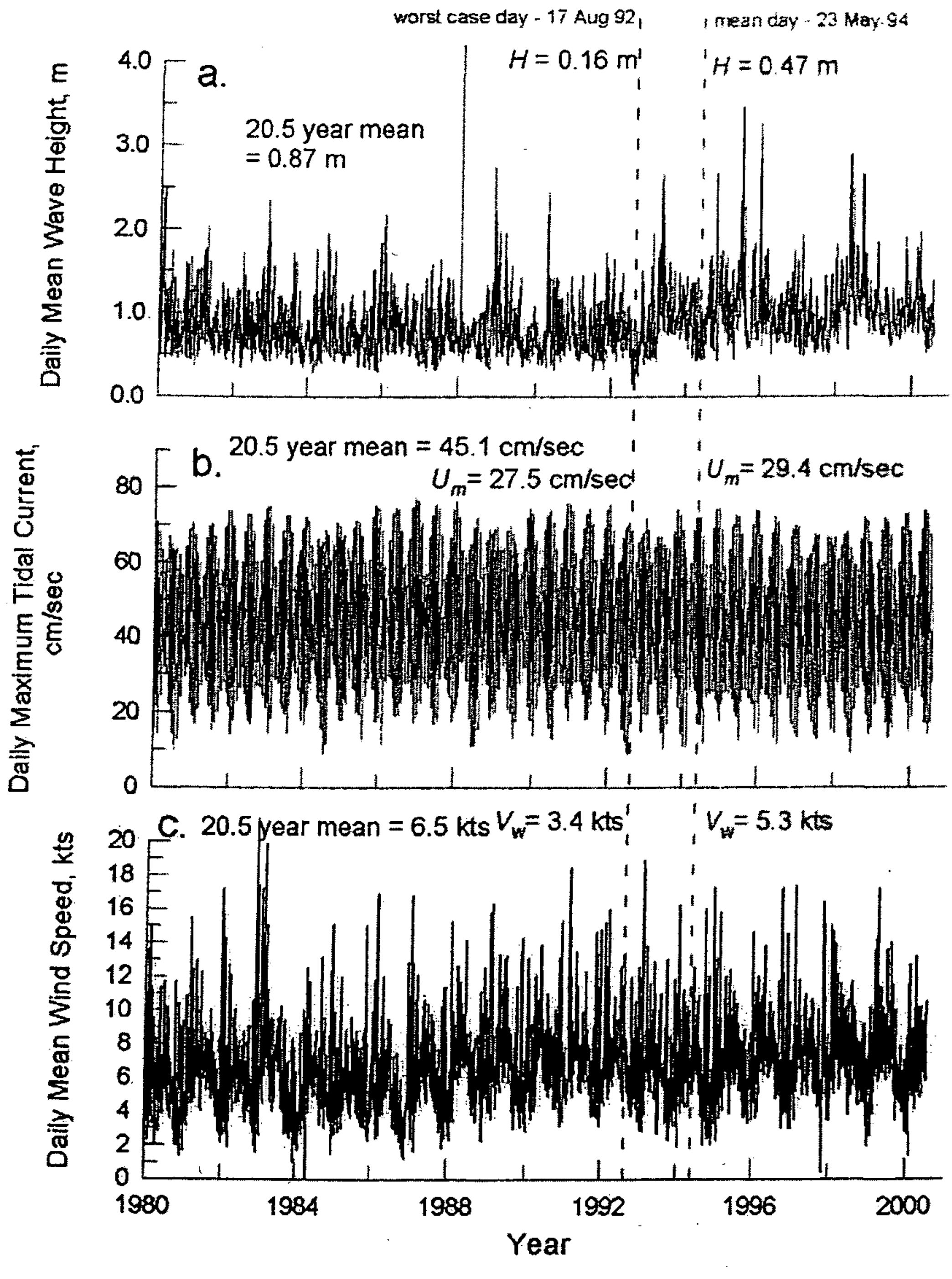


Figure 2. Period of record of forcing functions in the nearfield of Encina Power Plant, 1980-2000.5: a) daily mean wave height, b) daily maximum tidal current velocity, and c) daily mean wind.

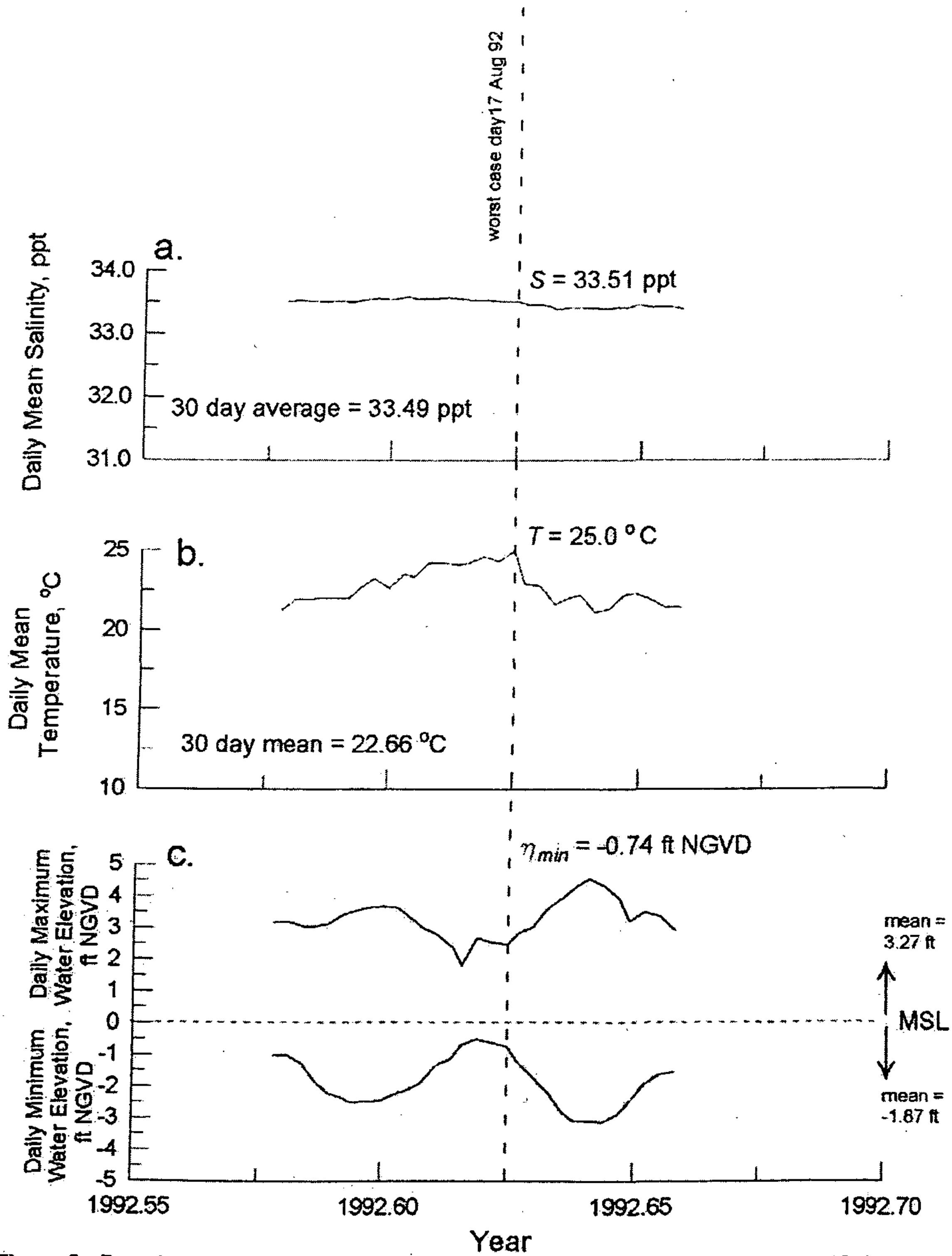


Figure 3. Boundary conditions in the nearfield of the Encina Power Plant: worst case 30 day period: a) daily mean salinity, b) mean temperature, and c) high and low ocean water elevations.

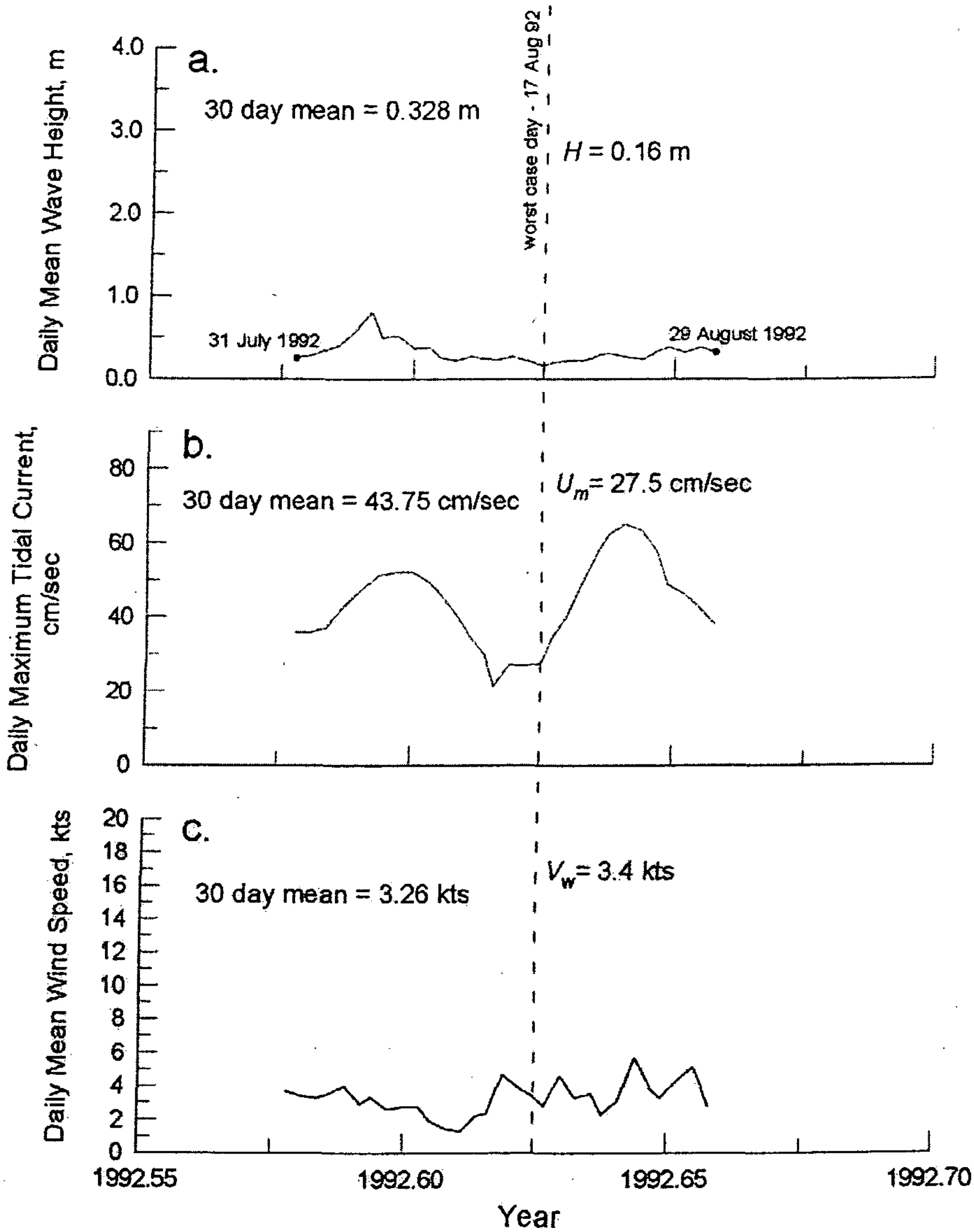


Figure 4. Forcing functions in the nearfield of Encina Power Plant, worst case 30 day period: a) daily mean wave height, b) daily maximum tidal current velocity, and c) daily mean wind.

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

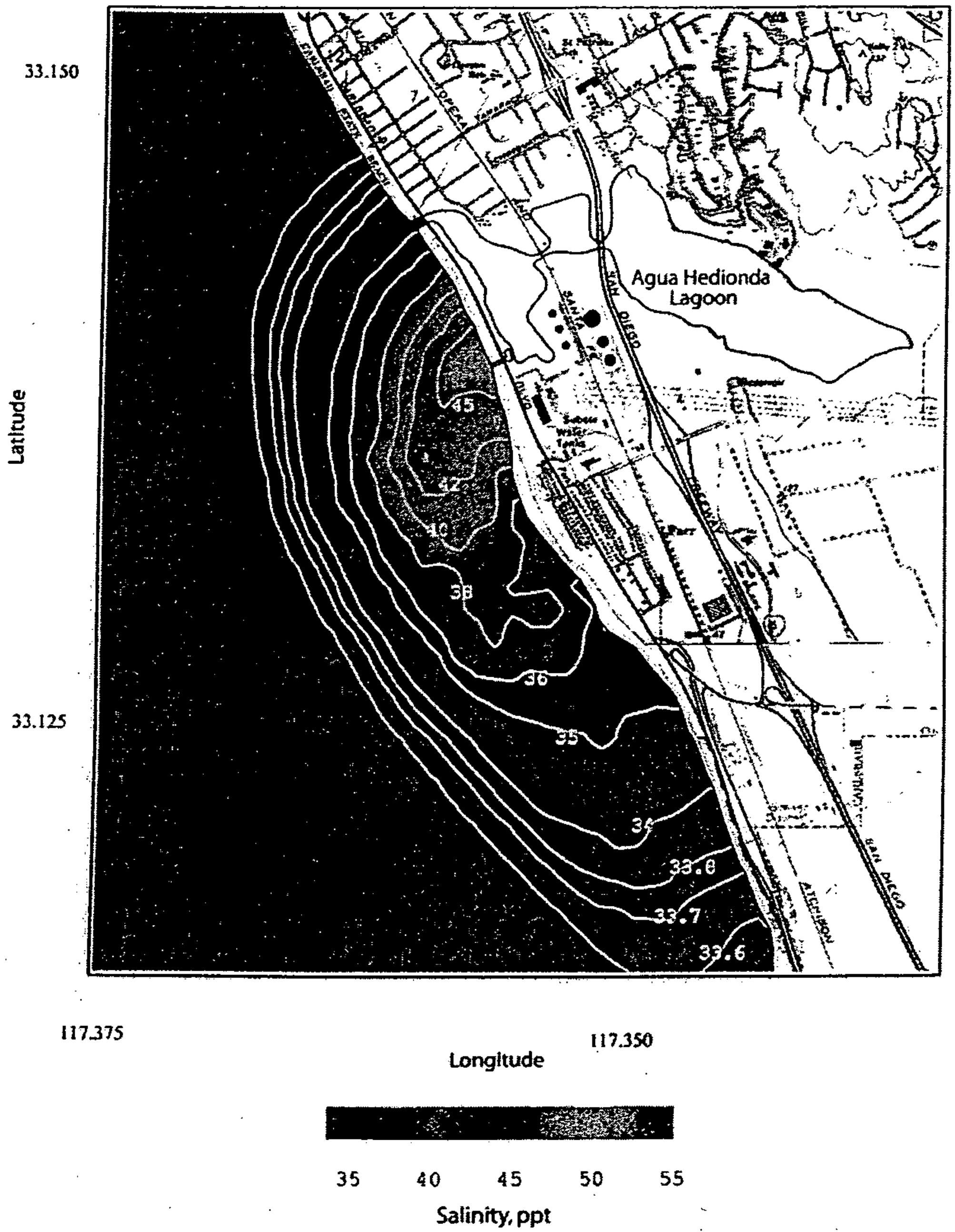


Figure 5. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0$ °C. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

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

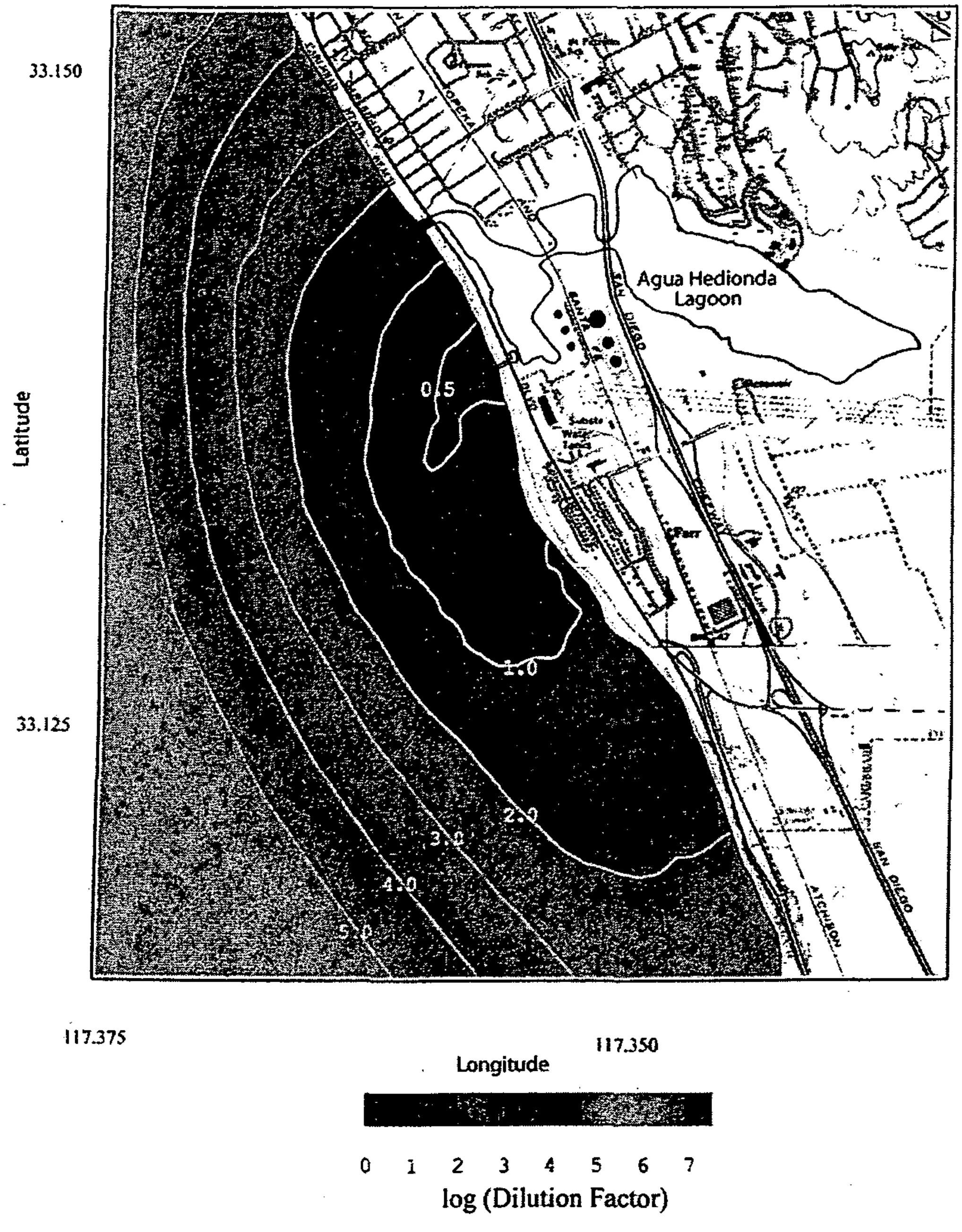


Figure 6. Scenario 1 worst case with one Unit 5 circulation pump for ΔT = 0 °C. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

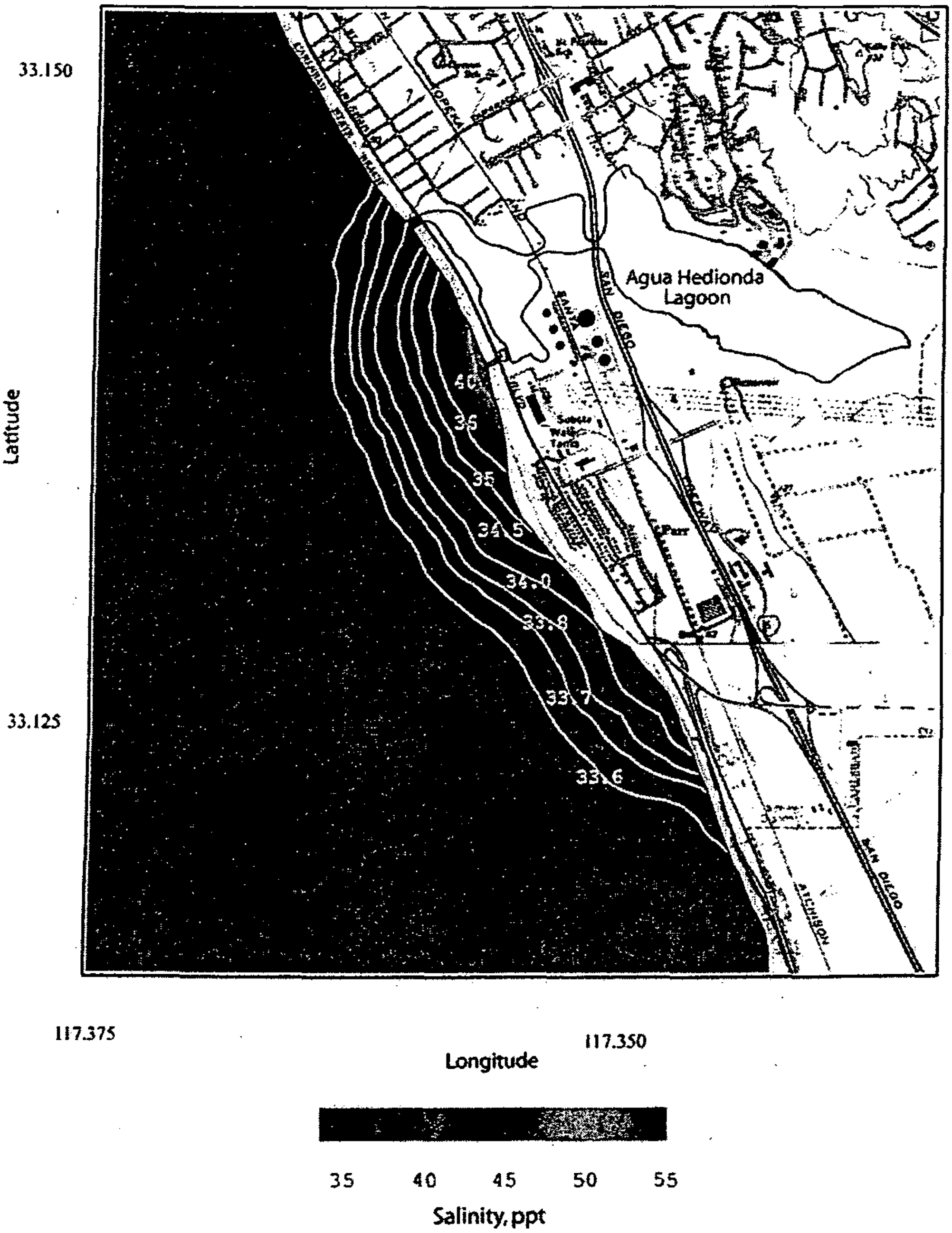


Figure 7. Scenario 1 worst case with one Unit 5 circulation pump for $\Delta T = 0\ ^{\circ}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

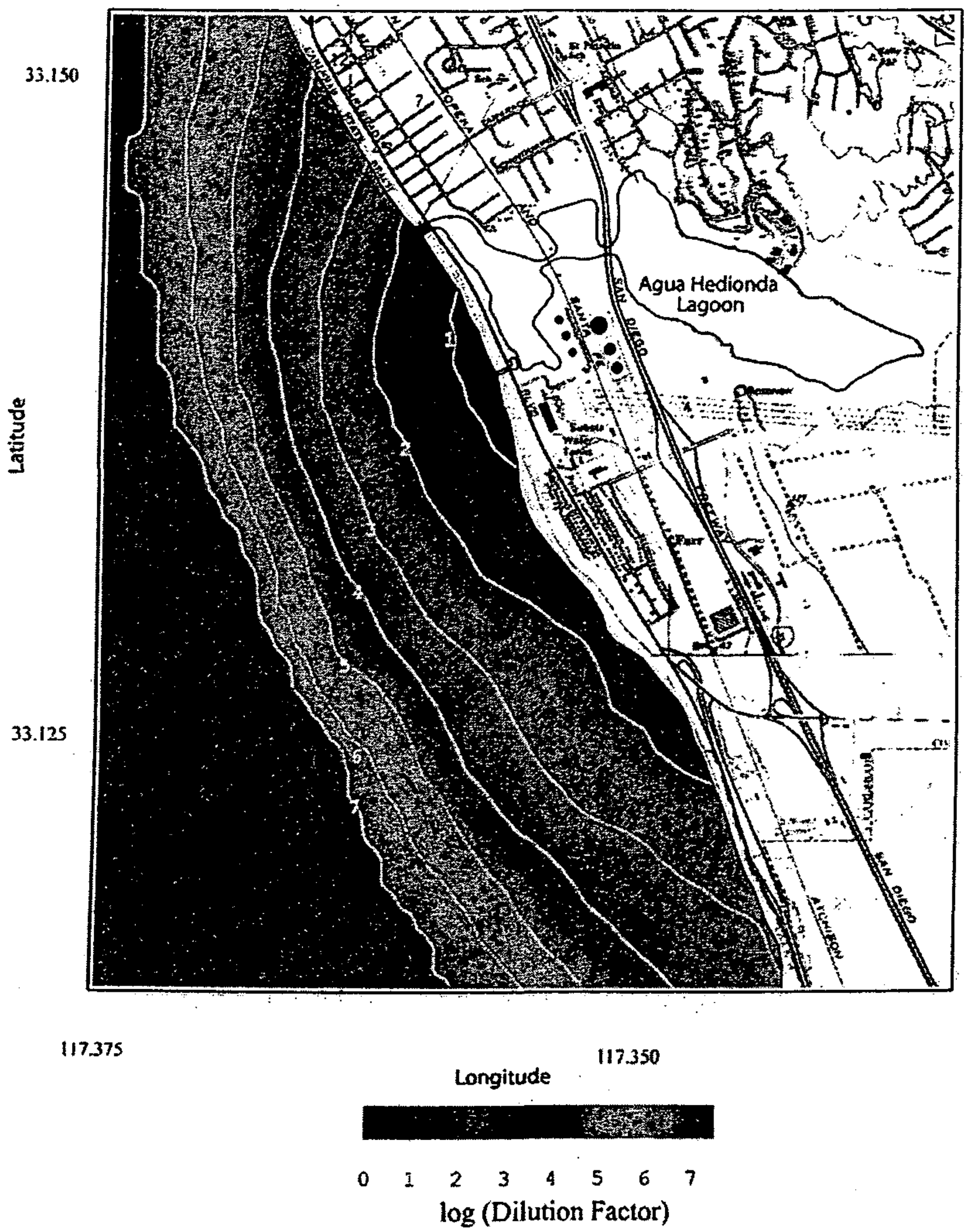


Figure 8. Scenario 1 worst case with one Unit 5 circulation pump for ΔT = 0 °C. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

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

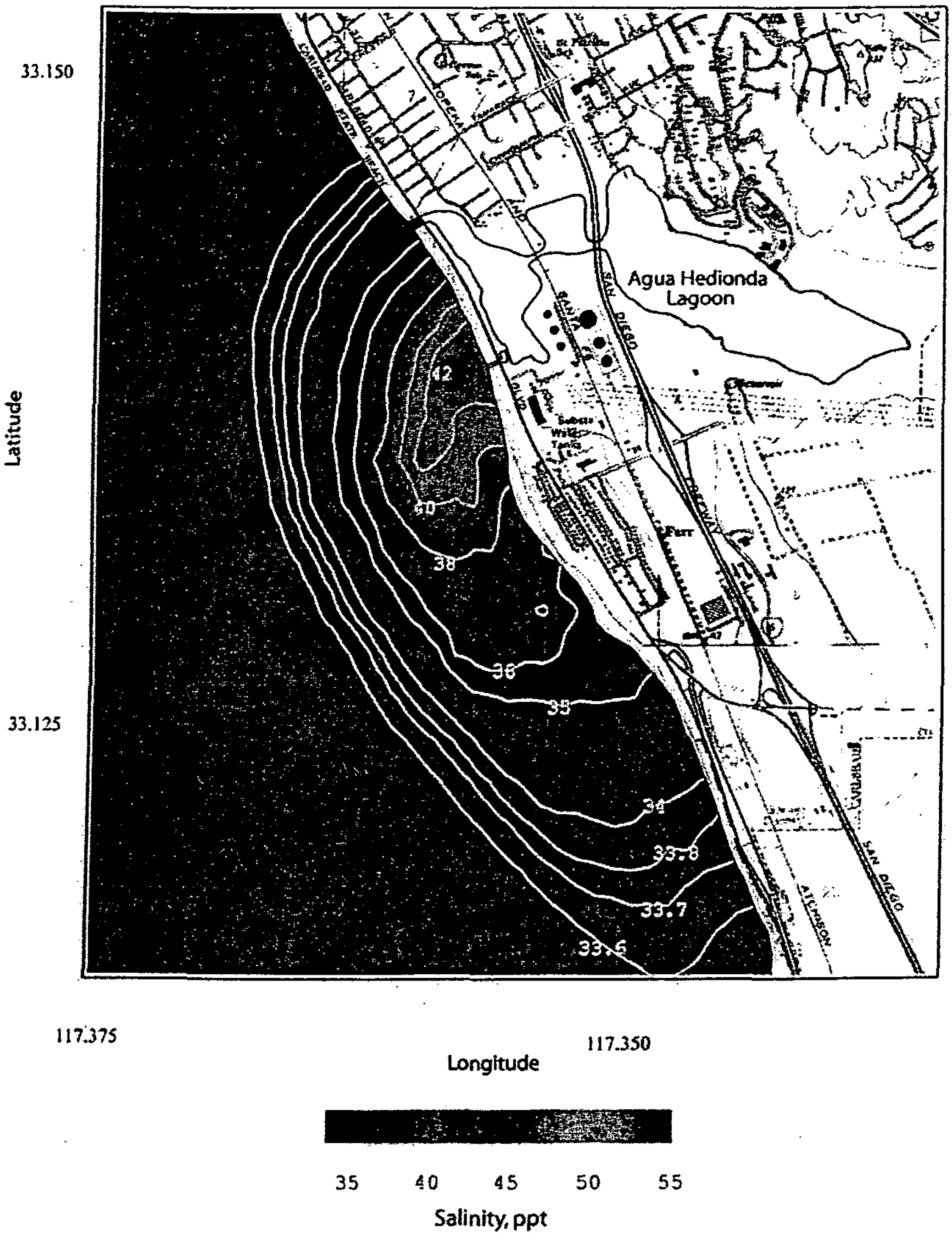


Figure 9. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt,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

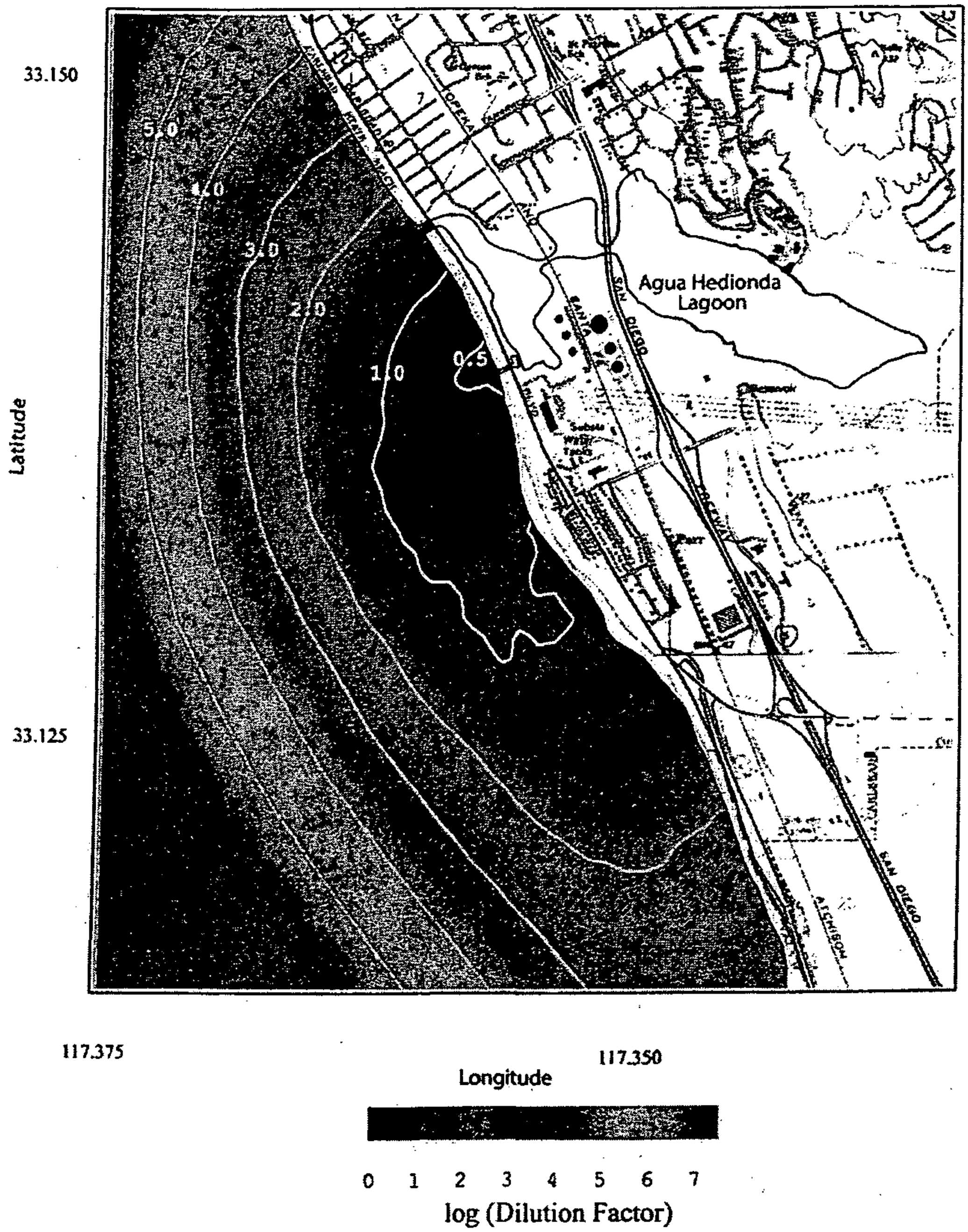


Figure 10. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean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

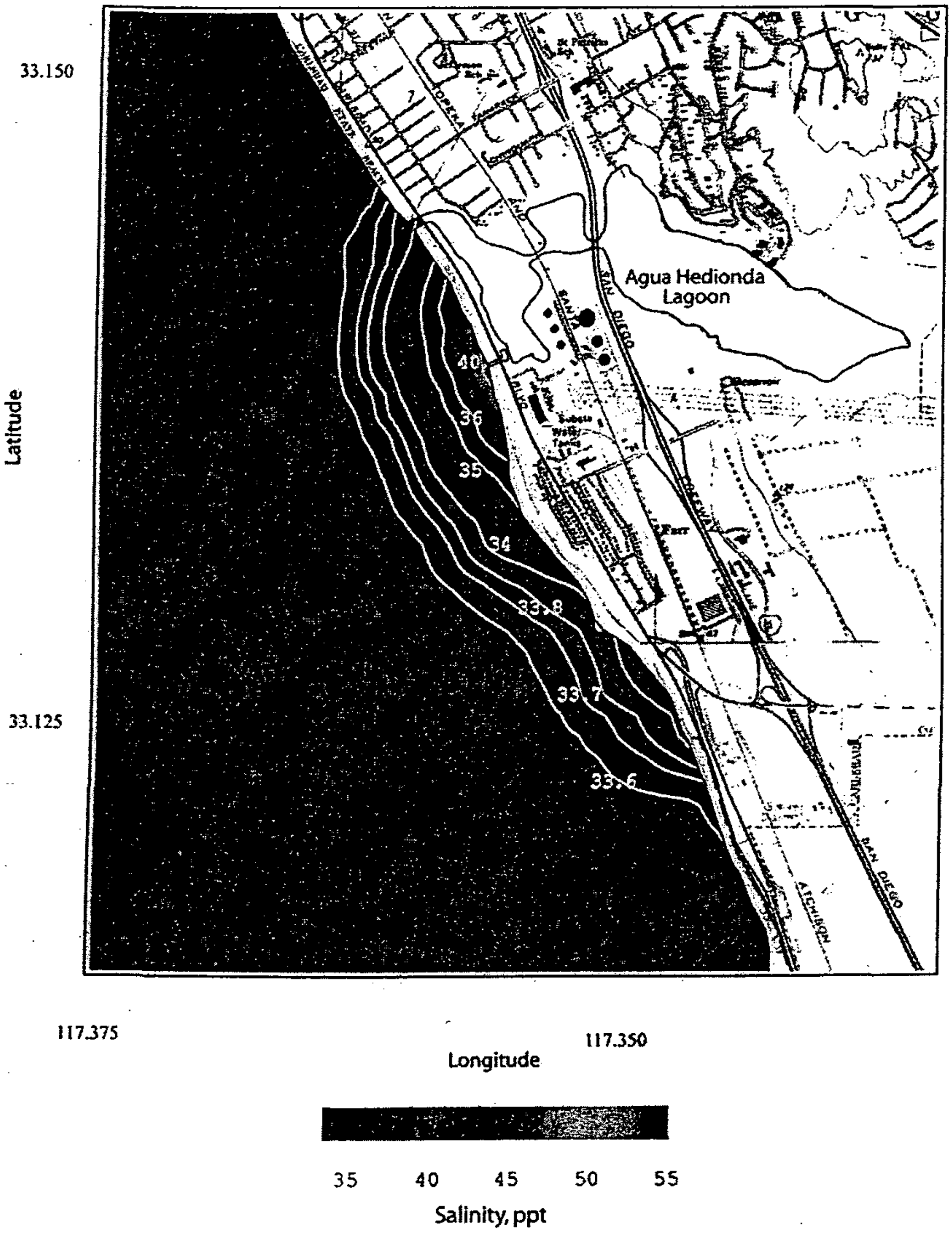


Figure 11. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51 ppt, ocean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

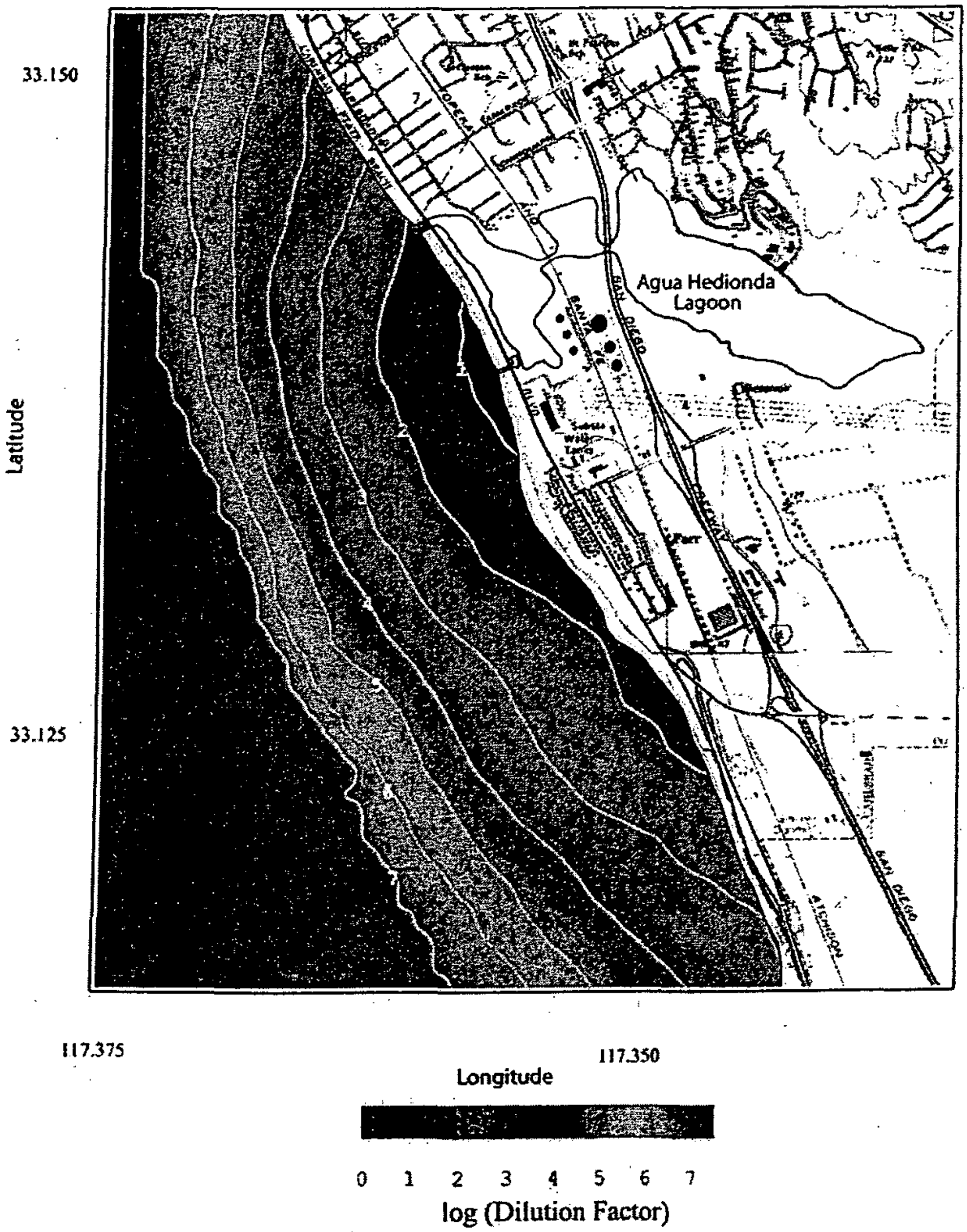


Figure 12. Scenario 2 worst case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\,^{0}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.51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

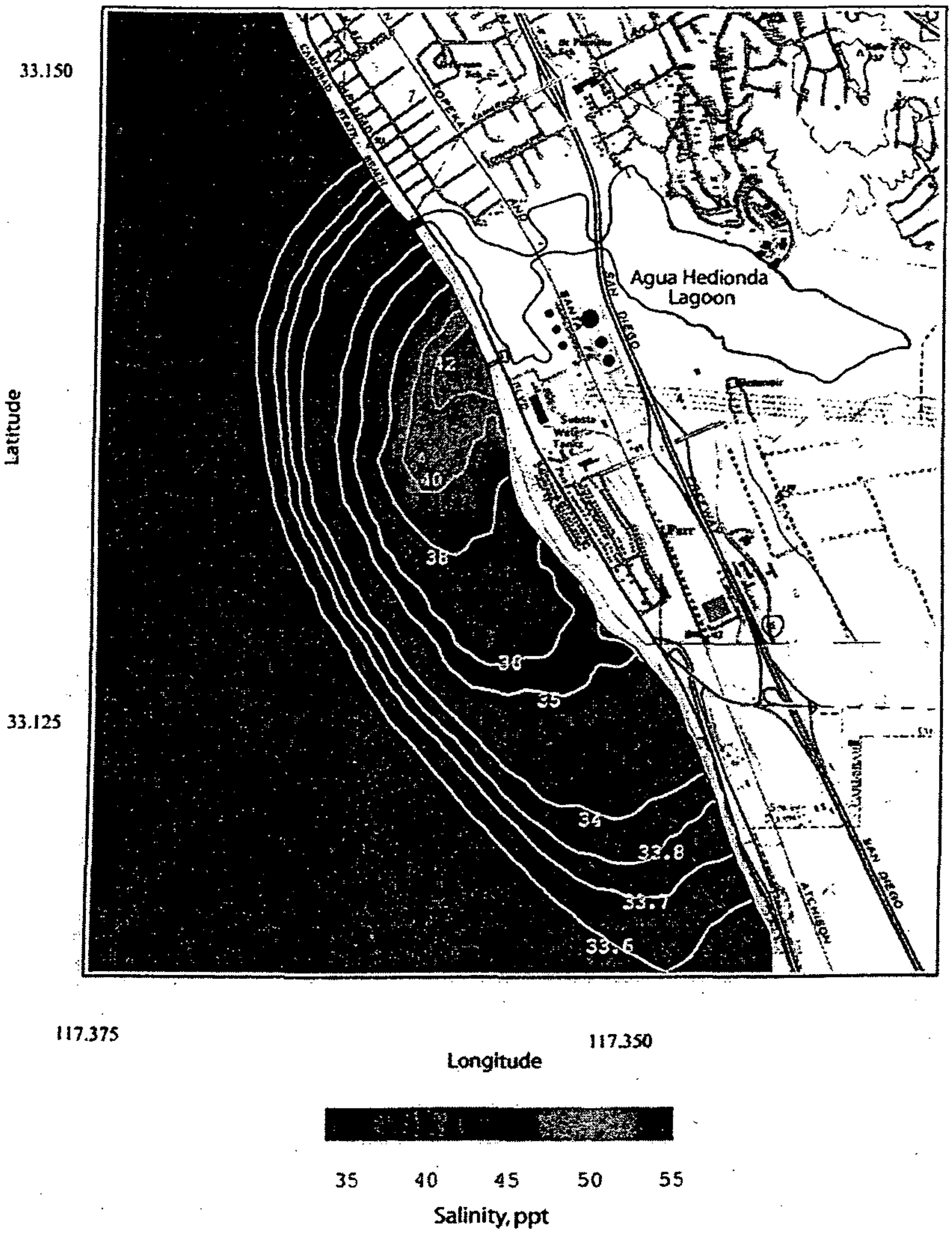


Figure 13. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean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

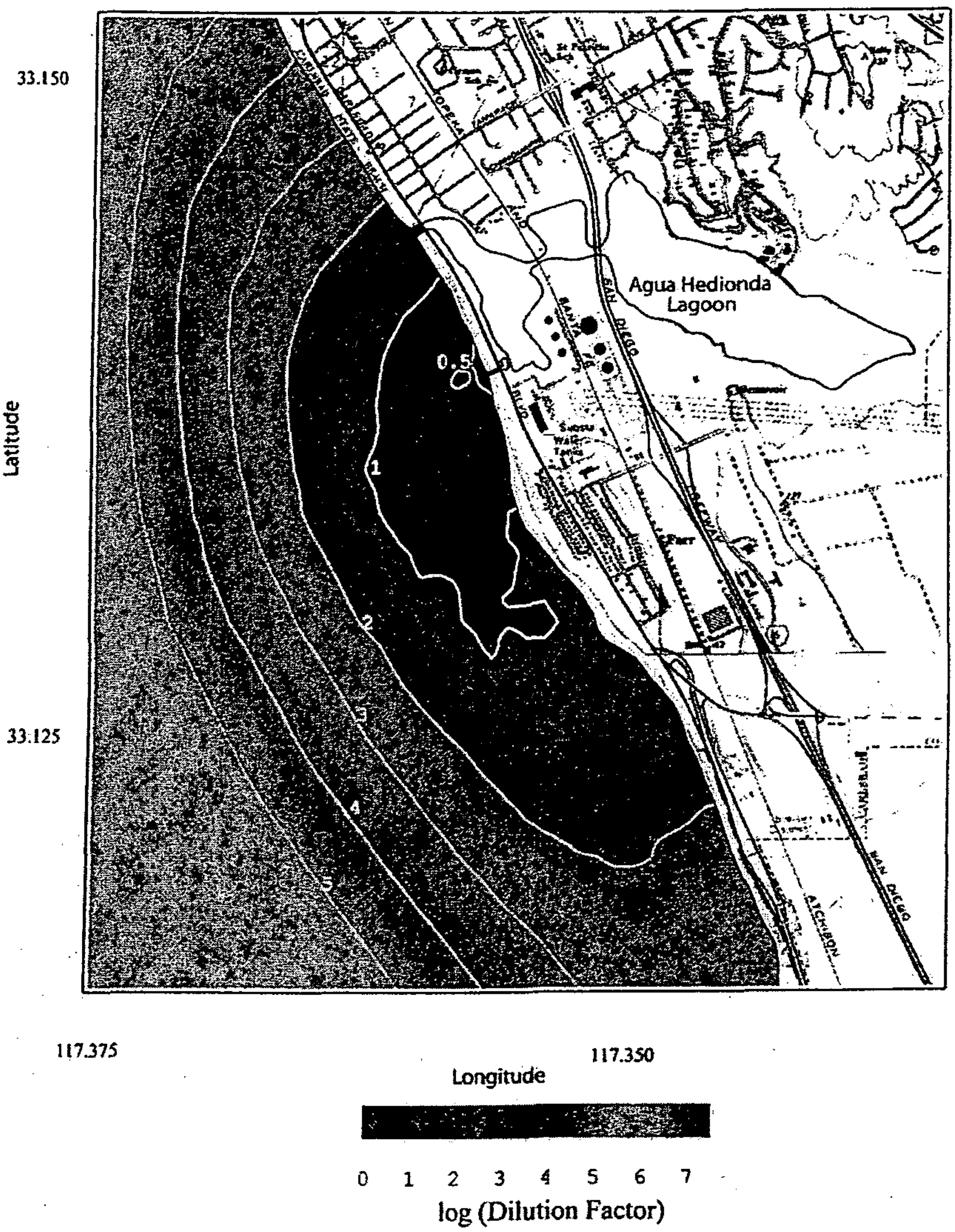


Figure 14. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions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

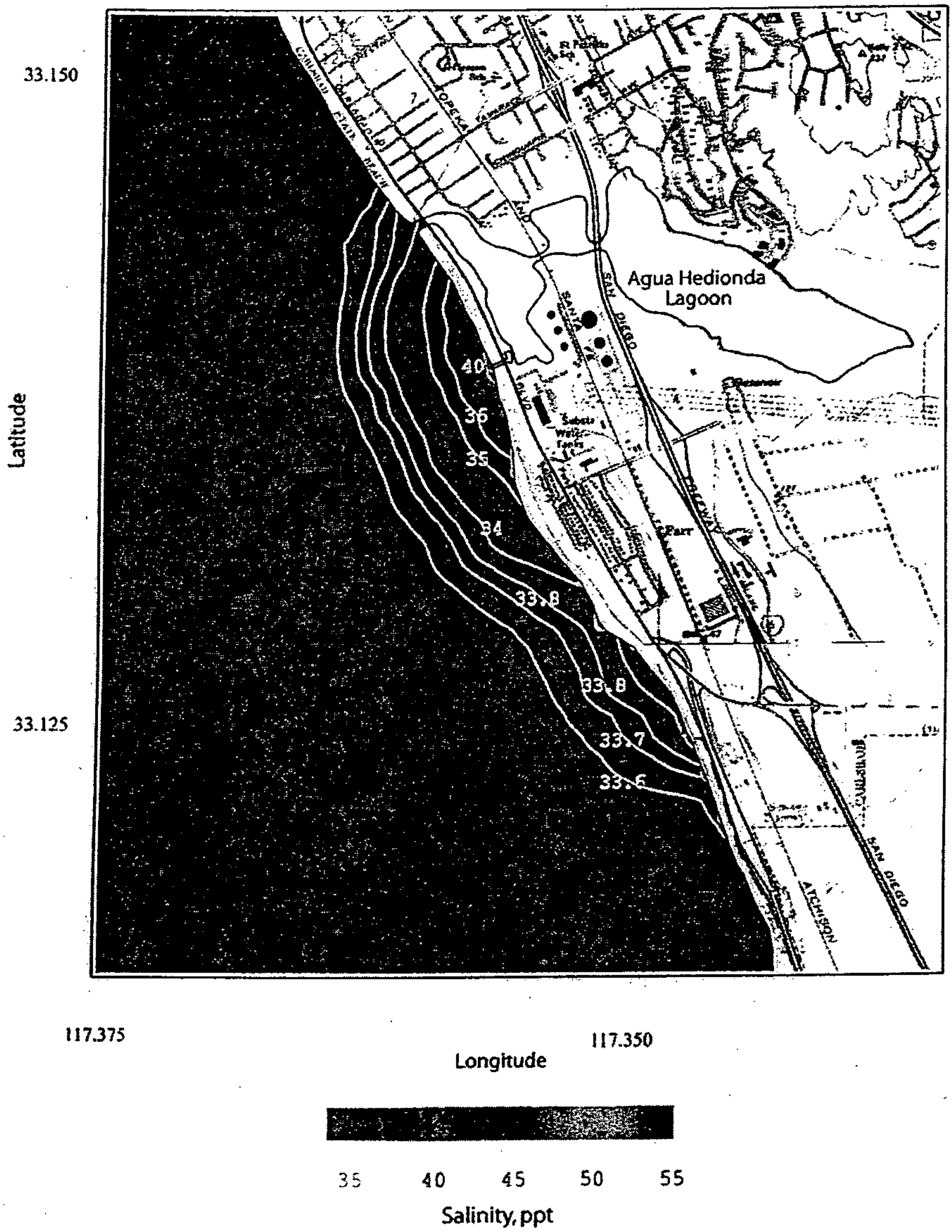


Figure 15. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{\circ}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions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

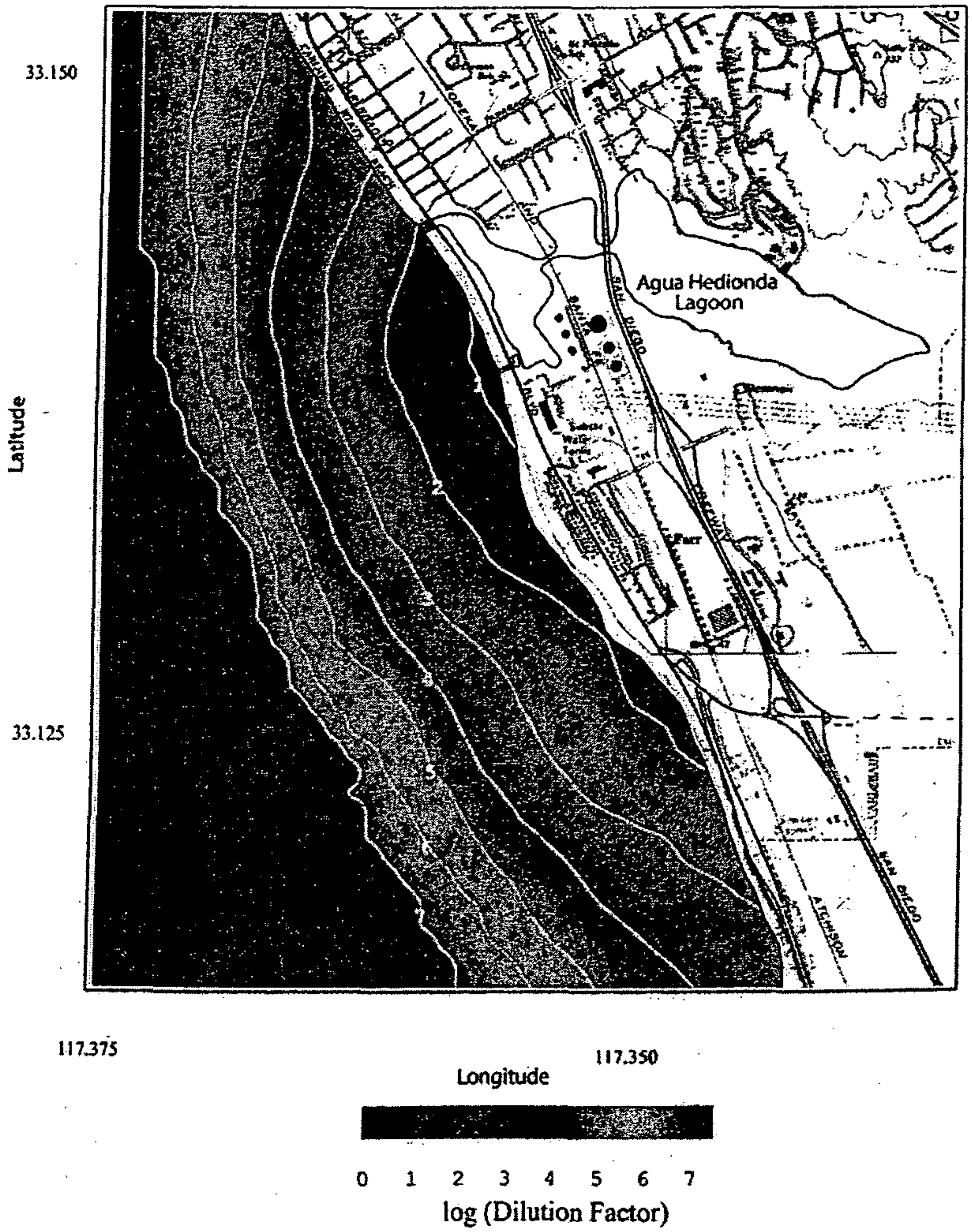


Figure 16. Scenario 3 worst case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.51 ppt, ocean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

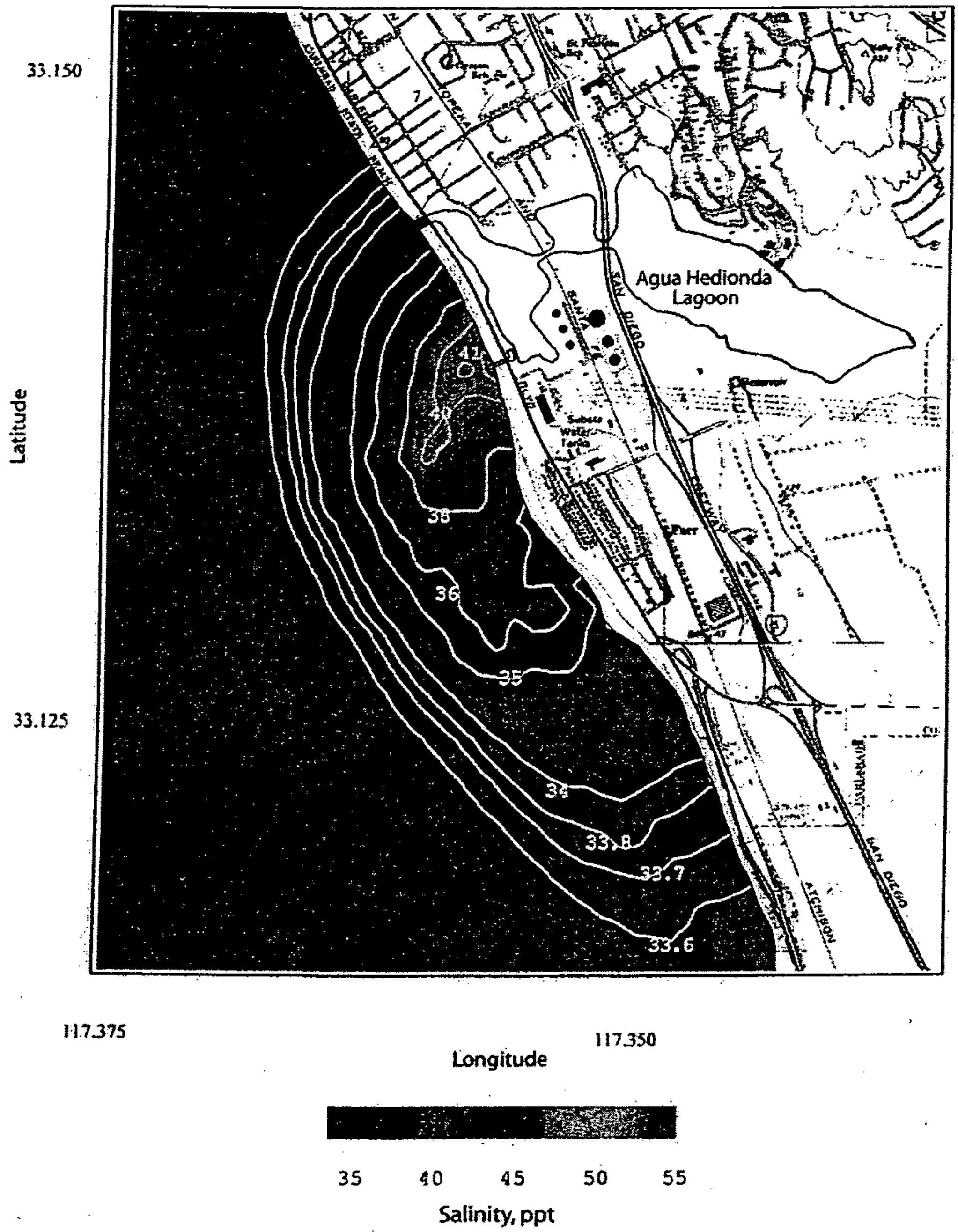


Figure 17. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean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

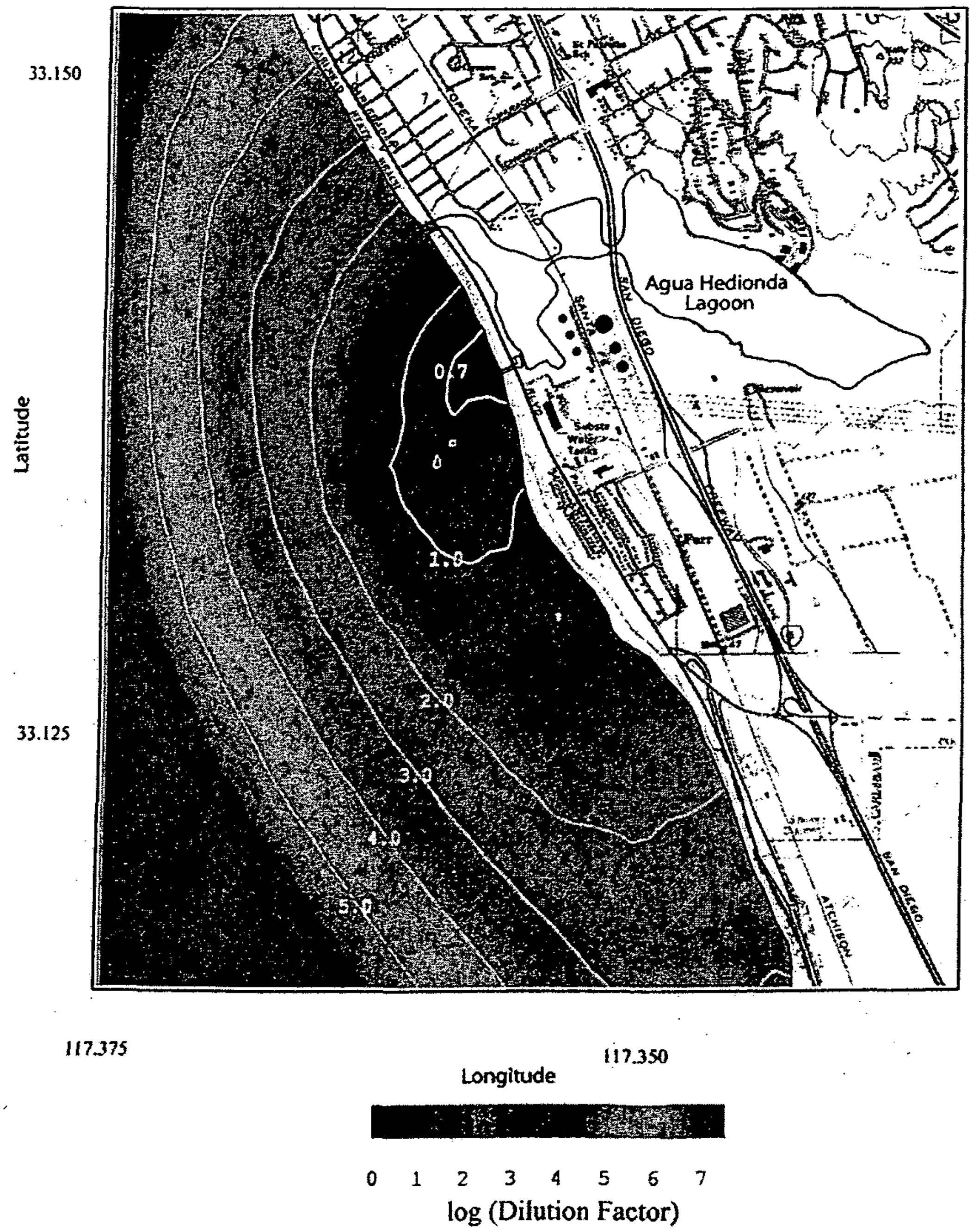


Figure 18. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean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

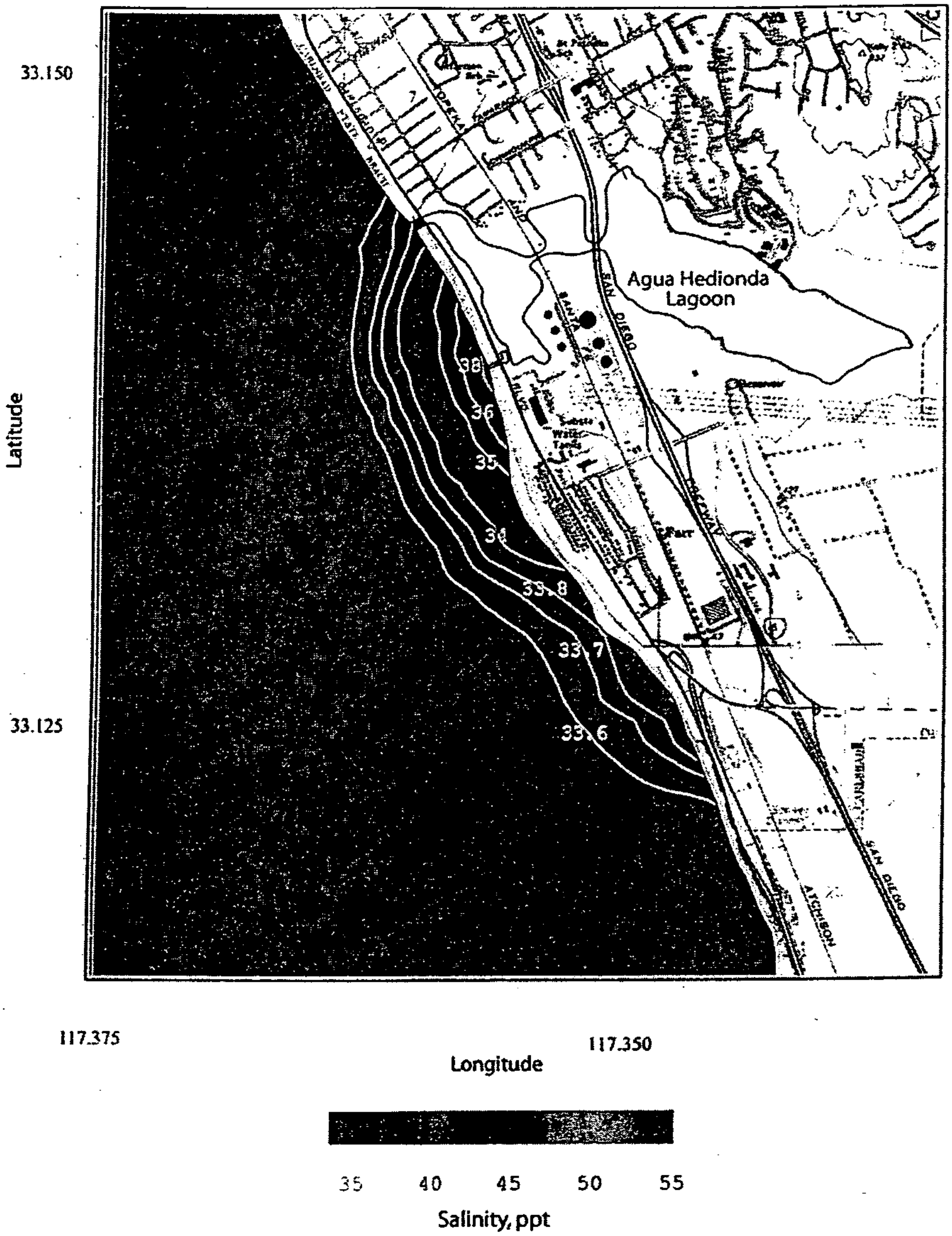


Figure 19. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions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

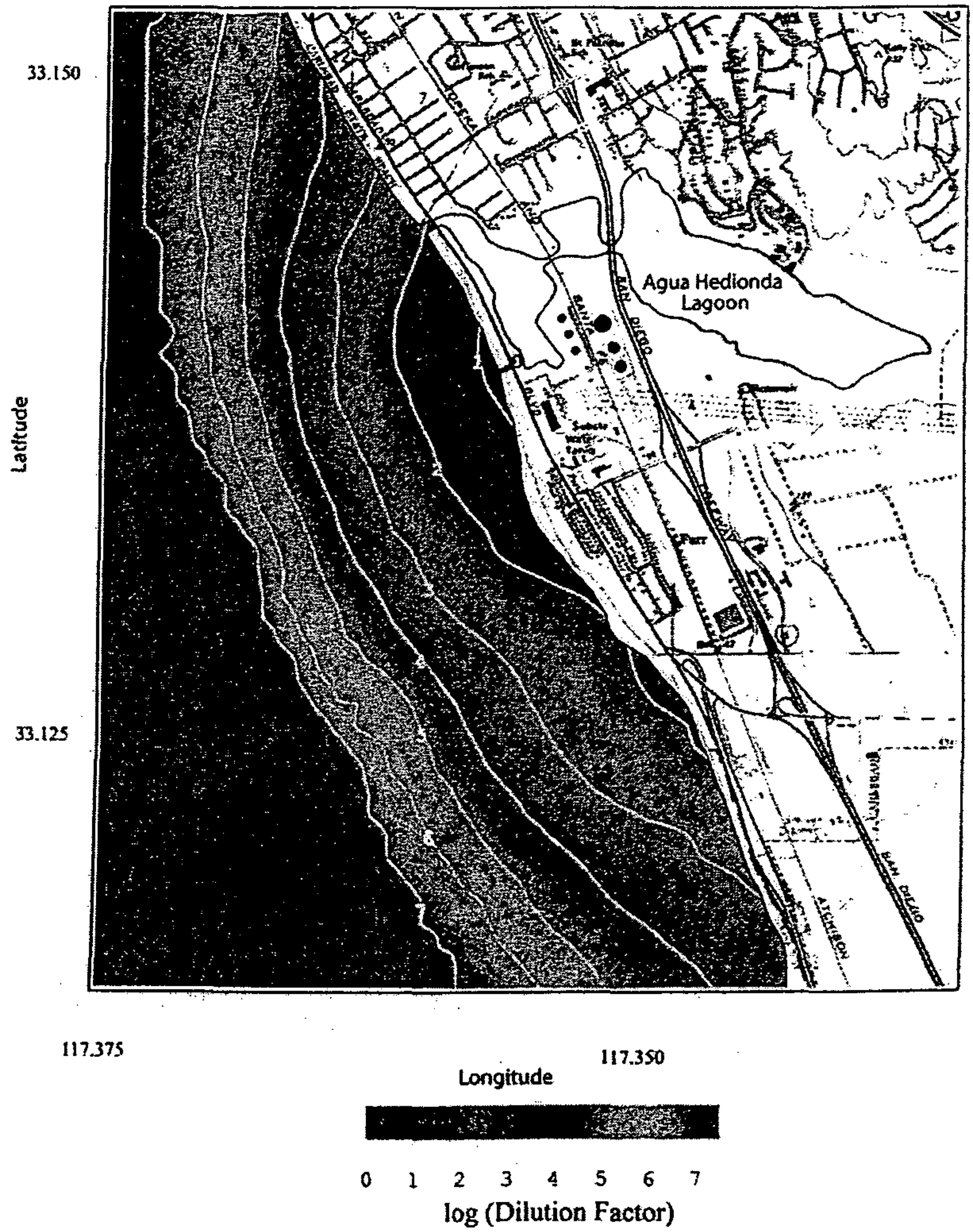


Figure 20. Scenario 4 worst case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.51 ppt,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

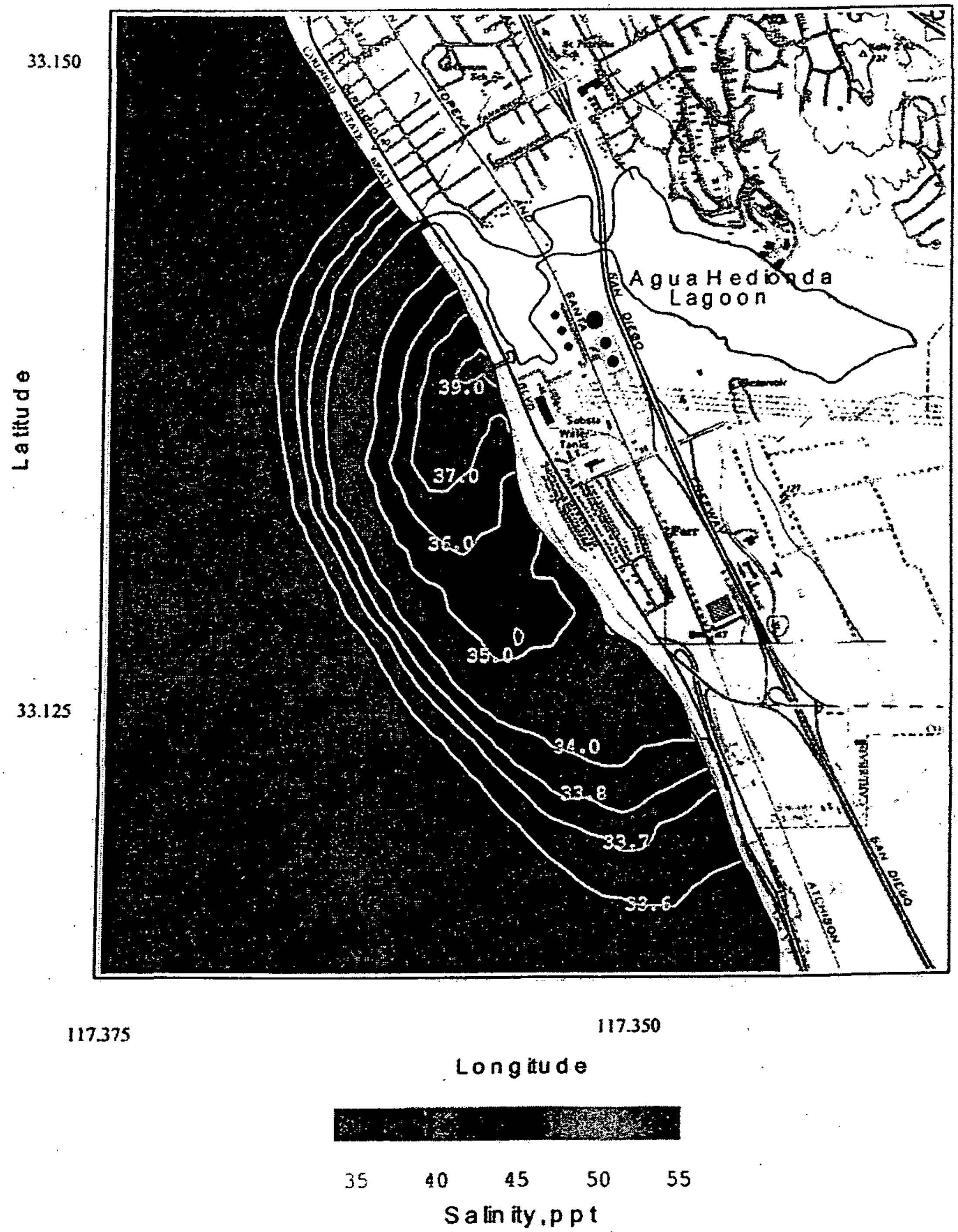


Figure 21. Scenario 5 worst case with two Unit 4 circulation 2 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions - 17 Aug 1992.

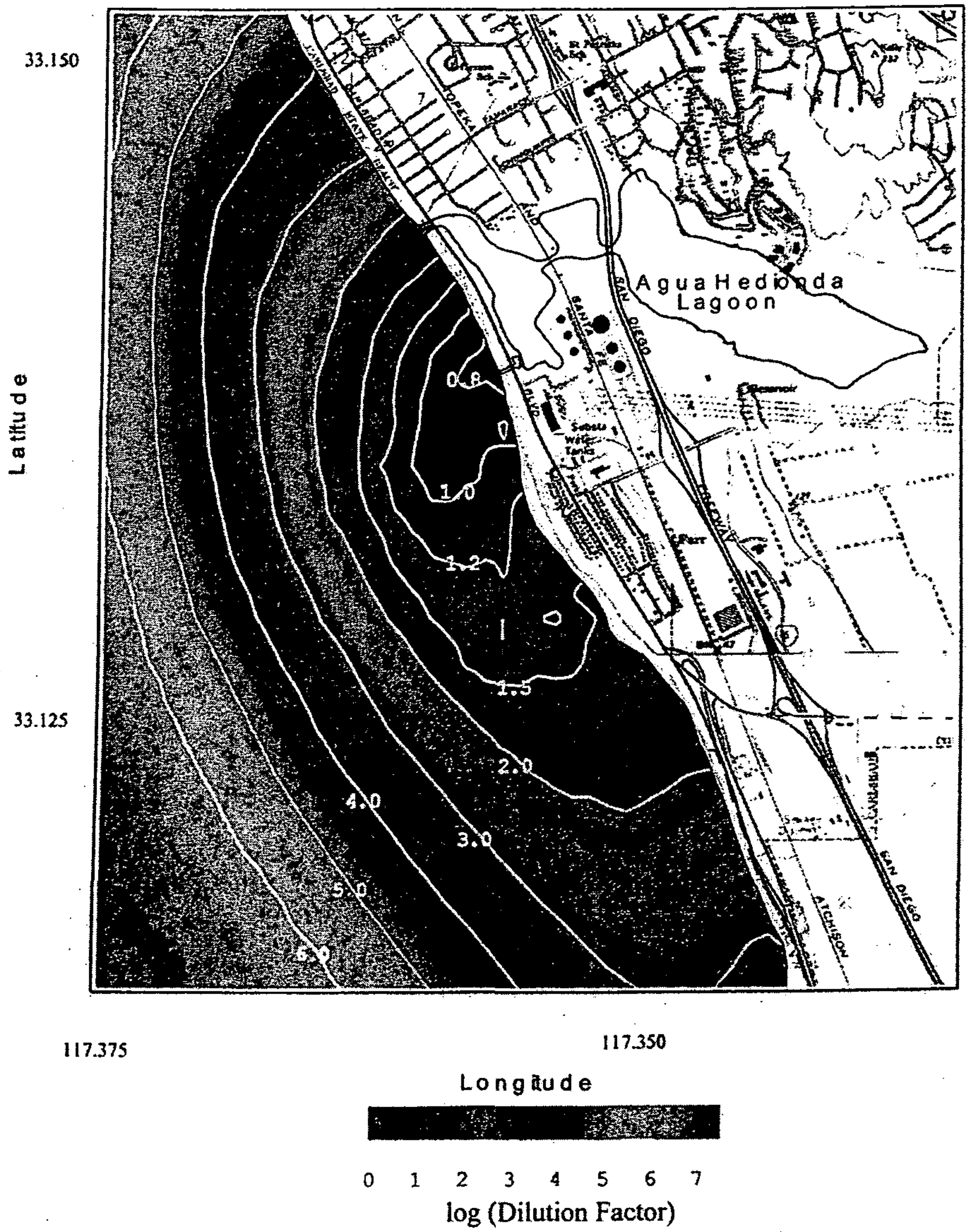


Figure 22. Scenario 5 worst case with two Unit 4 circulation pumps for ΔT = 0 °C. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

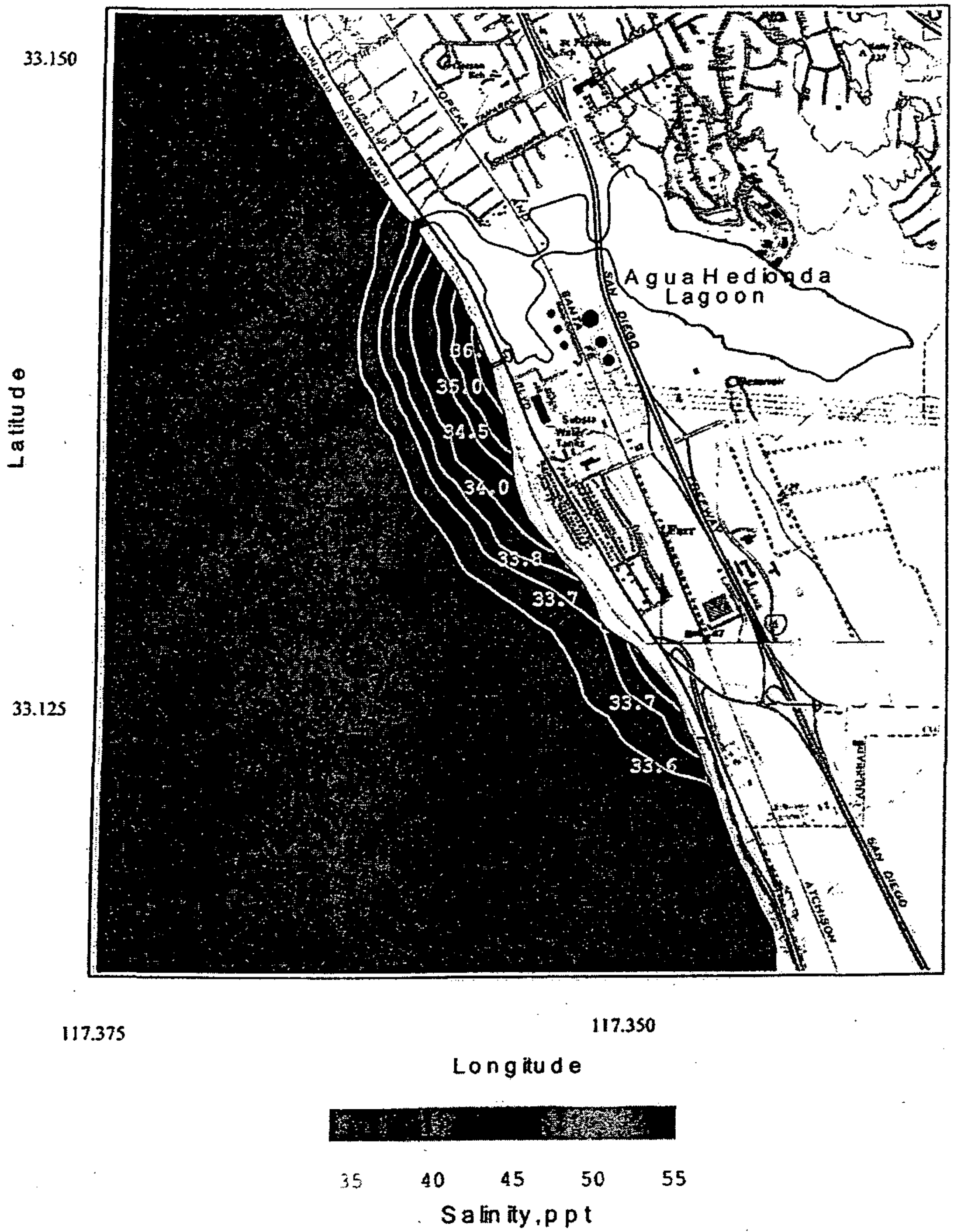


Figure 23. Scenario 5 worst case with two Unit 4 circulation pumps for $\Delta T = 0$ ^{o}C. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

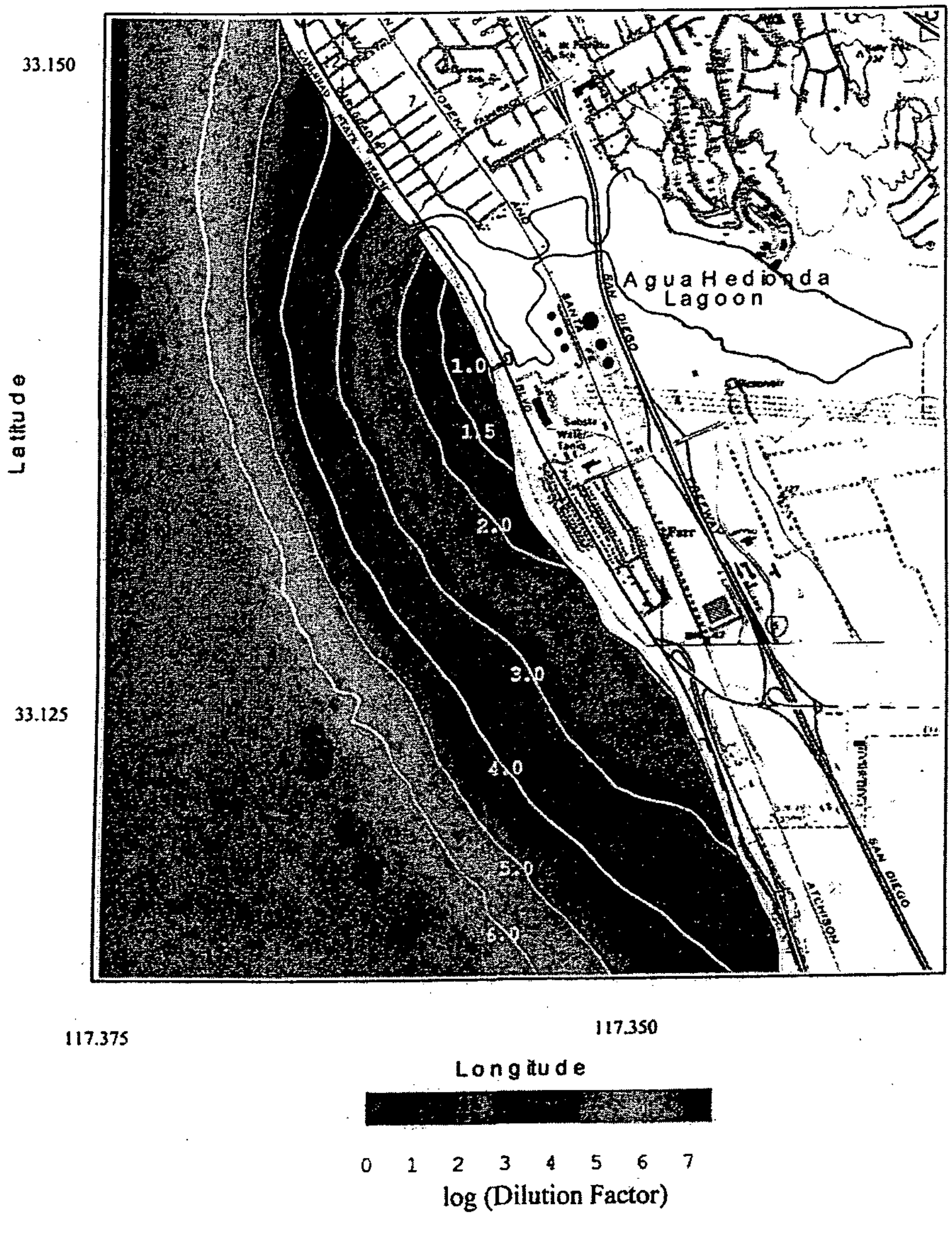


Figure 24. Scenario 5 worst case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.51 ppt, ocean conditions, 17 Aug 1992.

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 $\Delta T = 0° C$. 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.

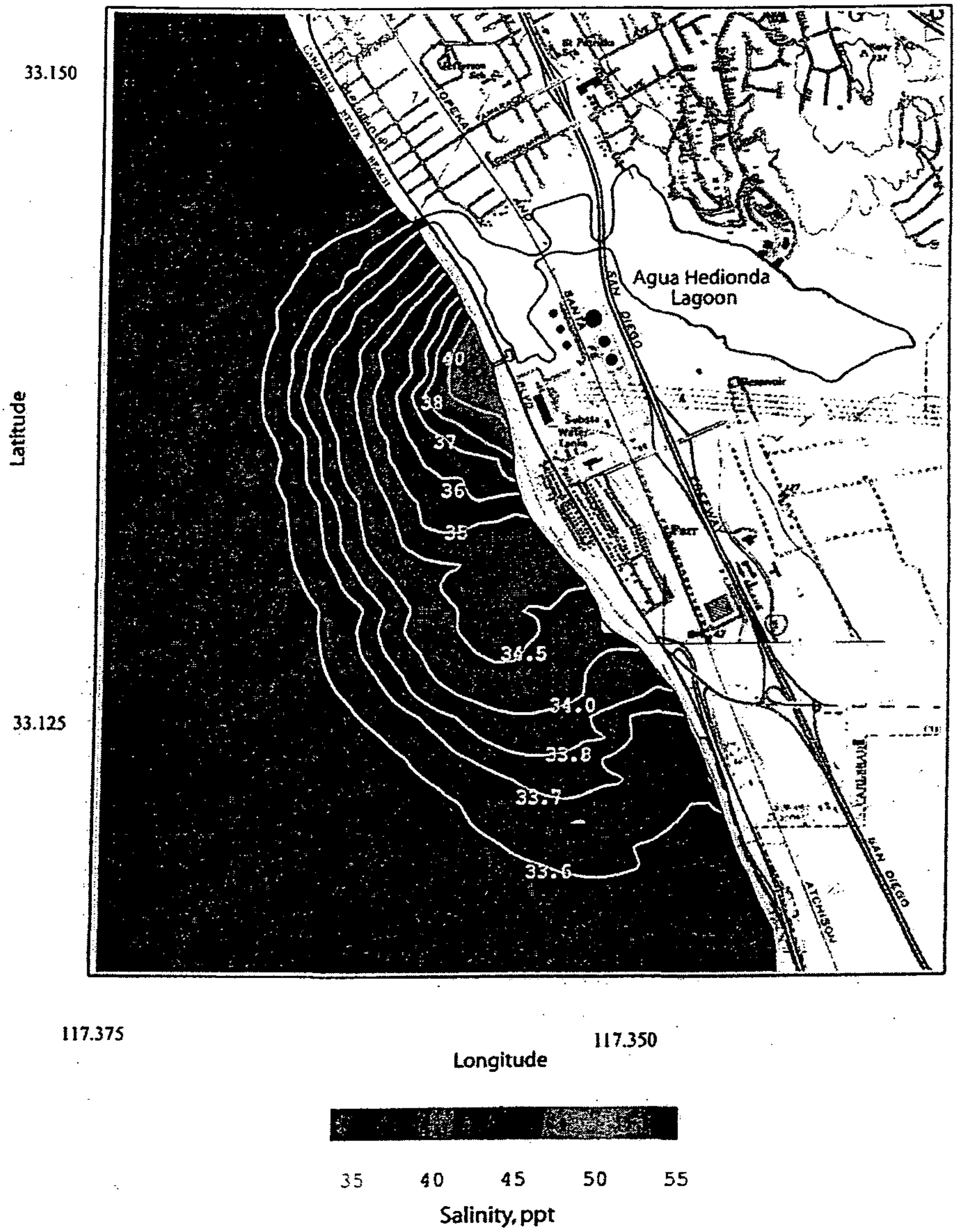


Figure 25. Scenario 1 average case with 1 Unit 5 circulation pump, for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May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

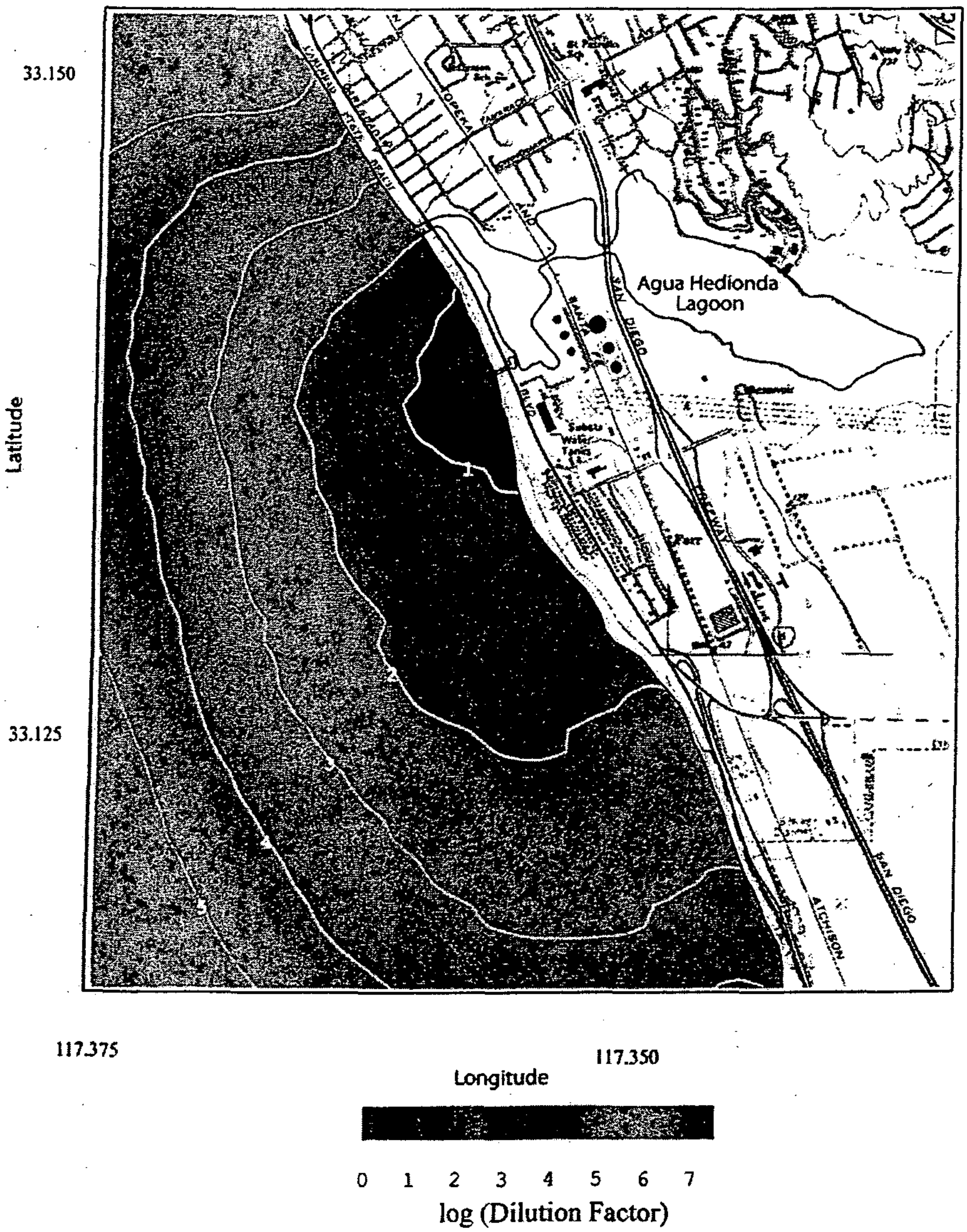


Figure 26. Scenario 1 average case with one Unit 5 circulation pump for DT = 0 °C. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

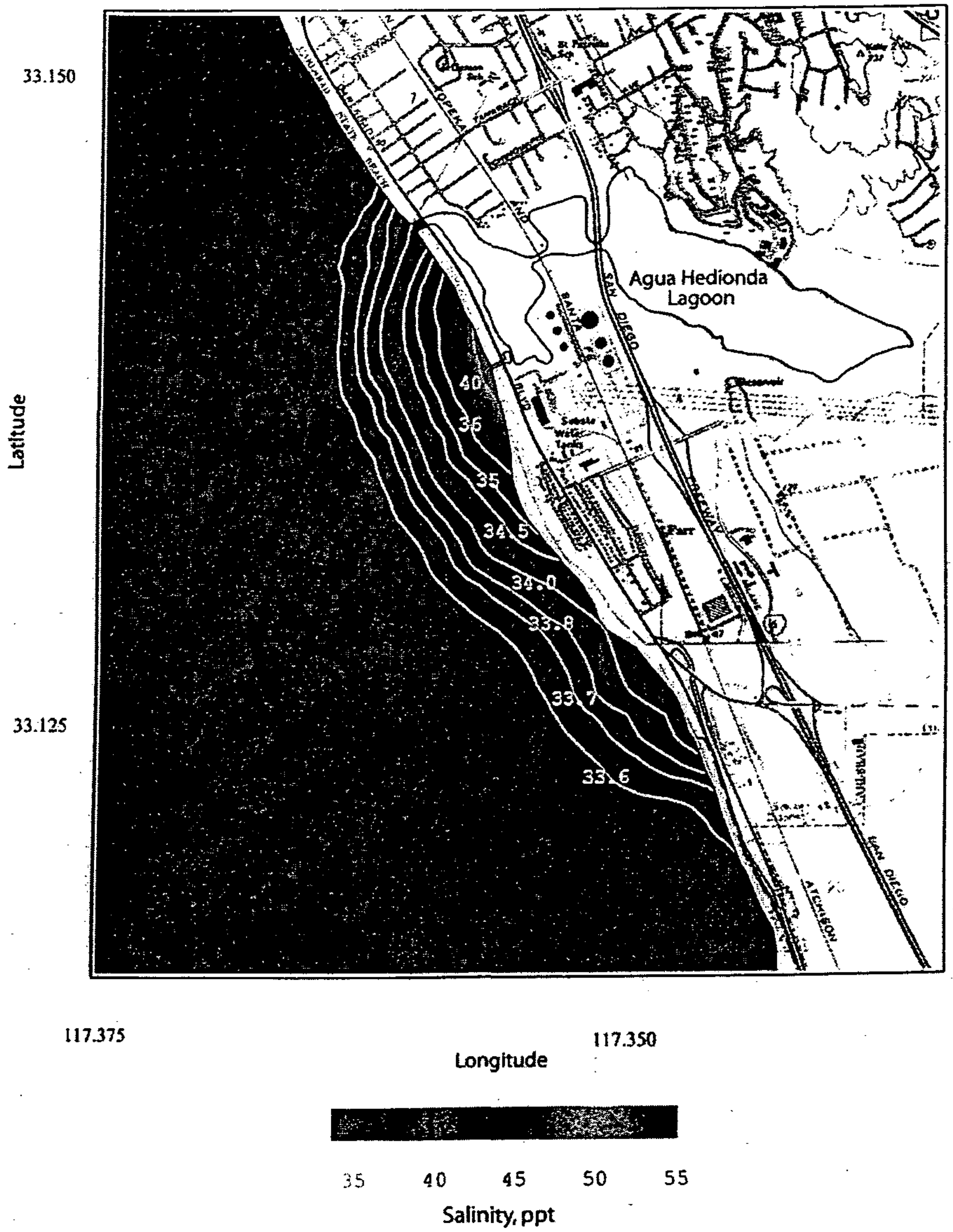


Figure 27. Scenario 1 average case with one Unit 5 circulation pump for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

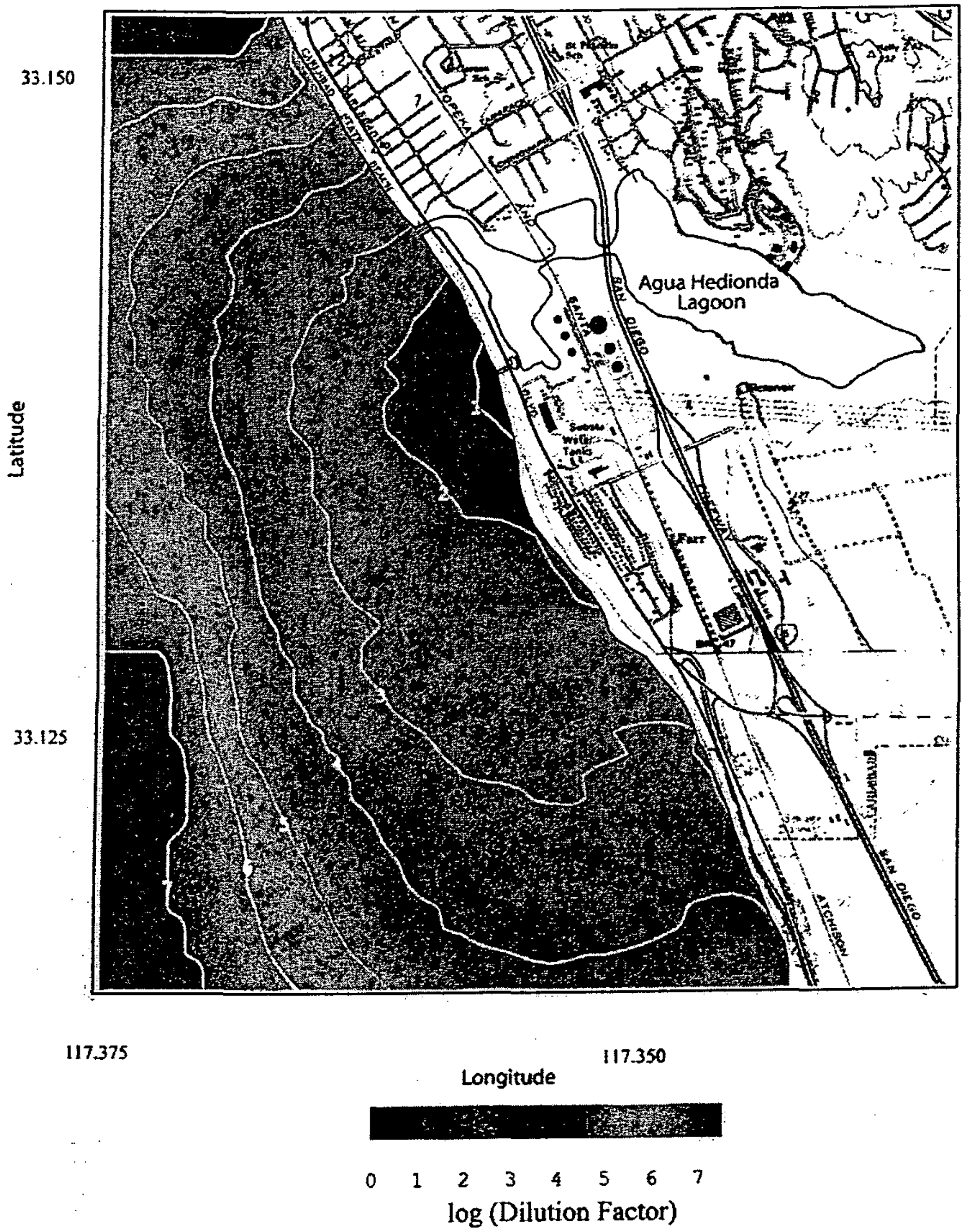


Figure 28. Scenario 1 average case with one Unit 5 circulation pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 149.76 mgd, combined discharge = 99.76 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23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

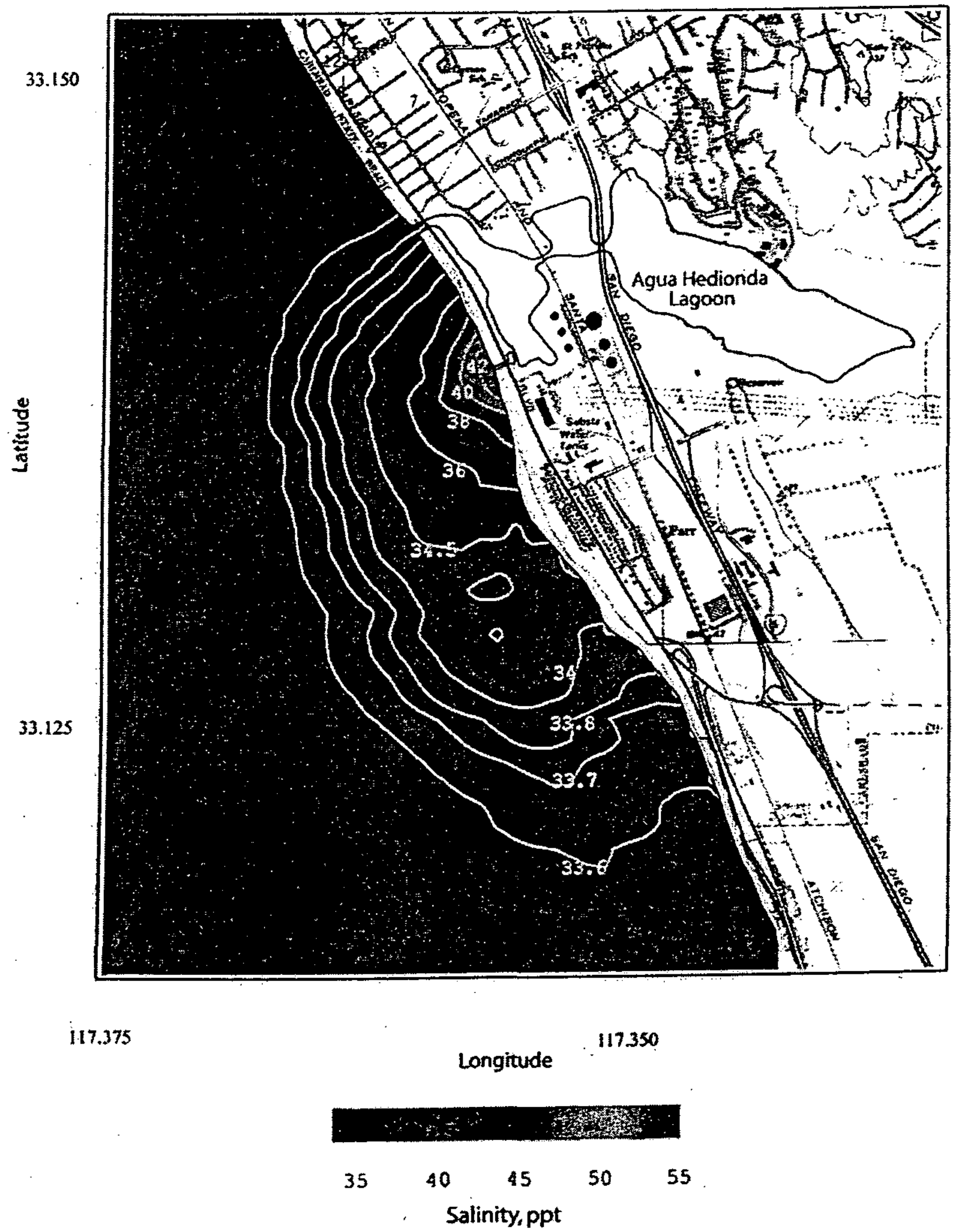


Figure 29. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt,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

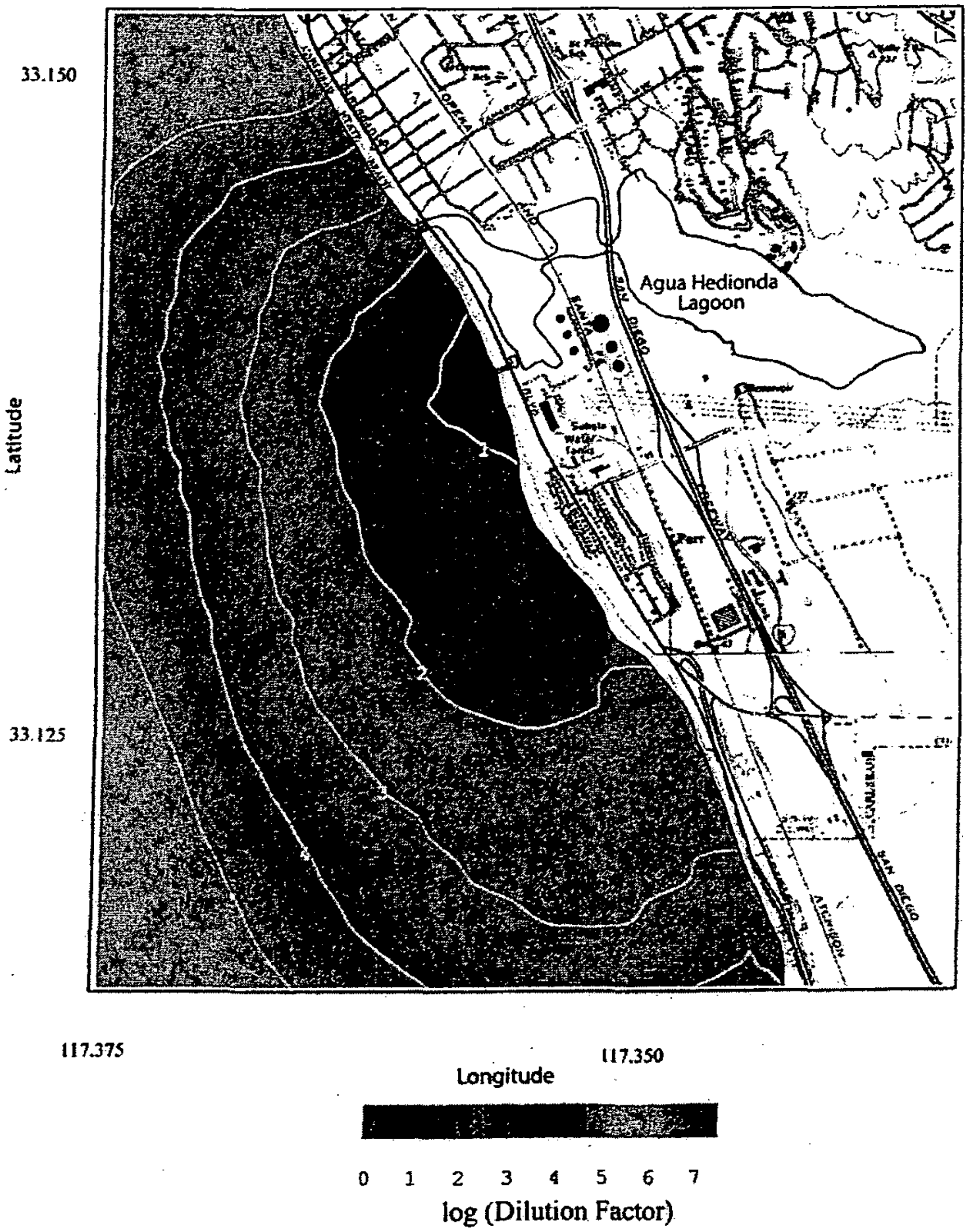


Figure 30. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt,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

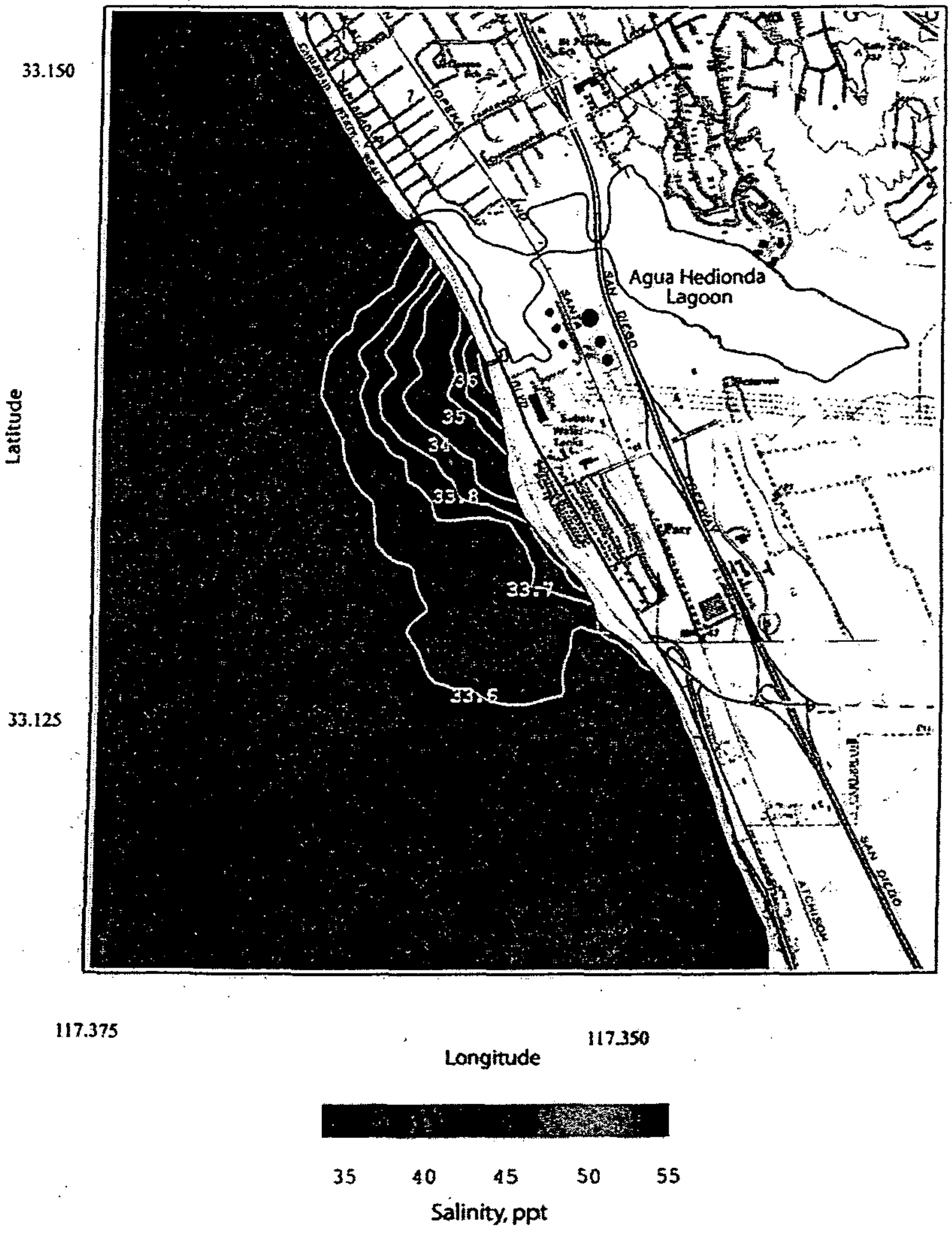


Figure 31. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52 ppt, ocean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

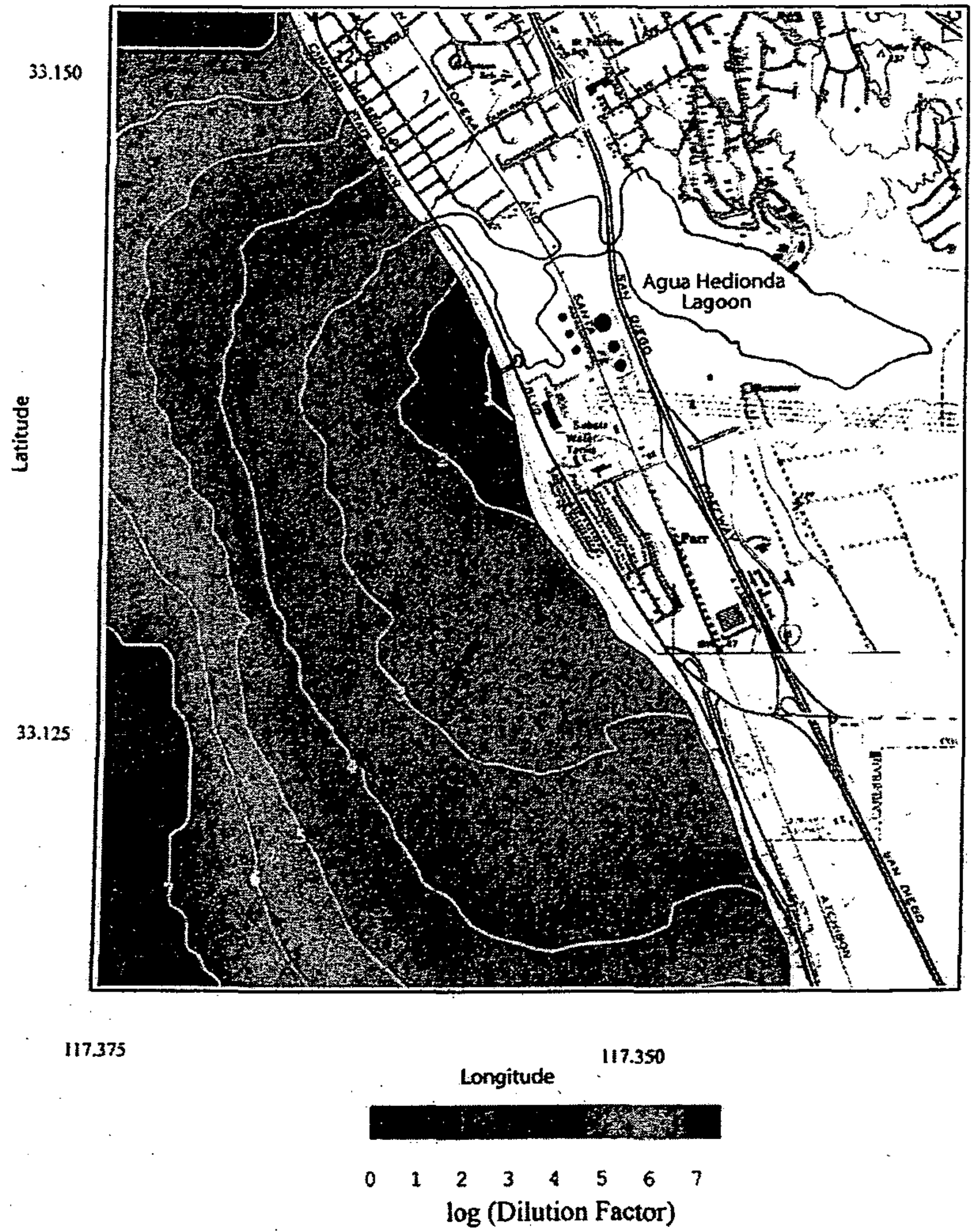


Figure 32. Scenario 2 average case with all circulation pumps - Units 1&2, and one pump - Unit 3 for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 172.8 mgd, combined discharge = 122.8 mgd, ambient ocean salinity = 33.52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

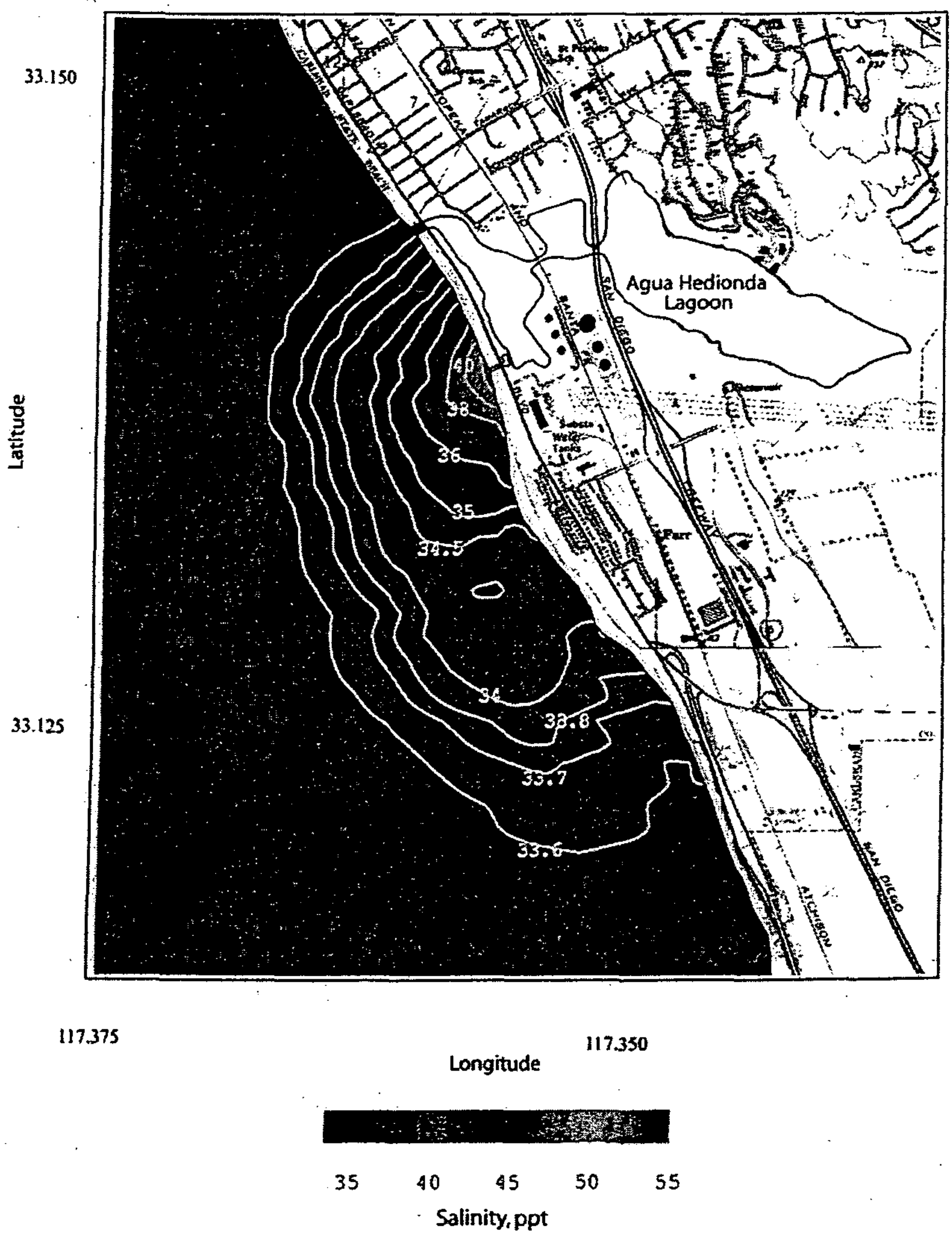


Figure 33. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean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

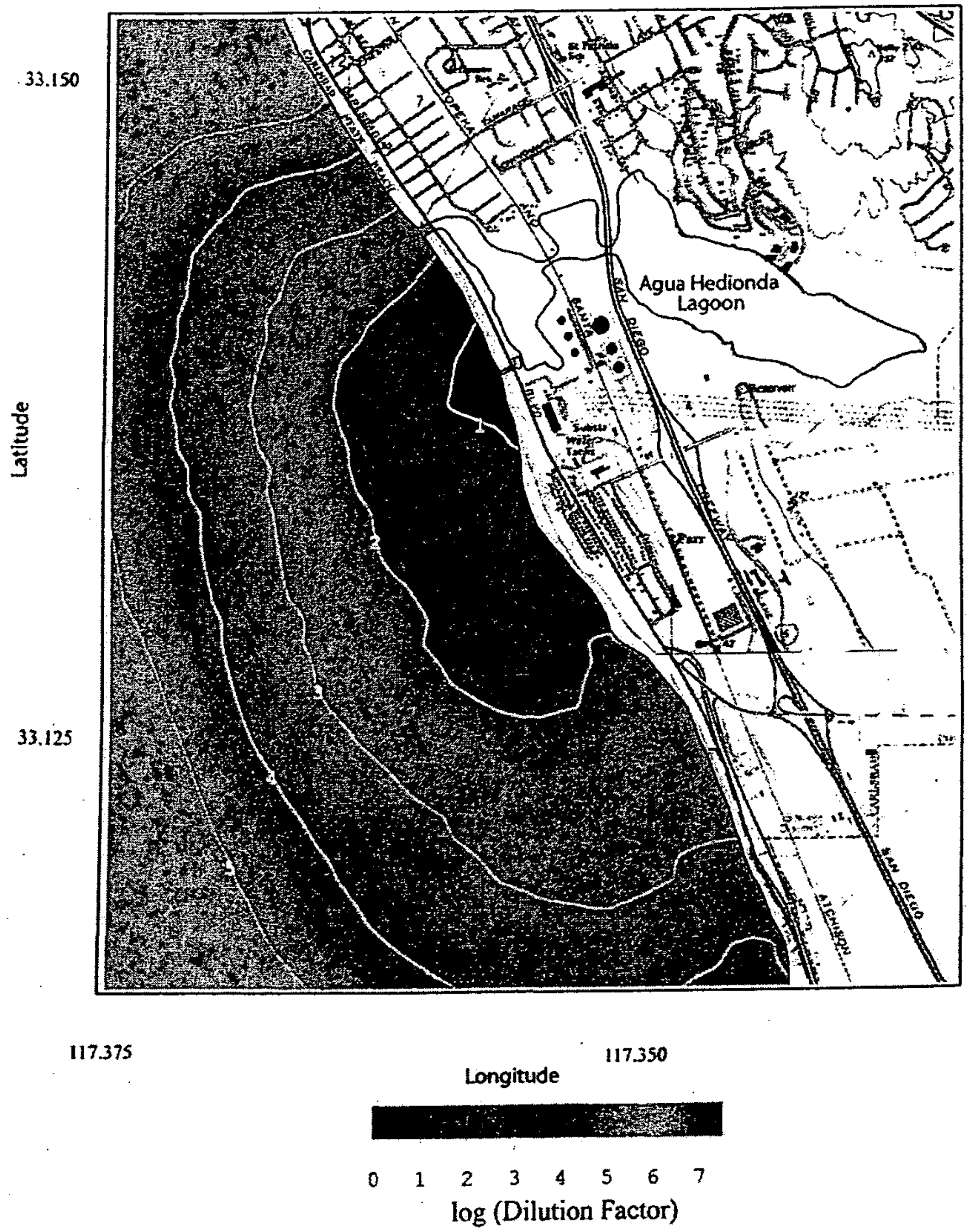


Figure 34. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean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

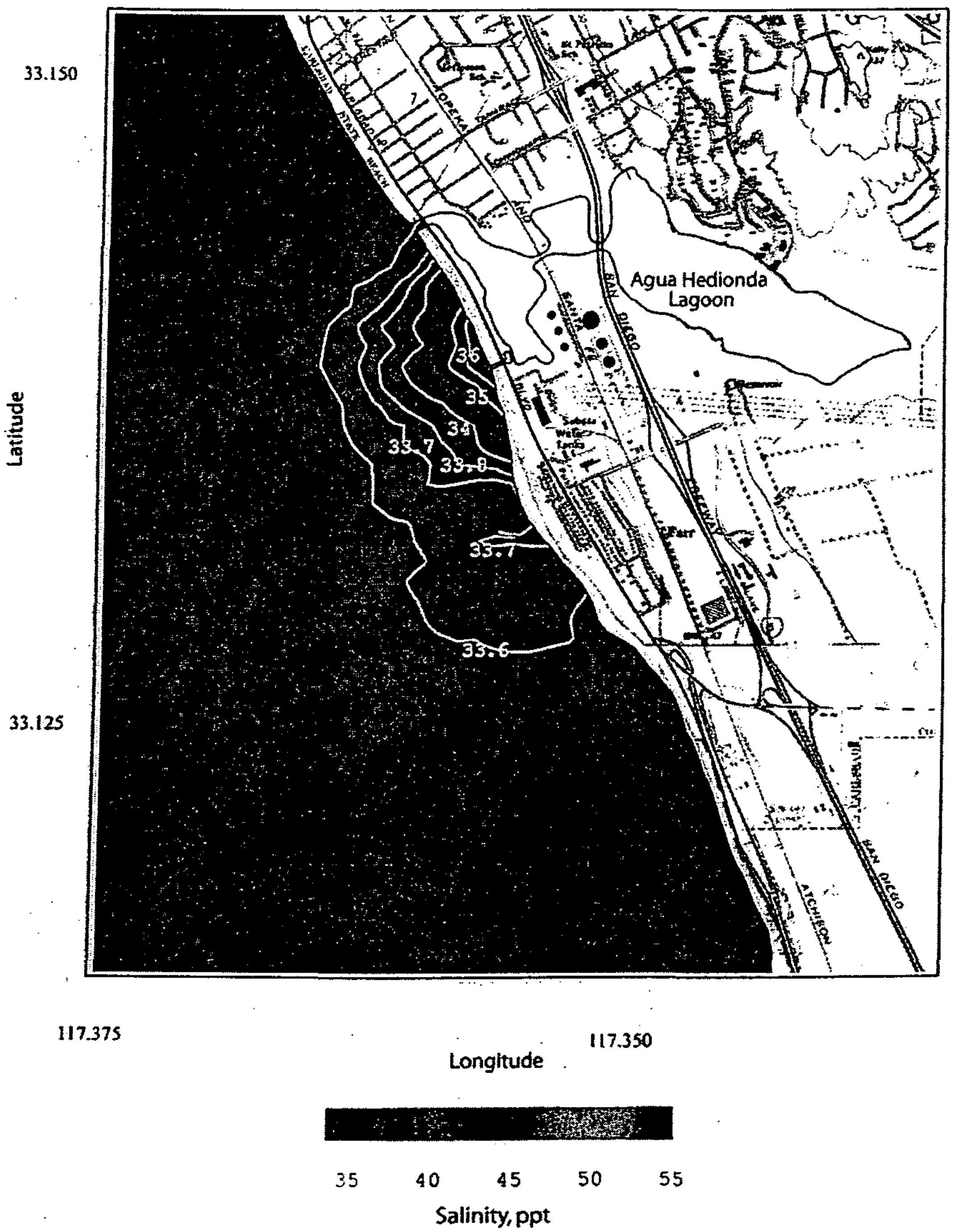


Figure 35. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions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

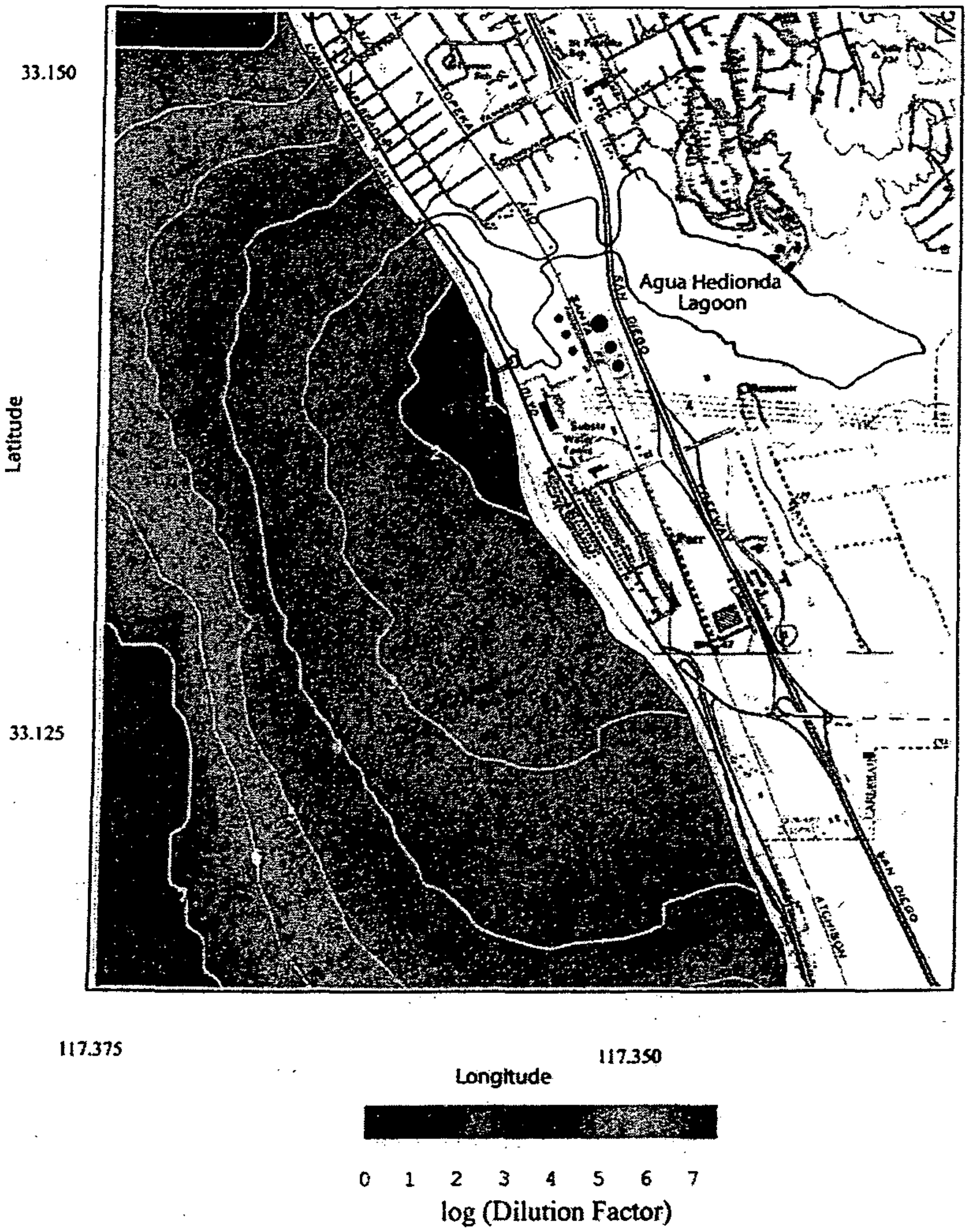


Figure 36. Scenario 3 average case with one Unit 5 circulation pump, and one Unit 1 pump for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 184.32 mgd, combined discharge = 134.32 mgd, ambient ocean salinity = 33.52 ppt,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

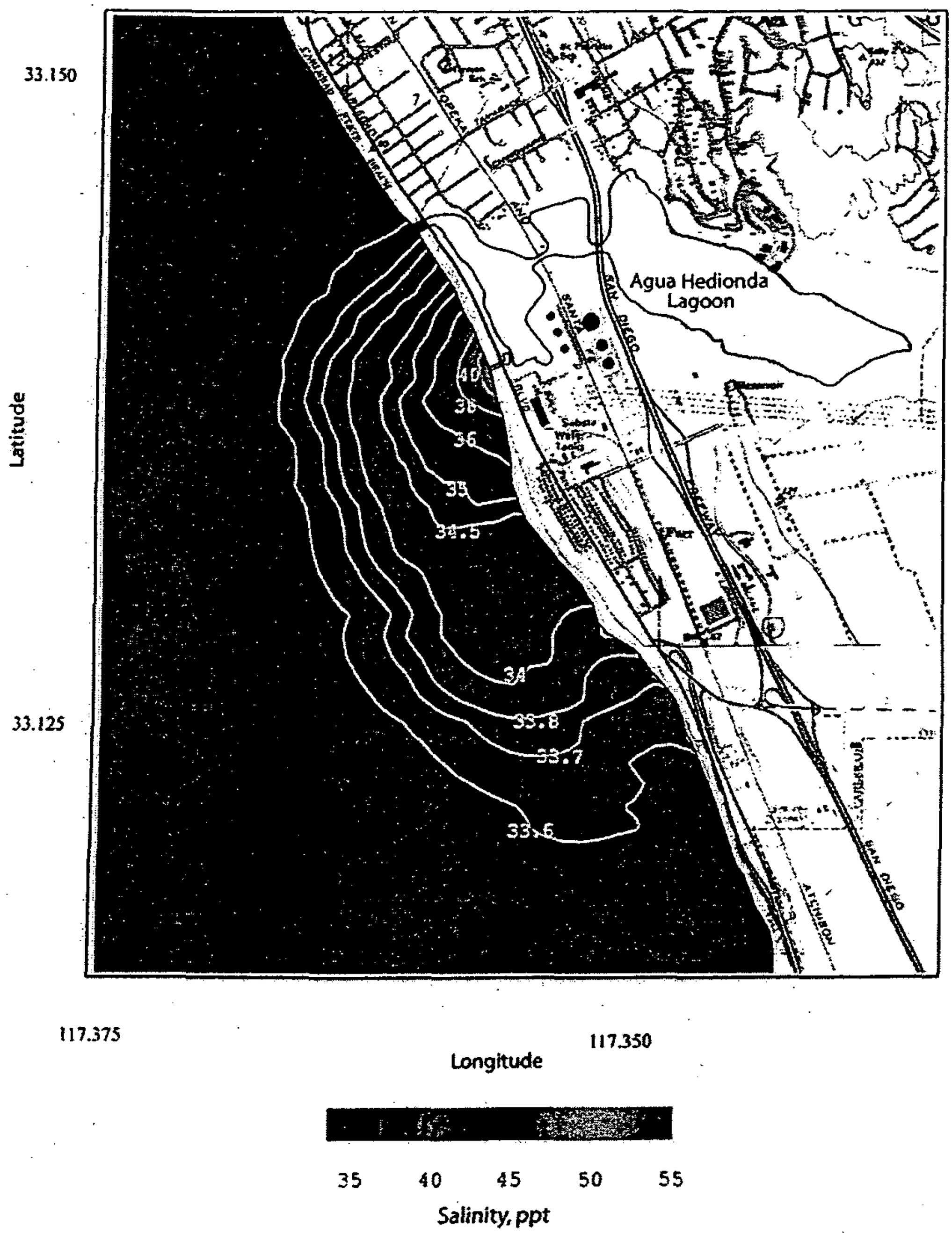


Figure 37. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean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

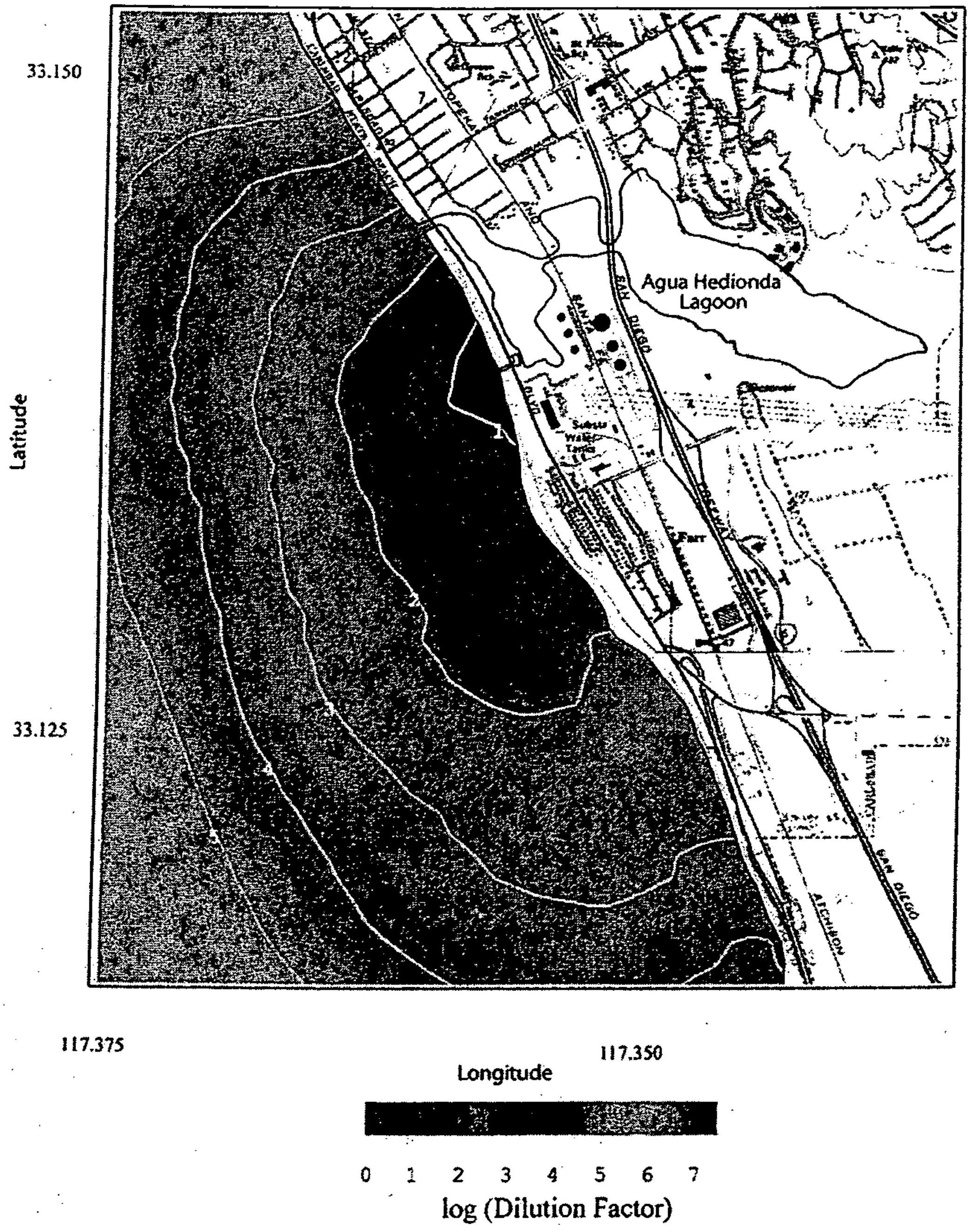


Figure 38. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean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

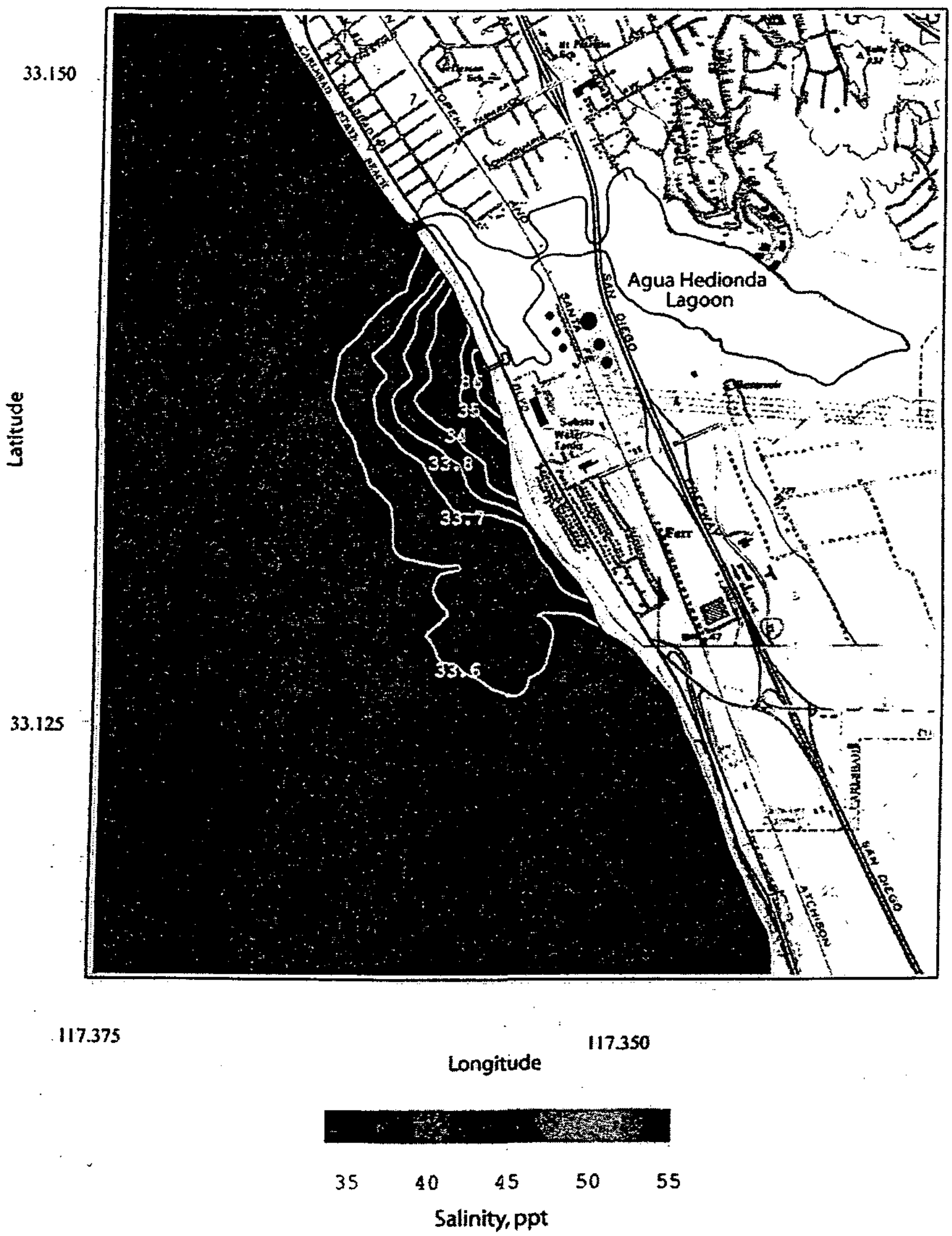


Figure 39. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions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

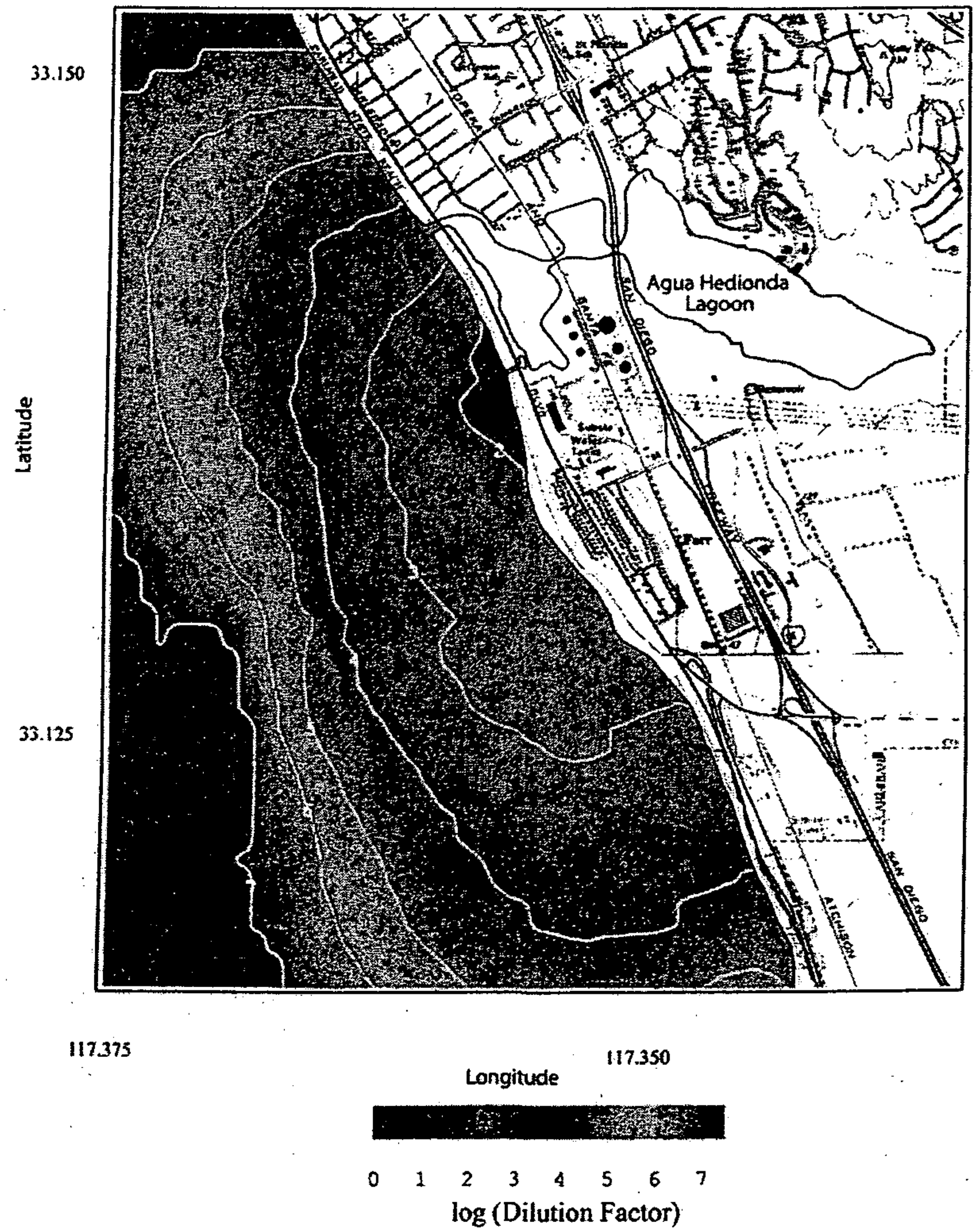


Figure 40. Scenario 4 average case with one Unit 5 circulation pump, and two Unit 1 pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 218.88 mgd, combined discharge = 168.88 mgd, ambient ocean salinity = 33.52 ppt,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

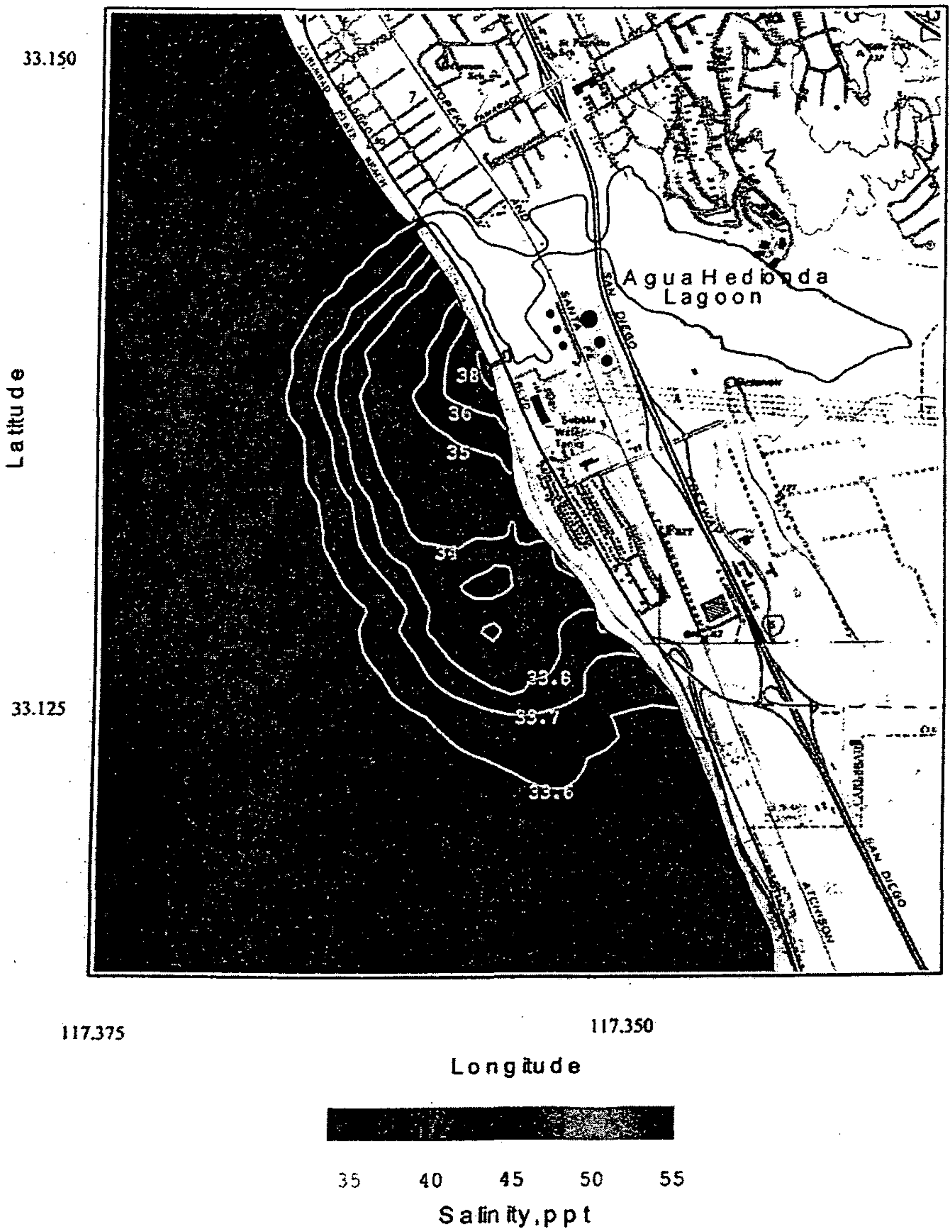


Figure 41. Scenario 5 average case with two Unit 4 circulation 2 pumps for $\Delta T = 0\ ^{o}C$. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions - 23 May 1994.

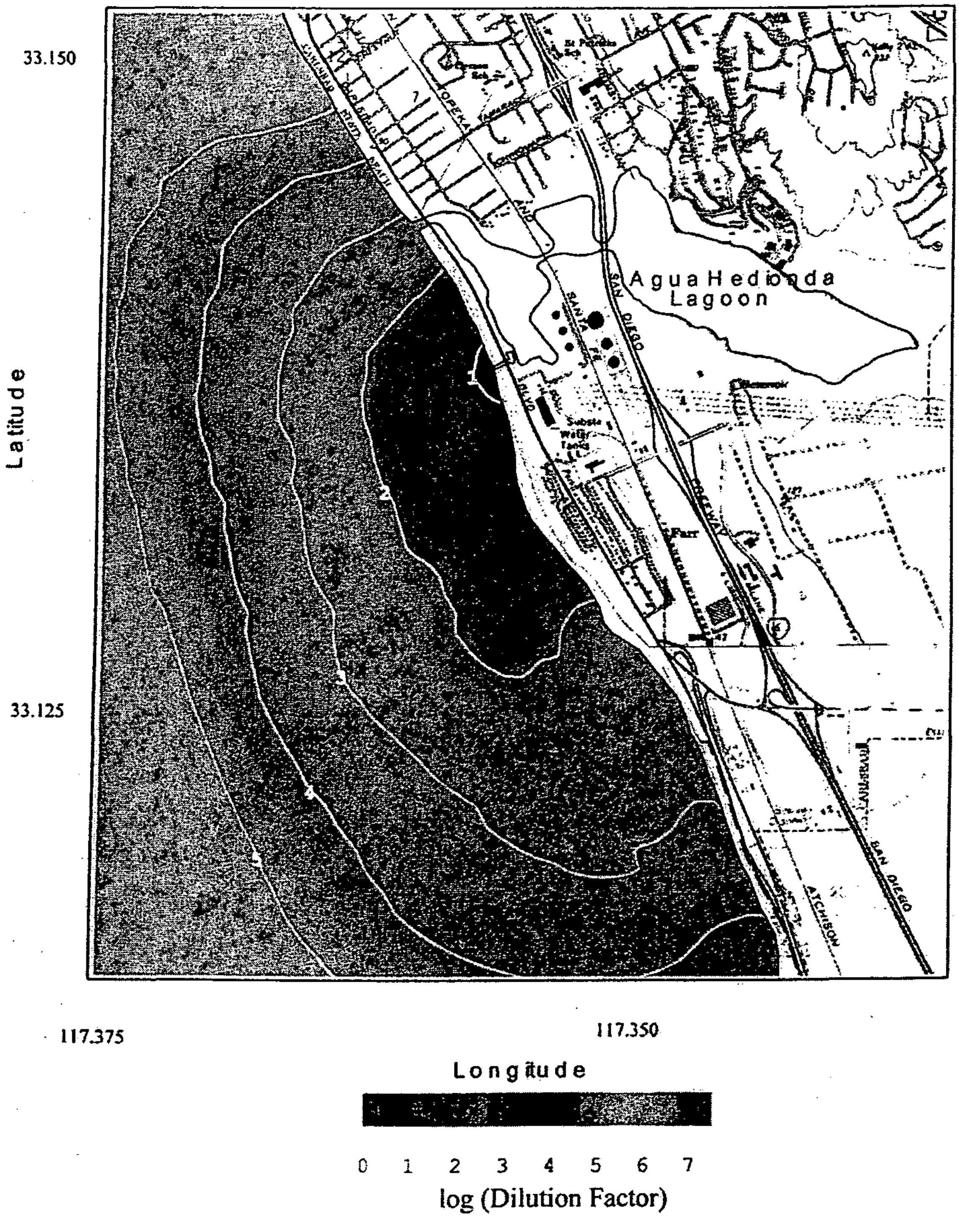


Figure 42. Scenario 5 average case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Seafloor dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May 1994.

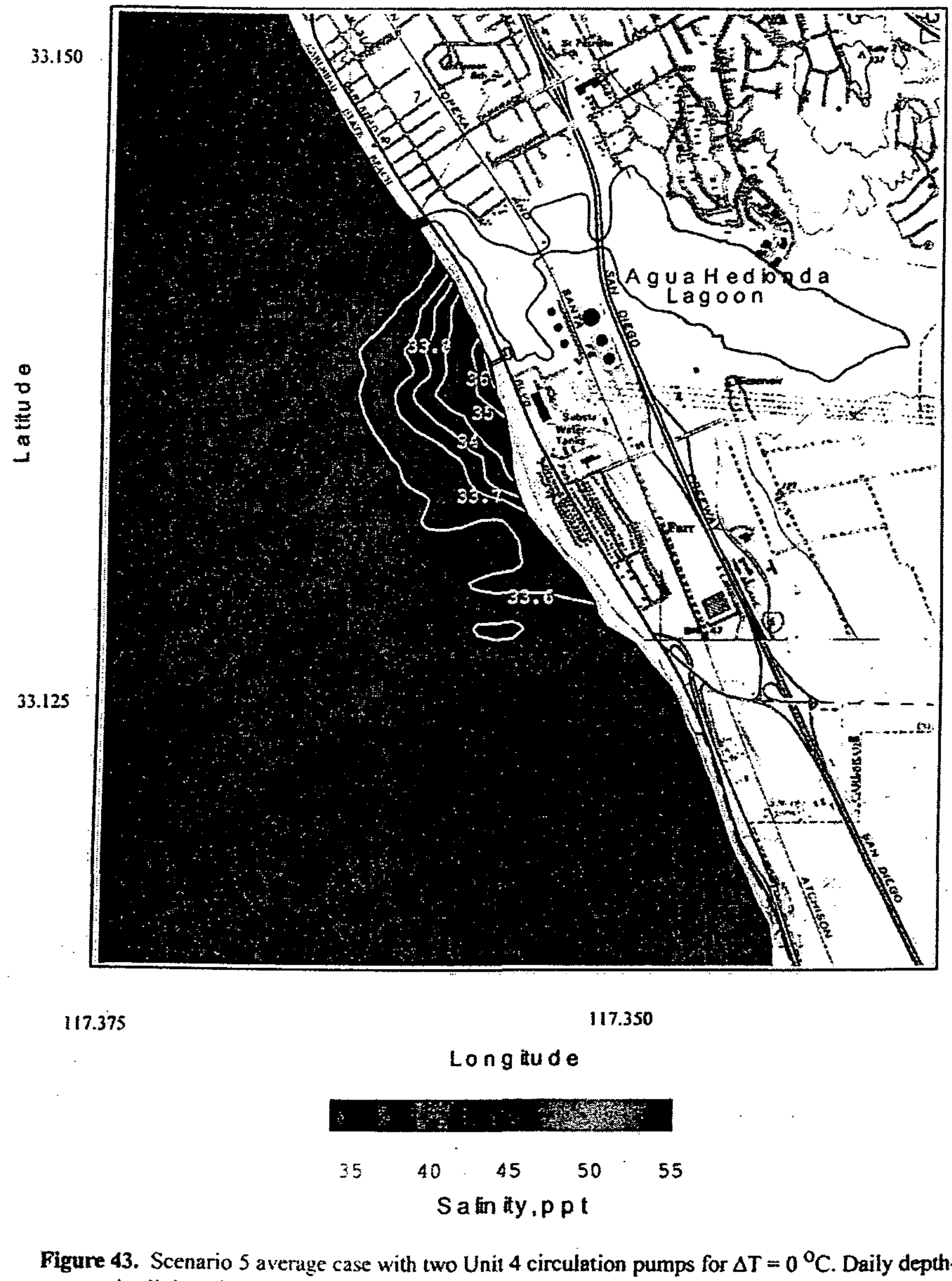


Figure 43. Scenario 5 average case with two Unit 4 circulation pumps for ΔT = 0 °C. Daily depth-averaged salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May 1994.

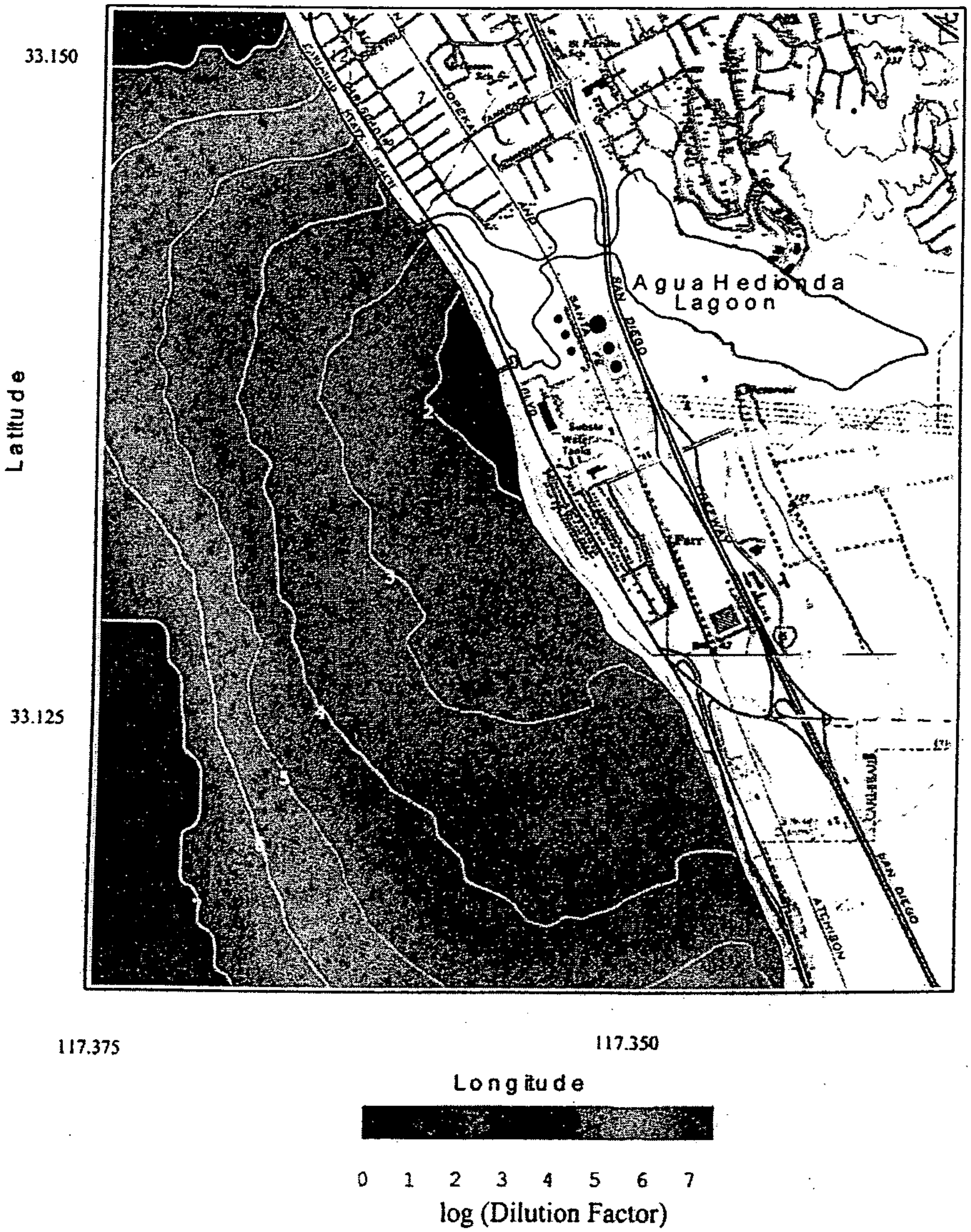


Figure 44. Scenario 5 average case with two Unit 4 circulation pumps for $\Delta T = 0\ ^{o}C$. Depth-averaged dilution factor for raw concentrate from desalination. R.O. = 50 mgd, plant inflow rate = 304 mgd, combined discharge = 254 mgd, ambient ocean salinity = 33.52 ppt, ocean conditions, 23 May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

ATTACHMENT 4

UPDATED IMPINGEMENT AND ENTRAINMENT ASSESSMENT

TENERA ENVIRONEMNTAL, MAY 2007

TENERA Environmental

CARLSBAD SEAWATER DESALINATION PROJECT

Technical Memorandum

ASSESSMENT OF POTENTIAL IMPINGEMENT AND ENTRAINMENT ATTRIBUTED TO DESALINATION PLANT OPERATIONS AND ASSOCIATED AREA OF PRODUCTION FORGONE

Prepared

By Tenera Environmental, Inc.

For

Poseidon Resources Channelside, LLC

May 2007

INTORDUCTION

The purpose of this technical memorandum (TM) is to present an estimate to of the maximum impingement and entrainment of marine organisms that could be attributed to the operations of the 50 MGD Carlsbad Seawater Desalination Facility (CDF) based on the most recent data collection study completed during the period of June 1, 2004 to May 31, 2005 at the Encina Power Generation Station (EPS). This memorandum also provides an estimate of the maximum area (acreage) of production forgone (APF) associated with the operation of the intake of the desalination plant under a stand-alone operational condition, when the plant collects 304 MGD of seawater through the existing system of the EPS to produce 50 MGD of drinking water and the power plant does not generate energy.

The data collected during the June'04/May'05 period and used for this study represent the most contemporary data on entrainment and impingement applicable to the CDF project. These impingement and entrainment data were collected in accordance with a published study plan (see Appendix 1), which plant was reviewed and approved by the San Diego Regional Water Quality Control Board, representatives of the California Department of Fish and Game, the National Marine Fisheries Service, and by an EPA-appointed independent consultant. The study plan, as appended to this technical memorandum, includes a review of the previous impingement and entrainment study results and methods completed in 1980 and a rationale, plan, and methods for completion of the 2004/2205 study results of which are used in this memorandum.

ASSESSMENT OF ENTRAINMENT EFFECT AND APF

The analysis presented in this TM employed entrainment impacts expressed as proportional losses as calculated using the empirical transport modeling (ETM) method (see Appendix 1- Study Plan, for description of model and formula). The ETM method is widely approved by numerous State and Federal agencies, and ETM results have been employed recently by these agencies in combination with an mitigation method referred to as area of production foregone (APF), as is also done in this TM.

All of the ETM values computed for this analysis were based on a total flow of 304 mgd collected through the existing EPS intake system. Of this total flow of 304 mgd, an average of 104 mgd would be used for production of drinking water and 200 mgd for dilution of concentrated seawater. The results of the ETM calculations are summarized in Table 1.

Table 1. ETM values for Encina Power Station larval fish entrainment for the period of 01 Jun 2004 to 31 May 2005, based on steady annual intake flow of 304 mgd.

	ETM Estimate	ETM Std.Err.	ETM + SE	ETM - SE
ETM Model Data for 3070 - Gobies	0.21599	0.30835	0.52434	-0.09236
ETM Model Data for 1495 - Blennies	0.08635	0.1347	0.22104	-0.04835
ETM Model Data for 1849 - Hypsopops	0.06484	0.13969	0.20452	-0.07485
AVERAGE	**0.122393**			
ETM Model Data for 3062 – White Croaker	0.00138	0.00281	0.00419	-0.00143
ETM Model Data for 1496 – Northern Anchovy	0.00165	0.00257	0.00422	-0.00092
ETM Model Data for 1219 – California Halibut	0.00151	0.00238	0.00389	-0.00087
ETM Model Data for 1471 - Queenfish	0.00365	0.00487	0.00852	-0.00123
ETM Model Data for 1494 – Spot Fin Croaker	0.00634	0.01531	0.02165	-0.00896
AVERAGE	**0.002906**			

The average ETM for the three most commonly entrained species living in Agua Hedionda Lagoon (gobies, blennies and hypsopops) of 0.122393 (i.e., 12.2 %) was used to assess the potential area of impact of the intake operations. This approach makes it possible to establish a definitive habitat value for the source water, and is consistent with the approach taken by the California Energy Commission and their independent consultants for the Morro Bay Power Plant (MBPP) in assessing and mitigating the entrainment effects of the proposed combined cycle project. In this case, as is the case at the CDF and EPS in Agua Hedionda, the MBPP is located inside the harbor near the bay's ocean entrance and the primarily entrained species are bay species of larvae. The average Pm value used was based on the three lagoon species was 12.2 % (0.122393 was rounded to 12.2 % to reflect the accuracy of data collection).

In order to calculate the Area of Production Foregone (in acres), the number of lagoon habitat acres used by the three most commonly entrained lagoon species was multiplied by the average Pm of the three species. The estimated acres of lagoon habitat for these species are based on a 2000 Coastal Conservancy inventory of Agua Hedionda Lagoon habitat (see Table 2).

Table 2. Wetland Profile: Agua Hedionda Lagoon[1]

Approximate Wetland Habitat Acreage 330 (11)
Approximate Historic Acreage 695

Habitat	Acres	Vegetation	Source
Brackish/ Freshwater	3	Cattail, bulrush and spiny rush were dominant	(11[2], 1[3])
Mudflat/Tidal Channel	49	Not specified	(1)
		Estuarine flats	
Open Water	253	Eelgrass occurred in all basins	(11,1)
Riparian	11	Not specified	(11)
Salt Marsh	14	(11,1)	
Upland	61	(11)	
	391	(brackish/freshwater, riparian, saltmarsh and upland not included)	

The calculation of APF (acres of lagoon habitat, Table 2, multiplied by the average Pm, Table 1) excluded the lagoon's acres of upland habitat (61 acres), riparian habitat (11 acres), salt marsh habitat (14 acres) and brackish/freshwater habitat (3 acres), a total of 89 acres. These habitats were excluded from the estimate because they would not contribute to the species that were found to be entrained by the EPS intake. Using the average Pm value of 12.2 % for the three lagoon species of entrained larvae and the estimated 302 acres of Agua Hedionda habitat supporting these species' larval populations, the APF value is 36.8 acres (302 acres x 0.122 = 36.8 acres).

IMPINGEMENT ASSESSMENT

A number of juvenile and adult fishes and other marine life are impinged on the existing screens across the intake flow. The amount of impinged organisms generally varies with the amount of flow, but it not in a direct or linear manner. The daily biomass of

2 MEC Analytical Systems Inc.. 1993. San Dieguito Lagoon restoration project Lagoon restoration project regional coastal lagoon resources summary.56 pp and appendix. This report provides a summary of habitat types, fish, bird and benthic invertebrate populations at 16 coastal wetlands south of Anaheim Bay. It is primarily a synopsis of existing information; sources used in identifying and quantifying habitat types include aerial photographs taken in early 1993. It discusses restoration of habitats at San Dieguito Lagoon given present and historic conditions of other coastal wetlands in the region. This report was prepared as part of the San Dieguito Restoration Project undertaken by Southern California Edison to mitigate for damage to coastal marine resources from the operation of the San Onofore Nuclear Generating Station.

3 MEC Analytical Systems Inc.. 1995. *1994* and *1995* field survey report *of* the ecological resources ofAgua Hedionda Lagoon.47 pp., plus appendices.*This report summarizes the results offield surveys conducted between April 1994 and June 1995 at Agua Hedionda Lagoon. The surveys collected data on eelgrass, salt marsh vegetation, birds, fish, and benthic invertebrates. Data were also collected for water quality. The surveys were designed to provide adequate environmental information to support agency review of a dredging project. The survey design and methods were developed in consultation with state andfederal regulatory agencies.*

impinged fish during normal power plant operations declined from the previous February 1979 to January1980 study that reported a rate of 2.46 kg/day, to impingement rates during June 2004 to June 2005 of 0.96 kg/day. The results of the June 2004 to June 2005 impingement study are summarized in Table 3 for the abundance and weight of sampled fish. Table 3 pr esents impingement losses during both normal operations and heat treatment operations. It should be noted that as described in the certified Environmental Impact Report for the Carlsbad seawater desalination project, the desalination plant will be shut down during periods of tunnel heat treatment. Therefore, the desalination plant operations do not contribute to the heat-treatment related impingement losses. The results of the 2004-2005 impingement survey indicate that by not heat treating CDF will reduce the number of impinged fish sampled by approximately 80 percent and the weight of impinged fish sampled by approximately 83 percent.

Analysis of the impingement data presented in Table 3 indicates that the impingement effect attributed to the desalination plant operation would be minimal. The total daily weight of the impinged marine organisms when the desalination plant is operating on a stand-alone basis at 304 MGD and the power plant is not operating is estimated at 1.92 lbs/day (0.96 kg/day). To put this figure in perspective, it is helpful to note that 1.92 lbs/day of impinged organisms represents 0.0000001 percent of the total volume of material flowing through the intake.

TABLE 3 Number and weight of fishes, sharks, and rays impinged during normal operation and heat treatment surveys at EPS from June 2004 to June 2005.

			Normal Operations Sample Totals				Heat Treatment	
	Taxon	**Common Name**	**Sample Count**	**Sample Weight (g)**	**Bar Rack Count**	**Bar Rack Weight (g)**	**Sample Count**	**Sample Weight (g)**
1	*Atherinops affinis*	topsmelt	5,242	42,299	10	262	15,696	67,497
2	*Cymatogaster aggregata*	shiner surfperch	2,827	28,374	-	-	18,361	196,568
3	*Anchoa compressa*	deepbody anchovy	2,079	11,606	2	21	23,356	254,266
4	*Seriphus politus*	queenfish	1,304	7,499	2	17	929	21,390
5	*Xenistius californiensis*	salema	1,061	2,390	-	-	1,577	6,154
6	*Anchoa delicatissima*	slough anchovy	1,056	3,144	-	-	7	10
7	Atherinopsidae	silverside	999	4,454	-	-	2,105	8,661
8	*Hyperprosopon argenteum*	walleye surfperch	605	23,962	1	21	2,547	125,434
9	*Engraulis mordax*	northern anchovy	537	786	-	-	92	374
10	*Leuresthes tenuis*	California grunion	489	2,280	-	-	7,067	40,849
11	*Heterostichus rostratus*	giant kelpfish	344	2,612	-	-	908	9,088
12	*Paralabrax maculatofasciatus*	spotted sand bass	303	4,604	-	-	1,536	107,563
13	*Sardinops sagax*	Pacific sardine	268	1,480	-	-	6,578	26,266
14	*Roncador stearnsi*	spotfin croaker	182	8,354	2	3,000	106	17,160
15	*Paralabrax nebulifer*	barred sand bass	151	1,541	-	-	1,993	32,759

16	*Gymnura marmorata*	Calif. butterfly ray	146	60,629	1	390	70	36,821
17	*Phanerodon furcatus*	white surfperch	144	4,686-	-		53	823
18	*Strongylura exilis*	California needlefish	135	6,025-	-		158	11,899
19	*Paralabrax clathratus*	kelp bass	111	680-	-		976	13,279
20	*Porichthys myriaster*	specklefin midshipman	103	28,189-	-		218	66,860
21	unidentified chub	unidentified chub	96	877-	-		7	44
22	*Paralichthys californicus*	California halibut	95	1,729-	-		21	4,769
23	*Anisotremus davidsoni*	sargo	94	1,662-	-		963	68,528
24	*Urolophus halleri*	round stingray	79	20,589-	-		1,090	300,793
25	*Atractoscion nobilis*	white seabass	70	11,295	6	872	1,618	332,056
26	*Hypsopsetta guttulata*	diamond turbot	66	10,679	1	85	112	24,384
27	*Micrometrus minimus*	dwarf surfperch	57	562-	-	-	-	
28	*Syngnathus spp.*	pipefishes	55	161-	-		56	90
29	*Atherinopsis californiensis*	jacksmelt	54	1,152-	-		4,468	45,152
30	*Myliobatis californica*	bat ray	50	19,899	4	5,965	132	68,572
31	*Menticirrhus undulatus*	California corbina	43	1,906-	-		16	4,925
32	*Amphistichus argenteus*	barred surfperch	43	1,306-	-		34	2,528
33	*Fundulus parvipinnis*	California killifish	43	299-	-		16	41
34	unidentified fish, damaged	unid. damaged fish	36	1,060	1	70	8	262
35	Ictaluridae	catfish unid.	35	4,279-	-	-	-	
36	*Leptocottus armatus*	Pacific staghorn sculpin	32	280-	-		5	26
37	*Sphyraena argentea*	California barracuda	29	397-	-		46	1,667
38	*Lepomis cyanellus*	green sunfish	29	1,170-	-	-	-	
39	*Umbrina roncador*	yellowfin croaker	28	573-	-		127	22,399
40	*Lepomis macrochirus*	bluegill	20	670-	-	-	-	
41	*Ophichthus zophochir*	yellow snake eel	18	5,349-	-		51	17,303
42	*Citharichthys stigmaeus*	speckled sanddab	17	62-	-		1	30
43	*Brachyistius frenatus*	kelp surfperch	16	182-	-		17	598
44	*Cheilotrema saturnum*	black croaker	15	103-	-		288	9,029
45	*Embiotoca jacksoni*	black surfperch	14	1,240-	-		69	5,367
46	*Genyonemus lineatus*	white croaker	12	171-	-		9	79
47	*Platyrhinoidis triseriata*	thornback	11	4,731	1	1,500-	-	
48	*Chromis punctipinnis*	blacksmith	10	396-	-		151	4,431
49	unidentified fish	unidentified fish	10	811-	-	-	-	
50	*Porichthys notatus*	plainfin midshipman	9	1,792-	-	-	-	
51	*Hermosilla azurea*	zebra perch	9	1,097-	-		62	3,518
52	*Micropterus salmoides*	large mouth bass	9	27-	-	-	-	
53	*Trachurus symmetricus*	jack mackerel	7	7-	-		15	702
54	*Hypsoblennius gentilis*	bay blenny	7	37-	-		440	2,814
55	*Heterostichus* spp.	kelpfish	7	48-	-	-	-	
56	Engraulidae	anchovies	6	3-	-	-	-	
57	*Anchoa* spp.	anchovy	6	27-	-	-	-	
58	*Peprilus simillimus*	Pacific butterfish	5	91-	-		1	33
59	*Rhacochilus vacca*	pile surfperch	4	915-	-	-	-	
60	*Sebastes atrovirens*	kelp rockfish	4	40-	-	-	-	
61	*Pleuronichthys verticalis*	hornyhead turbot	4	190-	-		2	251
62	*Pylodictis olivaris*	flathead catfish	4	480-	-	-	-	
63	Pleuronectiformes unid.	flatfishes	4	62-	-	-	-	
64	*Syngnathus leptorhynchus*	bay pipefish	3	9-	-	-	-	

65	*Hypsoblennius gilberti*	rockpool blenny	3	16	-	-	8	77
66	*Mustelus californicus*	gray smoothhound	3	1,850	-	-	22	19,876
67	*Cheilopogon pinnatibarbatus*	smallhead flyingfish	3	604	-	-	-	-
68	*Ameiurus natalis*	yellow bullhead	3	220	-	-	-	-
69	*Lepomis* spp.	sunfishes	3	196	-	-	-	-
70	*Girella nigricans*	opaleye	2	346	-	-	355	30,824
71	*Rhinobatos productus*	shovelnose guitarfish	2	461	2	6,200	-	-
72	*Acanthogobius flavimanus*	yellowfin goby	2	55	-	-	-	-
73	*Scomber japonicus*	Pacific mackerel	2	10	-	-	15	880
74	*Hypsoblennius* spp.	blennies	2	11	-	-	113	489
75	*Hypsoblennius jenkinsi*	mussel blenny	2	17	-	-	175	946
76	*Paralabrax* spp.	sand bass	2	2	-	-	6	19
77	*Scorpaena guttata*	Calif. scorpionfish	2	76	-	-	-	-
78	*Hyporhamphus rosae*	California halfbeak	2	23	-	-	1	-
79	*Symphurus atricauda*	California tonguefish	2	15	-	-	-	-
80	*Tilapia* spp.	tilapias	2	7	-	-	-	-
81	*Sarda chiliensis*	Pacific bonito	2	1,010	-	-	2	540
82	*Albula vulpes*	bonefish	2	1,192	-	-	1	900
83	Sciaenidae unid.	croaker	2	3	-	-	17	1,212
84	*Oxylebius pictus*	painted greenling	1	5	-	-	-	-
85	*Lyopsetta exilis*	slender sole	1	26	-	-	-	-
86	*Citharichthys sordidus*	Pacific sanddab	1	1	-	-	-	-
87	*Gibbonsia montereyensis*	crevice kelpfish	1	8	-	-	-	-
88	*Pleuronichthys ritteri*	spotted turbot	1	7	-	-	13	2,745
89	*Gillichthys mirabilis*	longjaw mudsucker	1	34	-	-	-	-
90	*Dorosoma petenense*	threadfin shad	1	3	-	-	-	-
91	*Porichthys* spp.	midshipman	1	200	-	-	-	-
92	*Cynoscion parvipinnis*	shortfin corvina	1	900	-	-	-	-
93	*Mugil cephalus*	striped mullet	1	3	-	-	5	3,854
94	*Paraclinus integripinnis*	reef finspot	1	4	-	-	4	12
95	*Hyperprosopon* spp.	surfperch	1	115	-	-	7	552
96	*Ameiurus nebulosus*	brown bullhead	1	100	-	-	-	-
97	*Micropterus dolomieu*	smallmouth bass	1	150	-	-	-	-
98	*Citharichthys* spp.	sanddabs	-	-	-	-	1	3
99	*Triakis semifasciata*	leopard shark	-	-	-	-	2	688
100	*Medialuna californiensis*	halfmoon	-	-	-	-	53	1,864
101	*Torpedo californica*	Pacific electric ray	-	-	1	3,750	-	-
102	Scorpaenidae	scorpionfishes	-	-	-	-	2	64
103	*Halichoeres semicinctus*	rock wrasse	-	-	-	-	1	33
104	*Hypsypops rubicundus*	garibaldi	-	-	-	-	5	1,897
105	*Seriola lalandi*	yellowtail jack	-	-	-	-	21	978
106	*Dasyatis dipterura*	diamond stingray	-	-	-	-	2	1,468
107	*Heterodontus francisci*	horn shark	-	-	-	-	1	850
108	Zoarcidae	eelpouts	-	-	-	-	1	17
			19,408	351,672	34	22,152	94,991	2,034,900

ATTACHMENT 5

PROPOSAL FOR INFORMATION COLLECTION
CLEAN WATER ACT SECTION 316(B)

ENCINA POWER STATION
CABRILLO POWER I LLC

NPDES PERMIT NO. CA0001350

APRIL 1, 2006

PROPOSAL FOR INFORMATION COLLECTION
CLEAN WATER ACT SECTION 316(B)

ENCINA POWER STATION
CABRILLO POWER I LLC

NPDES PERMIT NO. CA0001350

Project No. 1009704003

April 1, 2006

Prepared for:

Cabrillo Power I LLC
4600 Carlsbad Boulevard
Carlsbad, CA 92008

Prepared by:

Shaw® Shaw Environmental & Infrastructure, Inc.
3347 Michelson Drive, Suite 200
Irvine, CA 92612-1692

TENERA Environmental
Tenera Environmental
141 Suburban Rd.
Suite A2
San Luis Obispo, CA 93401

Table of Contents

Table of Contents (continued)

List of Figures

List of Tables

Table of Contents (continued)

List of Attachments

Acronyms and Abbreviations

AEL	Adult Equivalent Loss
AFC	Application for Certification
AHL	Agua Hedionda Lagoon
amsl	above mean sea level
BTA	Best Technology Available
CCC	California Coastal Commission
CDFG	California Department of Fish & Game
CDS	Comprehensive Demonstration Study
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
CWIS	Cooling Water Intake Structure
DCTP	Design & Construction Technology Plan
E	entrainment
EAM	Equivalent Adult Model
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPS	Encina Power Station
ETM	Empirical Transport Model
FH	Fecundity Hindcasting
F&WS	Fish and Wildlife Service

Acronyms and Abbreviations (continued)

fps	feet per second
gpm	gallons per minute
HEA	Habitat Equivalency Analysis
hrs	hours
IM&E	Impingement Mortality and/or Entrainment
JWPCP	Joint Water Pollution Control Plant
MBC	MBC Applied Environmental Sciences
MGD	million gallons per day
mi	miles
min	minute
MLES	Marine Life Exclusion System
MLLW	mean lower low water
mm	millimeter
MW	megawatt
N	North
NMFS	National Marine Fisheries Service
NOAA	National Oceanic & Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRDA	National Resources Defense Council
O&M	Operation and Maintenance
OBGS	Ormond Beach Generating Station
PIC	Proposal for Information Collection
psig	pounds per square inch gauge
QA/QC	Quality Assurance/Quality Control
RP	Restoration Plan
SAP	sampling and analysis plan
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric Company
SDRWQCB	San Diego Regional Water Quality Control Board
SGS	Scattergood Generating Station
TAG	Technical Advisory Group
TDD	Technical Development Document
TIOP	Technology Installation & Operation Plan
USFWS	U.S. Fish & Wildlife Service
W	West
y^3	cubic yard
°F	degrees Fahrenheit

1.0 Introduction

Section 316(b) of the Clean Water Act (CWA) requires that the location, design, construction, and capacity of cooling water intake structures (CWIS) reflect the best technology available (BTA) to minimize adverse environmental impacts due to the impingement (IM) of aquatic organisms (i.e., fish, shellfish, and other forms of aquatic life) on intake structures and the entrainment (E) of eggs and larvae through cooling water systems. On July 9, 2004, the U.S. Environmental Protection Agency (EPA) promulgated regulations in the Federal Register applicable to large existing power plants (Phase II facilities) that use large amounts of cooling water. These regulations, published in the Code of Federal Regulations (CFR) Chapter 40 Part 125 Subpart J, became effective on September 7, 2004.

The Phase II regulations establish performance standards for CWIS of existing power plants that withdraw more than 50 million gallons per day (MGD) of surface waters and use more than 25 percent of the withdrawn water for cooling purposes. The new rule requires all large existing power plants to reduce impingement mortality by 80 – 95 percent and to reduce the number of smaller aquatic organisms drawn through the cooling system by 60 – 90 percent. The water body type on which the facility is located, the capacity utilization rate, and the magnitude of the design intake flow relative to the waterbody flow determine whether a facility will be required to meet the performance standards for IM or both IM&E. The final rule allows these performance standards to be met through using a combination of the existing intake design, additional intake technologies, operational modifications, and using restoration measures. This approach also provides flexibility by allowing site-specific performance standards, if economic conditions do not justify the full cost of meeting the standards.

The EPA 316(b) Phase II rule requires that each affected facility develop and submit a *Proposal for Information Collection (PIC)* to the applicable permitting agency prior to implementation of data collection activities. The PIC must include the following key elements:

- A description of the proposed and/or implemented technologies, operational measures, and/or restoration measures to help develop a compliance strategy to meet the performance standards;
- A description of any historical studies characterizing IM&E and/or the physical and biological conditions in the vicinity of the CWIS and their relevance to the proposed study;
- A summary of any past or ongoing consultations with regulatory agencies and other stakeholders that are relevant to the study; and

- A sampling and analysis plan (SAP) for any new field studies needed to estimate IM&E.

This PIC serves as a study plan for a Comprehensive Demonstration Study (CDS), which provides the information to:

- Determine the baseline calculations of IM&E to be compared with performance standards;
- Evaluate combinations of technologies, operational measures and/or restoration measures, which may be implemented to meet the performance standards; and
- Evaluate whether a site-specific BTA determination is warranted and can be justified using a cost/cost or cost/benefit test.

1.1 Regulatory Applicability

The Encina Power Station (EPS) is located adjacent to the *Agua Hedionda Lagoon* (or AHL) on the Pacific Ocean. Because of its location near the ocean, the facility is subject to the following national performance standards (Table 1-1) for the reduction of IM&E resulting from the operation of the CWIS:

Table 1-1
IM&E Performance Standards for Phase II Facilities

Standard	Reduction Requirement
Impingement mortality	80 – 95%
Entrainment	60 – 90%

The EPA 316(b) Phase II rule generally requires that facilities subject to the rule submit the CDS with the application for renewal of the National Pollutant Discharge Elimination System (NPDES) permit. Facilities with NPDES permits expiring prior to July 9, 2008 may request an extension for submittal of the CDS no later than January 7, 2008. The current EPS NPDES permit has expired on February 5, 2005. A timely application for renewal was submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) on June 23, 2004. The EPS has submitted a letter to the SDRWQCB on January 6, 2005 requesting the following schedule for submittal of the two reports required under the EPA 316(b) Phase II Rule:

- Proposal for Information Collection – submittal due April 1, 2006
- Comprehensive Demonstration Study – submittal due January 7, 2008

1.2 Purpose

The purpose of this document is to meet or exceed the requirement for the preparation and submittal of the PIC in accordance with 40 CFR 125.95(b)(1). This Plan is being submitted for agency review and comment in advance of implementation. However, information collection activities may be initiated prior to receipt of agency comments.

2.0 Facility Description

The EPS has been owned and operated by Cabrillo Power I LLC (Cabrillo) since May 22, 1999. The power plant was previously owned by San Diego Gas and Electric Company (SDG&E).

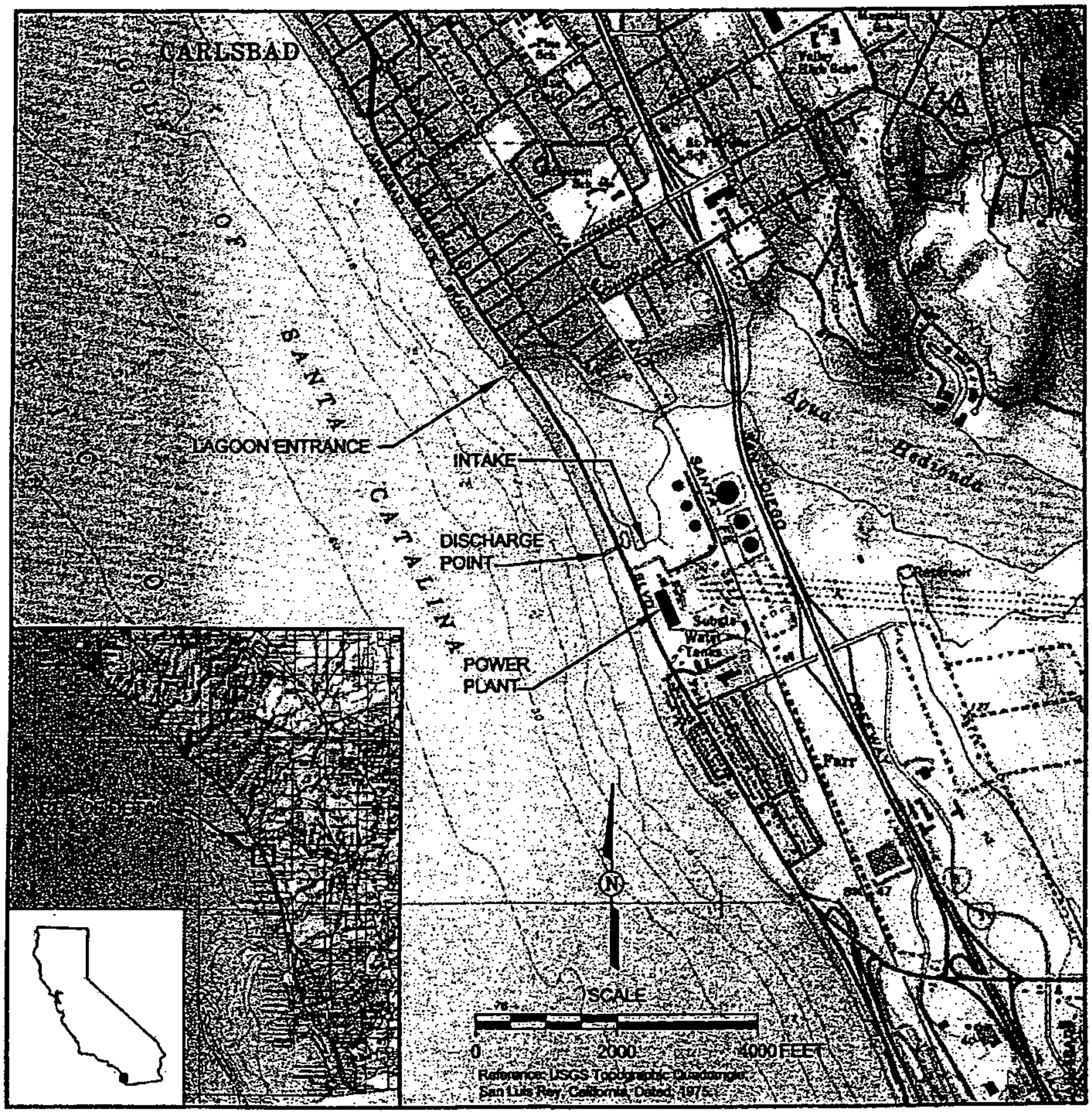
The EPS is a fossil-fueled steam electric power generating station that began operation in 1954. Thermal energy provided by the combustion of the fossil-fuels is used to generate steam to drive five steam turbine generators. The plant also has one air-cooled gas turbine generator achieving a combined nominal thermal energy output capacity for the plant of 939 megawatts. Waste heat generated at EPS is discharged to the Pacific Ocean. The combined cooling and service water design flow is 857.29 MGD.

Cooling water is withdrawn from the Pacific Ocean via the AHL. The cooling water intake structure complex is located approximately 2200 feet from the ocean inlet to the lagoon. Variations in the water surface due to tide range from a low of –3.52 feet to a high of +4.79 feet [elevation "0" being mean sea level, (msl)], based on measurements made by Coastal Environments (2005). The intake structure is located in the lagoon, in front of the generating units.

2.1 Facility Location

The EPS is located at 4600 Carlsbad Boulevard, in the southwest area of the City of Carlsbad, California, adjacent to the AHL on the Pacific Ocean in Section 18, Township 12 South, Range 4 West of the San Bernardino Baseline Meridian. Figure 2-1 depicts the location of the facility and the location of the cooling water intake and discharge points relative to the shoreline.

Figure 2-1
Encina Power Station Location Map



2.2 Source Water Body Description

The environmental setting of AHL, the primary source water body for the EPS, is discussed in detail in Bradshaw et al (1976), SDG&E (1980), and summarized in EA Engineering, Science and Technology (1997). The following is a description of the physical and ecological characteristics of the AHL, on which the EPS is located.

2.2.1 Physical Characteristics

Agua Hedionda is the third largest watershed within the Carlsbad Hydrologic Unit. The watershed, dominated by Agua Hedionda Creek, extends approximately 10.62 miles (mi) inland from the coast and is about 18,837 acres in area, comprising 14 percent of the Carlsbad Hydrologic Unit. Agua Hedionda Creek originates on the southwestern slopes of the San Marcos Mountains in west central San Diego County and discharges into the Pacific Ocean via AHL. The highest elevation within the watershed is 1,500 feet above mean sea level (amsl), located in the San Marcos Mountains.

The EPS is located on the AHL, which is a man-enhanced coastal lagoon that extends 1.7 mi inland and is up to 0.5 mi wide. The lagoon is located along the Pacific Coast in San Diego County approximately 26 mi north of the City of San Diego. The lagoon was constructed in 1954 to provide cooling water for the power plant. The construction enhancement involved a permanent opening of the connection of the lagoon with the ocean. Prior to this, the lagoon was ephemerally connected to the ocean when creek flows were high. A railroad trestle and the Interstate Highway 5 bridge separate AHL into three interconnected segments: an Outer, Middle, and Inner lagoon. The surface areas of the Outer, Middle, and Inner lagoons are 53, 24, and 190 acres, respectively based on measurements made by Coastal Environments (2005). The lagoon is separated from the ocean by Carlsbad Boulevard and a narrow inlet 151 feet wide and 9 feet deep at the northwest end of the Outer Lagoon that passes under the highway and allows tidal exchange of water with the ocean.

Circulation and input into AHL is dominated by semi-diurnal tides that bring approximately 1,454 acre feet of seawater through the entrance to the Outer Lagoon on flood tides based on measurements made by Coastal Environments (2005). Approximately half of this tidal volume flows into the Middle and Inner lagoons. On ebb tides this same tidal volume flows out through the entrance to the ocean. As a result of this tidal flushing, the lagoon is largely a marine environment. Although freshwater can enter the lagoon through Agua Hedionda Creek, which drains an 18,500 acre watershed, for most of the year freshwater flow is minimal. Heavy rainfall in the winter can increase freshwater flows, reducing salinity, especially in the Inner Lagoon. The lagoon system is kept open to the ocean by routine dredging of the Outer Lagoon and the channel to the ocean.

Bottom sediments in the lagoon reflect the speed and location of the periodic tidal currents. The Outer Lagoon sediments consist of coarser gravel and sands in areas of highest current velocities. The Middle Lagoon consists of an inter-tidal zone largely comprised of mud. The largest water body segment, the Inner Lagoon, consists of mostly finer sands, silt, and clay with organic detritus, especially at the far eastern end of the lagoon. Some narrow sand beaches and rock rip-rap substrate are also present in the Inner Lagoon.

AHL is tidally flushed through the small inlet in the Outer Lagoon by waters from the Pacific Ocean. The physical oceanographic processes of the southern California Bight that influence the lagoon includes, the tides, currents, winds, swell, temperature, dissolved oxygen, salinity, nutrients. These are most affected by the daily tidal exchange of coastal seawater. Near the mouth of the lagoon the mean tide range is 3.7 feet with a diurnal range of 5.3 feet. Waves breaking on the shore generally range in height from 2 to 4 feet, although larger waves (6 to 10 feet) are not uncommon. Larger waves exceeding 15 feet occur infrequently and are usually associated with winter storms. Surface water in the local area ranges from a minimum of 57 degrees Fahrenheit (°F) to a maximum of 72°F with an average annual temperature between 63°F and 66°F.

2.2.2 Agua Hedionda Lagoon Ecological Characteristics

The AHL is listed by the State of California as a Section 303(d) impaired waterbody largely due to sedimentation/siltation and coliform contamination resulting from multiple non-point source discharges in Agua Hedionda watershed. Sedimentation of the lagoon can occur both from sediment flows within the watershed and from tidal flows from the Pacific Ocean. The bacterial contamination is likely from multiple sources within the watershed.

In November of 2000, the U. S. Fish and Wildlife Service (F&WS), under the Endangered Species Act of 1973, as amended, designated AHL as critical habitat for the tidewater goby (*Eucyclogobius newberryi*), a federally listed endangered species. However, no tidewater gobies have been observed in the AHL since the 1950's when the lagoon was originally dredged as the power plant cooling water source and the lagoon is no longer viable habitat for the species. Based on that fact, Cabrillo Power I LLC filed for declaratory and injunctive relief in federal district court on August 31, 2001, against the F&WS for failing to base the AHL and Creek critical habitat designation on best scientific data and failing to analyze the economic and other impacts of the designation. On February 28, 2003, based upon a stipulated settlement, the United States District Court ordered that the tidewater goby critical habitat designation for AHL and Creek be vacated without prejudice.

Land use within the watershed is dominated by urban development. Natural habitats are scattered and occur in a matrix of agricultural and urban development, however, several relatively large patches of native vegetation occur in the eastern portion of the watershed and in the central area just inland from AHL.

A study on the ecological resources of Agua Hedionda showed that it has good water quality and supports diverse benthic infauna, bird, and fish communities (MEC Analytical 1995). Eelgrass was found in all three lagoon segments, but was limited in the Inner Lagoon to depths above approximately –6.5 feet mean lower low water (MLLW) because water turbidity reduced penetration of light for photosynthesis in deeper areas. The eelgrass beds provide a valuable habitat for benthic organisms that are fed upon by birds and fishes. Although eelgrass beds were less well developed in areas of the Inner Lagoon, it was found to provide a wider range of habitats, including mud flats, salt marsh, and seasonal ponds than elsewhere in Aqua Hedionda. As a result, bird and fish diversity was highest in the Inner Lagoon.

A total of 35 species of fishes was found during the 1994 and 1995 sampling conducted by MEC (MEC Analytical 1995). The Middle and Inner lagoons had more species and higher abundances than the Outer Lagoon. During the 1995 survey, only four species were collected in the Outer Lagoon, compared to 14 to 18 species in the Middle and Inner lagoons. Silversides (Atherinopsidae) and gobies (Gobiidae) were the most abundant fishes collected. Silversides, including jacksmelt and topsmelt, that occur in large schools in shallow waters where water temperatures are warmest were most abundant in the shallower Middle and Inner lagoons. Gobies were most abundant in the Inner Lagoon, which has large shallow mudflat areas that are their preferred habitat.

An impingement and entrainment study was conducted at EPS in 1979-1980 (SDG&E 1980). In the impingement study, fishes and invertebrates were collected and quantified from the traveling screens and bar rack system of the power plant. Seventy-six species of fishes, 45 species of macroinvertebrates, and 7 species of algae and marine plants were impinged. There were also seven thermal treatments (intake tunnel heat shock treatments) sampled during the year and 90 percent of the fishes collected consisted of nine species: deepbody anchovy, topsmelt, northern anchovy, shiner surfperch, California grunion, walleye surfperch, queenfish, round stingray, and giant kelpfish.

The recent assessment of the ecological resources of Agua Hedionda (MEC Analytical 1995) did not find any tidewater gobies (*Eucyclogobius newberryi*). This federally endangered species was once recorded as occurring in the lagoon prior to construction of the Outer Lagoon in the early 1950s. The present marine-influenced environment in the lagoon would not tend to support tidewater gobies because they prefer brackish water habitats. No listed fish species were collected in the recent study.

2.2.3 Pacific Ocean Ecological Resources

The outer coast has a diversity of marine habitats and includes zones of intertidal sandy beach, subtidal sandy bottom, rocky shore, subtidal cobblestone, subtidal mudstone and water column. Organisms typical of sandy beaches include polychaetes, sand crabs, isopods, amphipods, and clams. California grunion utilize the beaches around EPS during spawning season from March through August. Numerous infaunal species occur in subtidal sandy bottoms with mollusks, polychaetes, arthropods, and echinoderms comprising the dominant invertebrate fauna. Typical fishes in the sandy subtidal include queenfish, white croaker, several surfperch species, speckled sanddab, and California halibut. Also, California spiny lobster and *Cancer* spp. crabs forage over the sand. Many of the typically outer coast species can occasionally occur within AHL, carried by incoming tidal currents.

The rocky habitat at the discharge canal and on offshore reefs supports various kelps and invertebrates including barnacles, snails, sea stars, limpets, sea urchins, sea anemones, and mussels. Giant kelp (*Macrocystis*) forests are an important community in the area offshore from Agua Hedionda. Kelp beds provide habitat for a wide variety of invertebrates and fishes. The water column and kelp beds are known to support many fish species, including northern anchovy, jack smelt, queenfish, white croaker, garibaldi, rockfishes, kelp bass, white seabass, surfperches, and halibut.

Marine-associated wildlife that occur in the Pacific waters off AHL are numerous and include birds such as brown pelican, surf scoter, cormorants, western grebe, gulls, terns and loons. Marine mammals, including porpoise, sea lions, and migratory gray whales, also frequent the adjacent coastal area.

2.3 Cooling Water Intake Structure Design

Cooling water is withdrawn from the Pacific Ocean via the AHL. The CWIS complex is located approximately 2,200 feet from the ocean inlet to the lagoon. The intake structure is located on the lagoon, to the north of the generating units as shown on Figure A-1 included in Appendix A.

As the water flows into the intake structure, it passes through trash racks made up of metal bars spaced about 3½ inches apart, which prevent passage of large debris into the intake. The trash rack inlet structure is shown on Figure A-2 included in Appendix A. The intake downstream of the trash rack tapers into two, 12-foot wide intake tunnels. From these tunnels, the cooling water enters four six-foot wide conveyance tunnels. Cooling water for conveyance tunnels 1 and 2 passes through one of two vertical traveling screens to prevent fish, grass, kelp, and debris from entering pump intakes for generating units 1, 2, and 3.

Conveyance tunnels 3 and 4 carry cooling water to the intakes for generating units 4 and 5, respectively. Traveling water screens are located at the intake of pump 4 and the intake of pump 5. A detailed plan layout of the entire tunnel system is shown on Figure A-1 included in Appendix A.

Each cooling water intake consists of two circulating water pumps and one or two service pumps. During normal operation, one circulating water pump serves each half of the condenser, so when a unit is generating power, both pumps are in operation.

There are a total of seven traveling screens that remove any debris which has passed through the trash racks. Two screens service the combined flows of generating Units 1, 2, and 3. Unit 4 has two traveling water screens, while Unit 5 has three traveling water screens. The screens are conventional through-flow, vertically rotating, single entry, band-type screens, mounted in the screen wells of the intake channels. Each screen consists of a series of baskets or screen panels attached to a chain drive. Since the screens are designed to prevent the passage of particles large enough to clog the condenser tubes, the screening surface is made of 3/8-inch meshed stainless steel wire, with the exception of Unit 5 screens, which have 5/8-inch square openings. Cooling water passes through the wire mesh screening surface and floating or suspended matter is retained on the screens. The screens rotate automatically when the debris buildup causes a predetermined pressure differential across the screen (or the difference in sea water level before and after the screen increases to a set level). As the screens revolve, the material is lifted from the front of the intake screenwell by the upward travel of the baskets. The screens travel 3 feet per minute, making one complete revolution in about 20 minutes. A screen wash system in the traveling screen structure provides water (sea water from the intake tunnel) to wash the debris from the traveling screen. At the head of the screen, matter is removed from the baskets by a spray of water, which is evenly distributed over the entire basket width. The jet spray washes the accumulated material into a trough and the trough conveys the debris into debris collection baskets. Accumulated organic debris is discharged to the outfall structure.

Characteristics and specifications of the CWIS are presented in Table 2-1.

Table 2-1
Design Characteristics of EPS Cooling Water Intake Structure

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Latitude	33° 08' 16" N	33° 08' 16" N	33° 08' 16" N	33° 08' 16" N	33° 08' 16" N
Longitude	117° 20' 16" W	117° 20' 16" W	117° 20' 16" W	117° 20' 16" W	117° 20' 16" W
Number of circulating water pumps	2	2	2	2	2
Pump capacity (per pump)	24,000 gpm	24,000 gpm	24,000 gpm	100,000 gpm	104,000 gpm
Service water	3000 gpm	3000 gpm	6000 gpm	13,000 gpm	18,200 gpm
Trash bar opening	3 ½ inch	3 ½ inch	3 ½ inch	3 ½ inch	3 ½ inch
Number of traveling water screens	2 (shared)	2 (shared)	2 (shared)	2	3
Screen type	Standard through flow	Standard through flow	Standard through flow	Standard through flow	Standard through flow
Screen mesh opening	3/8 inch	3/8 inch	3/8 inch	3/8 inch	5/8 inch
Screen height (in water, high tide)	24.8 feet	24.8 feet	24.8 feet	24.8 feet	24.8 feet
Approach velocity (low tide)	1.2 fps	1.2 fps	1.2 fps	1.6 fps	1.1 fps
Through-screen velocity (low tide)	2.1 fps	2.1 fps	2.1 fps	2.9 fps	2.0 fps
Screen rotation	Automatic on ΔP	Automatic on ΔP	Automatic on ΔP	Automatic on ΔP	Automatic on ΔP
Screen wash pressure	70 psig	70 psig	70 psig	70 psig	70 psig

2.4 Cooling Water Intake Structure Operation

During normal operation, one circulating water pump serves each half of the condenser, so when a unit is generating power, both pumps are in operation.

Traveling water screens normally are set on automatic, starting up when the differential pressure across the screen exceeds the set point. At the beginning of each work shift (0600, 1800), the screens are turned on and the automatic start is checked to ascertain that the screens are functioning properly.

The plant produces its own sodium hypochlorite electrolytically from seawater for use in chlorination of the cooling water system. A bromide additive (sodium bromide), which reacts with chlorine to form hypobromous acid, and a bio-dispersant are also used with the sodium hypochlorite as enhancers.

The treatment solution is injected to the channel immediately upstream of the once-through cooling water and saltwater service pump suctions for each unit. Each injection point is individually controlled. Chlorination is conducted for about five minutes per hour per unit on a timed cycle each day. This method of chlorination results in a minimal chlorine residual in the cooling water being discharged to the ocean.

The intake tunnels are thermally treated (tunnel re-circulation) approximately every five weeks. Encrusting organisms in the early stages of development are small enough to pass through the trash racks and screens and enter the intake tunnels, attach themselves to the tunnel walls, traveling water screens, and other parts of the cooling-water system. If not removed, the encrusting organisms grow and accumulate at a rate of approximately 1000 yd^3 over a six-month period. These accumulations restrict the flow of cooling water to and through the condensers, causing a rise in the condenser operating temperature and the temperature of the discharged circulating water. A thermal tunnel re-circulation treatment process prevents encrusting organisms from developing to any significant size or quantity. The treatment causes the encrusting organisms to release from the surfaces and wash through the condensers to the ocean with the circulating water discharge, reducing the need for maintenance outages for normal cleaning of the circulating water inlet tunnels and condensers. This practice also helps to maintain the lowest possible temperature rise across the condensers, thereby improving plant efficiency and reducing thermal load to the ocean.

Thermal treatment is performed by restricting the flow of cooling water from the lagoon and re-circulating the condenser discharge water through the conveyance tunnels and condensers until an inlet water temperature of approximately 105°F is attained. Maintaining a temperature of 105°F in the intake tunnels for approximately two hours has proven to be effective in removing encrusting organisms. The total time required for the thermal treatment operation, including temperature buildup and cool down, is approximately six hours.

2.5 Calculation Baseline

EPA, in its 316(b) Phase II rule for existing facilities, requires reductions in IM&E when compared against a "calculation baseline." This calculation baseline is the level of IM&E that would occur if the CWIS were designed with the following characteristics:

- Once-through cooling system;
- Opening of CWIS located at, and the face of the traveling screens is oriented parallel to, the shoreline near the surface of the source waterbody;

- Conventional traveling screens with 3/8 inch mesh; and
- No structural or operational controls to reduce IM&E.

The EPS intake system is equivalent in terms of entrainment of aquatic organisms and impingement of organisms on screens to the baseline shoreline intake with no fish protection features defined by the Environmental Protection Agency in the new Section 316(b) Phase II Existing Facilities Rule (National Pollutant Discharge Elimination System-Final Regulations). The EPS CWIS design has a few deviations from these baseline conditions. The traveling water screens on Unit 5 have 5/8" screens and each of the 7 sets of traveling water screens are set well back from the shoreline of the lagoon. The recent IM&E study performed at the EPS will provide the necessary information for determining a representative calculation baseline for the station.

3.0 Historical Studies

EPA Phase II 316(b) regulations [40 CFR 125.95(b)(1)(ii)] require that the PIC includes a list and description of any historical studies characterizing IM&E, as well as physical and biological conditions in the vicinity of the facility CWIS. The following sections provide a summary of previous entrainment and impingement studies conducted at the EPS and within AHL.

The following sections also present a discussion of the relevance of the data to the current conditions and the IM&E studies at the EPS.

3.1 EPS Impingement Mortality and Entrainment Characterization Studies

The following sections summarize previous IM&E characterization studies performed at the EPS.

3.1.1 1980 EPS 316(b) Demonstration

In 1980, SDG&E owned and operated the EPS (SDG&E, 1980). A 316(b) demonstration was conducted for the facility (SDG&E 1980) as required at the time by the SDRWQCB. The study included descriptions of the facility, descriptions of the physical and biological environment of AHL and surroundings, studies of entrainment, impingement, and entrainment survival at the plant, and an environmental impact assessment that also evaluated the feasibility of alternative intake technologies to reduce IM&E.

A list of taxa ("critical species") that included 16 fishes, 11 ichthyoplankton, and one zooplankter, were selected based on six criteria and approved by the SDRWQCB for detailed study during the program (Table 3-1). Some additional species that were found to be common in the subsequent sampling were also added to the list. The report reviewed the life histories of the critical species.

3.1.1.1 Entrainment

A one-year entrainment and source water characterization study was conducted beginning in 1979 as part of the 316(b) demonstration studies at the EPS. Plankton samples were collected monthly at five offshore stations using 505 and 335 micron mesh nets attached to a 2 feet diameter bongo net system. Collections were also made monthly in the Middle and Upper lagoon segments and every two weeks in the Outer Lagoon using 1.6 feet diameter nets (505 and 335 micron mesh size). The procedures specified the use of a depressor weight connected to the towing apparatus but there was no indication at what depths the plankton samples were typically taken. Tows were targeted at 10 minutes at a speed of 1.5 to 2 knots. Entrainment samples were also collected every two weeks using a plankton pumping system in front of the intakes.

Although most samples were collected during daylight hours some samples were occasionally taken in the evening or early morning hours.

Table 3-1
Critical Species Studied During 1979-1980

"Critical Species"	Common Name
Adult fishes	
Engraulis mordax	northern anchovy
Atherinops affinis	topsmelt
Paralabrax clathratus	kelp bass
Paralabrax maculatofasciatus	potted sand bass
Paralabrax nebulifer	barred sand bass
Cynoscion nobilis	white seabass
Menticirrhus undulatus	California corbina
Seriphus politus	queenfish
Amphistichus argenteus	barred surfperch
Hyperprosopon argenteum	walleye surfperch
Semicossyphus pulcher	California sheephead
Mugil cephalus	striped mullet
Citharichthys sordidus	Pacific sanddab
Paralichthys californicus	California halibut
Pleuronichthys verticalis	hornyhead turbot
Heterostichus rostratus	giant kelpfish
Ichthyoplankton	
Anchoa compressa	deepbody anchovy
Engraulis mordax	northern anchovy
Cottidae	sculpins
Serranidae	sea basses
Sciaenidae	croakers
Coryphopterus nicholsi	blackeye goby
Gobiidae	gobies
Citharichthys stigmaeus	spotted sanddab
Paralichthys californicus	California halibut
Pleuronectidae	righteye flounders
Hypsopsetta guttulata	diamond turbot
Atherinopsidae	silversides
Zooplankton	
Acartia tonsa	copepods

Anchovies (primarily deep body and northern) were the most abundant larval forms in both the source water and entrainment samples, followed by croakers and sanddabs (Table 3-2). There were fewer fish eggs and more goby larvae in the entrainment samples whereas kelp and sand bass larvae were substantially more abundant in the combined source water samples from the Lagoon and offshore. Overall the average composition between the entrainment and source water data sets were very similar for the ten most abundant taxa. Only English sole, *Parophrys vetulus*, larvae were among the top ten entrainment taxa not represented in the top ten source water taxa.

Table 3-2
Average Annual Densities of the Ten Most Abundant Ichthyoplankton Taxa per 100 m^3 (26,417 gal) In Source Water (lagoon and offshore stations combined) & Entrainment (pump sampling) Collections for 335μ Mesh Nets During 1979

	Taxon	Source Water	Entrainment
anchovies	Engraulidae	952.7	855.2
croakers	Sciaenidae	341.7	400.6
speckled sanddab	*Citharichthys* sp.	73.2	82.7
fish eggs	unidentified fish egg	33.8	20.2
gobies	Gobiidae	29.2	42.9
silversides	Atherinidae	8.3	10.8
wrasses	Labridae	6.4	4.0
combtooth blennies	*Hypsoblennius* sp.	6.1	5.7
sea basses	Serranidae	5.1	0.9
rockfishes	*Sebastes* sp.	2.8	2.5
English sole	*Parophrys vetulus*	0	1.9

Note: English Sole not collected in source waterbody.

Entrainment losses were calculated for each two-week sampling interval by multiplying the average plankton densities at the intake by the volume of cooling water drawn through the plant during that period. Annual, monthly, and daily rates were estimated by averaging the entrainment estimates for all sampling periods and calculating values for the indicated duration. Annual estimates for total zooplankton entrainment were 7.4×10^9 (505μ net data) and 30.9×10^9 (335μ net data) individuals. The copepod *Acartia tonsa* was the most abundant species in the entrainment collections (Table 3-3).

Annual estimates of the abundance of ichthyoplankton entrained through the power plant were 4.15×10^9 (505μ net data) and 6.66×10^9 (335μ net data) individuals per year. Fish eggs comprised 98 percent and 86 percent of the total annual ichthyoplankton entrainment using the 505μ and 335μ net estimates, respectively. Through-plant entrainment mortality was assumed to be 100% for larvae and 60% for eggs based on survival experiments that were conducted. The report presented average annual densities of the critical species by net type and daily entrainment estimates for selected plankton groups (Table 3-3).

Table 3-3
Average Daily Entrainment Estimates at EPS Based On Daily Plant Circulating Water Flow of 795 MGD

	Daily Entrainment		Mean Percent
Plankton Group	335 μ	505 μ	of Total
Acartia tonsa (copepod)	4.77×10^7	7.63×10^6	41.2%
fish eggs	1.57×10^7	1.11×10^7	19.9%
Decapoda	1.32×10^7	4.44×10^6	13.1%
other Copepoda	8.47×10^6	2.16×10^6	7.9%
other Crustacea	6.95×10^6	2.70×10^6	7.2%
other Zooplankton	5.68×10^6	4.55×10^5	4.6%
Chaetognatha	1.83×10^6	1.56×10^6	2.5%
fish larvae	2.52×10^5	2.46×10^5	2.1%
Mysidacea	6.70×10^5	1.34×10^6	1.5%
			100.0%

Entrainment impacts were assessed by qualitative comparisons of entrainment losses to the estimated numbers of larvae in nearby source waters, comparisons of additional power plant mortality to natural mortality rates, entrainment probabilities based on current studies, and primary productivity studies. It was concluded that the entrainment of 1.82×10^7 fish larvae and eggs daily was small compared to the egg and larval concentrations measured in monthly plankton tows in the source water body. It was estimated that average daily losses of planktonic organisms amounted to about 0.2% of the plankton available within one day's travel time from the power plant by current transport. At the seaward entrance to AHL, a water parcel was estimated to have a 34% probability of entering the lagoon. The 10% probability of entrainment isopleth was calculated to lie near the northern and eastern extremities of AHL, and the 70% and 90% entrainment probability isopleths were calculated to be near the intakes and well within the southern third of the Outer Lagoon. The modeled isopleths shifted toward the seaward entrance on a flood tide and toward the Middle Lagoon on an ebb tide. Using the 70% entrainment probability isopleth to define intake effects, it was shown that the maximum extent of intake effects was about 1000 feet into the southern end of the Outer Lagoon segment. With natural mortality rates assumed to be 99% for egg and larval stages of most marine fish species it was concluded that additional mortality from the EPS was not significant. There was no modeling of entrainment impacts on larvae using demographic or proportional loss models. It was also concluded, based on results of light-dark bottle experiments, that entrainment effects on source water primary productivity were negligible.

3.1.1.2 Impingement

Impingement of fishes and invertebrates on the traveling screens and bar rack system of the EPS were monitored daily during normal operations for 336 consecutive days in 1979. The main method was to obtain abundance and weights from samples accumulated over two 12-hour periods (daylight and night) each day for all three screening systems at the plant. During this period there were a total of 79,662 fishes from 76 taxonomic categories weighing a total of 3,076 lbs collected (Table 3-4). The six highest-ranking fishes by numbers impinged were queenfish, deepbody anchovy, topsmelt, California grunion, northern anchovy, and shiner surfperch. These are all open water forms that occur in schools. These six species represented 82% of all fishes impinged during normal operations sampling.

There were also seven heat treatments conducted during the study period. Heat treatments are operational procedures designed to eliminate mussels, barnacles, and other fouling organisms growing in the cooling water conduit system. During a heat treatment, heated effluent water from the discharge is redirected to the intake conduit via cross-connecting tunnels until the water temperature rises to approximately 105°F in the screenwell area. This water temperature is maintained for at least one hour, during which time all biofouling organisms, as well as fishes and invertebrates living within the cooling water system, succumb to the heated water. During heat treatment surveys, all material impinged onto the traveling screens are removed from the forebay. Fishes and macroinvertebrates were separated from incidental debris, identified, and counted. During the 1979 studies, the total weight of fishes impinged during these operations was 5,340 lb (Table 3-4). Over 90% of the fishes collected consisted of nine species: deepbody anchovy, topsmelt, northern anchovy, shiner surfperch, California grunion, walleye surfperch, queenfish, round stingray, and giant kelpfish. The numbers of fishes resident in the tunnels during heat treatments was greatest in winter and least in summer.

Macroinvertebrates that ranked high in the total numbers impinged included yellow crab (*Cancer anthonyi*) with 2,540 individuals, swimming crab (*Portunus xantusii*) with 884, lined shore crab (*Pachygrapsus crassipes*) with 866, and market squid (*Loligo opalescens*) with 522. The yellow crab and market squid both have commercial fishery value whereas the other two species are small and are not fished commercially. California spiny lobster, the most valuable invertebrate in the local commercial fishery, was rare in the samples with only two individuals impinged during the entire year-long study period.

Table 3-4
Impingement Summary Of Fishes Collected During Normal And Heat Treatment Surveys Conducted From January 1979 To January 1980 at the EPS

		Normal		Heat Treatment	
Common Name	Scientific Name	Count	Weight (lb [kg])	Count	Weight (lb [kg])
queenfish	*Seriphus politus*	18,681	201 (91.3)	3,483	212 (96.3)
deepbody anchovy	*Anchoa compressa*	13,299	142 (64.3)	23,142	402 (182.2)
topsmelt	*Atherinops affinis*	10,915	248 (112.3)	21,788	366 (166.1)
California grunion	*Leuresthes tenuis*	8,583	75 (33.8)	9,671	180 (81.7)
northern anchovy	*Engraulis mordax*	7,434	32 (14.6)	19,567	207 (94.0)
shiner surfperch	*Cymatogaster aggregata*	6,545	118 (53.3)	12,326	607 (275.5)
walleye surfperch	*Hyperprosopon argenteum*	1,877	111 (50.4)	8,305	1153 (522.8)
white surfperch	*Phanderodon furcatus*	1,751	37 (17.0)	604	19 (8.6)
round stingray	*Urolophus halleri*	1,686	410 (185.9)	1,685	891 (404.2)
California halibut	*Paralichthys californicus*	1,215	126 (57.1)	329	117 (53.0)
all others		7,676	1,577 (715.2)	7,200	1,366 (619.7)
Total		79,662	3,076 (1,395.2)	108,102	5,340 (2,422.4)

Note: The top 10 species by number are listed.

Impacts caused by impingement were assessed by comparing the numbers and biomass of fishes lost to plant operations to the abundance and biomass of fishes resident in the nearby source waters of AHL, nearshore habitats, and the San Diego coastal area. Samples of adult and juvenile fishes in the nearby source water were collected monthly with beach seines, otter trawls and gill nets. Seventeen of the 27 fish species were taken by all three types of gear. The role of gear selectivity in determining actual population sizes of the critical species was recognized. The ten most abundant species collected by all types of gear were California grunion (49%), topsmelt (17%), deepbody anchovy (7%), slough anchovy (6%), northern anchovy (3%), queenfish (3%), walleye surfperch (2%), speckled sanddab (2%), shiner surfperch (1%), and California halibut (1%). Most of the species removed by the power plant are widespread along the southern California and Baja California coasts and losses were small relative to these populations. On a local scale, it was calculated that the average daily power plant removal, including normal operations and heat treatment operations averaged throughout the year, was about 0.02% of the estimated standing crop in the local study area that extended along a shoreline distance of 3.6 miles out to a depth of 60 feet (1,211 acres). The removals also represented about 0.07% of local commercial fish landings by weight (excluding tuna) from the area between San Clemente and the Mexican border, and less than 7% of the recreational fishing landings by numbers annually in the area between Dana Point and the Mexican border.

3.1.2 1997 EPS Supplemental 316(b) Assessment Report

The SDRWQCB issued Order 94-58 in 1994 requiring SDG&E to conduct additional analyses of data from the 316(b) study conducted in 1979-1980 (EA Science and Technology, 1997). The supplemental analyses were completed in 1997. The purpose of the study was to further evaluate the effects of the EPS cooling water intake on the designated beneficial uses of AHL and the Southern California Bight using additional analysis methods. The three Special Conditions of the Order were:

1. Analysis of Family-Specific Entrainment Losses of Fish Eggs and Larvae—*Analysis shall include the estimated monthly and annual entrainment losses for each ichthyoplankton RIF (Representative Important Families) (i.e. identify the specific fish larvae and egg removals for each ichthyoplankton family considered in this study).*

2. Estimation of Combined Impingement Losses for Each of the Target Species—*The specific ichthyoplankton losses shall be evaluated using such factors as the importance of that species in food web structure, natural mortality, and plant selectivity for that species, and potential mitigating factors to reduce the kill of that species.*

3. Estimation of Annual Equivalent Adult Losses From Both Entrainment And Impingement—*Ichthyoplankton losses shall be evaluated using such factors as the importance of that species in the marine food web and its importance as a commercial or recreational species. This assessment shall include the use of a time reference for impact assessment longer than the 1-day entrainment zone. SDG&E may use the existing zone. SDG&E may use the existing data collected during the original demonstration project, but shall propose an alternative approach to assess the long-term effect of plankton removal.*

Estimates of loss were calculated for 17 selected species that included the original 16 "critical species" identified in the original 316(b) report and also tidewater goby, the only endangered aquatic species likely to occur in the area. Estimates of adult equivalent loss were calculated for the three representative species with the highest estimates of entrainment or impingement loss: northern anchovy, topsmelt, and queenfish. The modeling uses life stage-specific estimates of total mortality and yields estimates of the number of individual adult fishes which would have resulted from the young lost to entrainment and impingement under the conservative assumption of equal survival.

In order to put the entrainment losses in perspective and evaluate the magnitude of potential impacts, the report considered the life history characteristics of each target species (reproductive ability, geographic distribution, migratory capabilities) as well as estimates of current population size or harvest by commercial or sport fishermen. Although the original report touched on these topics, the 1997 report went into greater detail to evaluate potential impacts. Impacts were considered at three levels: individual population, overall community, and designated beneficial uses of the source waterbody.

The report concluded that the potential for adverse impacts from the EPS CWIS on individual target species was small compared to the sizes of the existing populations and the effects of fisheries. It similarly concluded that operation of the EPS cooling water intake has not, and will not, adversely affect the continued maintenance of balanced aquatic communities or designated beneficial uses of AHL or the Pacific Ocean in the vicinity of the EPS. Finally, the report stated that since the existing intake is not causing any adverse environmental impacts as defined under the CWA 316(b) guidelines that were in effect in 1997, it should be designated as best technology available.

3.1.3 2004-2005 EPS 316(b) Demonstration

In 2004 the EPS initiated new IM&E studies prior to the publication of the new Phase II rules to take advantage of sampling synergies associated with the permitting of a desalination facility planned for construction on the EPS property. A study plan for the desalination facility studies was submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) staff. The desalination facility study plan was designed to provide information on the larval fish and target invertebrates contained in the source of feedwater for the desalination facility, which is the power plant's cooling water discharge, that would be at risk to entrainment by the desalination plant, and information on the larval fish and target invertebrates contained in the power plant's source waterbody and intake flows. Data being collected for the desalination facility on the power plant's source population of entrainable larval fish and target invertebrates was similar to the information required under the new Phase II rules.

A plan for IM&E studies that directly addressed the requirement of 316(b) was submitted to the San Diego Regional Water Quality Control Board in September 2004 following the final publication of the new Rules in July 2004. The IM&E study plan was submitted as a first step in the facility's compliance with the new Phase II rule. The study plan was reviewed by the Board staff and their consultants, Tetra Tech Inc., and was approved contingent on certain comments and questions. Comments on the study plan were resolved and the studies continued through

June 2005 under the direction of a Technical Advisory Group comprised of staff from the Board, state and federal resource agencies, EPS, and their consultants. A summary of the 2004-2005 IM&E studies is presented in Section 9.0. The final report on the studies is being prepared and will be submitted as part of the CDS.

3.2 Survey of Ecological Resources of Agua Hedionda Lagoon (MEC Analytical Systems, Inc., 1995)

A series of field studies was completed in 1995 in AHL to characterize ecological resources of the lagoon prior to a proposed maintenance dredging project. The study delineated the extent of eelgrass and saltmarsh habitats in the lagoon, and provided quantitative information on the distribution and abundance of birds, fishes and benthic invertebrates. The studies occurred over a 14-month period from April 1994 to June 1995.

The fish surveys were conducted during two different seasons, spring and summer. A total of 29 species of fishes were collected during the two surveys (Table 3-5). Fewer taxa occurred in the Outer Lagoon compared to the Middle and Inner lagoons. The species composition recorded was indicative of the proximity of each lagoon segment to the outer coast with a higher proportion of nearshore species found in the Outer Lagoon samples and more estuarine/bay species in the Inner Lagoon. Mean total densities ranged from 0.016 fish per m^2 (10.76 $feet^2$) in the Outer Lagoon in April 1995 to 7.90 per m^2 (10.76 $feet^2$) in the east Inner Lagoon, also in April 1995. Overall densities were higher in the April than July for all lagoon segments. Silversides and gobies comprised over 90% of the individuals collected. The high densities recorded in the spring survey were due to recruitment of juveniles.

Although 29 species of fishes were found in the 1994-1995 surveys by MEC Analytical Systems, earlier studies (Bradshaw et al. 1976) reported a total of 42 species from occasional surveys and from intake screen collections from the power plant. A similar distribution pattern of increased diversity in the Inner Lagoon compared to the Outer Lagoon was also found in the SDG&E study. MEC Analytical Systems (1995) noted a lower abundance of California halibut in the lagoon than in previous surveys. California halibut were one of the most abundant species reported by Bradshaw and Estberg (1973), and were only collected in the Inner Lagoon in their survey. Studies by Kramer (1990) demonstrated the importance of the Middle and Inner lagoons as nursery habitat for California halibut.

Table 3-5
Mean Density per m² and Percent Composition Of Fish Species Collected In Aqua Hedionda Lagoon During Two Surveys By Benthic Trawl, Beach Seine, And Otter Trawl

Species	Common Name	AHL Mean	Percent
Gobiidae (< 25 mm)	gobies (< 25 mm)	0.550	31.54
Atherinopsidae (< 25 mm)	silversides (< 25 mm)	0.520	29.80
Atherinops affinis	topsmelt	0.325	18.64
Gobiidae	goby, unid.	0.076	4.33
Acanthogobius flavimanus	yellowfin goby	0.050	2.87
Hypsopsetta guttulata	diamond turbot	0.040	2.30
Clevlandia ios	arrow goby	0.037	2.15
Quietula y-cauda	shadow goby	0.021	1.21
Fundulus parvipinnis	California killifish	0.019	1.06
Cymatogaster aggregata	shiner surfperch	0.013	0.75
Syngnathus sp.	pipefish, unid.	0.013	0.75
Heterostichus rostratus	giant kelpfish	0.013	0.74
Paralichthys californicus	California halibut	0.012	0.70
Gillichthys mirabilis	longjaw mudsucker	0.012	0.67
Leptocottus armatus	staghorn sculpin	0.010	0.54
Paralabrax maculatofasciatus	spotted sandbass	0.009	0.52
Syngnathus auliscus	barred pipefish	0.005	0.28
Engraulis mordax	northern anchovy	0.005	0.27
Hypsoblennius gentilis	bay blenny	0.004	0.22
Ilypnus gilberti	cheekspot goby	0.004	0.20
Syngnathus leptorhynchus	bay pipefish	0.003	0.19
Seriphus politus	queenfish	0.003	0.17
Anchoa compressa	deepbody anchovy	0.002	0.10
Mustelus californicus	grey smoothhound shark	*	
Gymnura marmorata	California butterfly ray	*	
Paralabrax clathratus	kelp bass	*	
Micropterus dolomieui	small mouth bass	*	
Umbrina roncador	yellowfin croaker	*	
Sphyraena argentea	California barracuda	*	
Citharichthys stigmaeus	speckled sanddab	*	

Table 3-5 (Continued)
Mean Density per m^2 and Percent Composition Of Fish Species Collected In Aqua Hedionda Lagoon During Two Surveys By Benthic Trawl, Beach Seine, And Otter Trawl.

Species	Common Name	AHL Mean	Percent
Pleuronichthys ritteri	spotted turbot	*	
Symphurus atricauda	California tonguefish	*	

**Indicates species with no quantitative summary data included in report (from MEC 1995, Table 3.5).*
M^2 = 10.76 feet^2

Tidewater gobies (*Eucyclogobius newberryi*) were collected from AHL historically, but were not found in the 1994–1995 sampling. It is thought that the dredging and opening of the lagoon to higher saline marine waters in the 1950s significantly affected the tidewater goby population, which is adapted to primarily brackish water conditions.

A total of 143 macroinvertebrate taxa were collected with beam trawls in AHL during the MEC study. Very few of these taxa would be susceptible to impingement from EPS because of their primarily benthic habitat requirements. The most abundant taxa included the cockle (*Laevicardium substriatum*), a non-native mussel (*Musculista senhousi*); bubble snails (*Acteocina inculta, Bulla gouldiana, Haminaea vesicular*), mud dwelling snails, and several species of small crustaceans including amphipods, isopods, mysids, and shrimps. Differences in abundance of several taxa among the three lagoon segments was noted in the sampling and was attributed mainly to predominantly coarser sediments in the Outer Lagoon and finer sediments in the eastern inner portion of the Inner Lagoon.

A total 76 infaunal taxa was collected using a small coring apparatus with the sediments sieved through a 0.04 inches mesh screen. It was concluded that benthic infaunal populations were generally more diverse and abundant in the eelgrass beds than in non-vegetated sediments or in areas where currents deposited littoral sands.

Speckled scallop, *Argopecten circularis*, is a protected species that was known to occur in AHL. Only one individual was collected by MEC during the 1994-95 studies. The species had been studied previously by the California Department of Fish and Game (CDF&G) at AHL from March 1984 to October 1986 to obtain basic life history data (Haaker et al. 1988). Monthly samples of scallops were collected, measured, and released to obtain length frequency data for estimates of growth, life span, and spawning period. In 1984 large concentrations of speckled scallops were found on the sand-silt bottom of the lagoon, closely associated with eelgrass. During the course of the study the numbers of scallops declined, until their virtual disappearance at the end of 1986. Monthly length frequency plots from 24,375 scallop measurements indicate that this is a rapidly growing species with a short life span.

Special studies were done in conjunction with the new IM&E studies done in 2004 and 2005 to supplement the information on fishes provided in the MEC report. The MEC studies did not include sampling of mudflats in the Inner Lagoon and rocky habitat in the Outer Lagoon. The fishes in these two habitats produce large numbers of larvae at risk to entrainment. The data from these studies will be combined with data from the MEC study to provide more accurate estimates of the populations of fishes in the lagoon that will help provide some context for the estimates of EPS entrainment.

4.0 Agency Consultations

As required by the EPA 316(b) Phase II regulation [40 CFR 125.95 (b)(1)(iii)], a summary of any past and ongoing consultations with federal and state Fish and Wildlife Agencies relevant to the development of the PIC for this facility is presented in this section. All communications related to the IM&E issues at the EPS have been conducted through the SDRWQCB with federal and state resource agencies providing input on the IM&E studies as described below.

IM&E studies at EPS were started in June 2004 prior to the publication of the new Phase II rules to take advantage of entrainment sampling that was being done as part of the permitting for a desalination facility planned for construction on the EPS property. A plan for IM&E studies that directly addressed the requirements of 316(b) under the new Phase II rule was submitted to the San Diego Regional Water Quality Control Board on September 2, 2004. The IM&E study plan was submitted as a first step in the facility's compliance with the new Phase II rule. The study plan was reviewed by the Board staff and their consultants, Tetra Tech Inc., and was approved contingent on certain comments and questions that did not affect the sampling procedures being used in the studies. A copy of the September 30, 2004 Tetra Tech review of the study is included as in Attachment B. A copy of the EPS response to the Tetra Tech comments, dated January 10, 2005 is included in Attachment B.

One of the recommendations of the Tetra Tech review was that the SDRWQCB staff and other resource agencies be involved in approving certain aspects of the study including the selection of the target organism that would be used in the final assessment of cooling water system effects. In response to these comments a Technical Advisory Group (TAG) was formed to provide guidance on the IM&E studies. The TAG consists of staff from the SDRWQCB, the National Marine Fisheries Service, the CDF&G, the EPS and their consultants, Tenera Environmental and Dr. Scott Jenkins, an oceanographer from the University of California, San Diego Scripps Institute of Oceanography. The functions of the TAG included the following:

- providing input and review on selection of target organisms for assessment;
- providing input and review on the definition of the source water for entrainment assessment modeling;
- providing input on special studies and other data sources that may be available for assessing source water populations; and
- providing review on reports.

The SDRWQCB and resource agencies' staff participated in three TAG meetings in March, June and in September of 2005. Details on discussion topics of PICs and conclusions from each meeting are presented in Table 4-1. Based on preliminary analyses of the IM&E data, a suite of target fishes and shellfishes for detailed analysis in the IM&E Characterization Study Final Report were selected by the TAG at the September 2005 meeting.

On January 6, 2005, EPS submitted a letter to the SDRWQCB requesting a schedule for submittal of information required to comply with the EPA 316(b) Phase II rule. The letter requested a schedule for submittal of the PIC on April 1, 2006 and for submittal of the CDS on January 7, 2008. A copy of the subject correspondence is included in Attachment B.

Table 4-1
Technical Advisory Group Meetings Held on Impingement Mortality and Entrainment Studies at EPS

Date	Attendees	Discussion Topics	Conclusions
March 14, 2005	Tim Hemig, Sheila Henika - EPS John Steinbeck, David Mayer - Tenera John Phillips, Peter Michael - SDRWQCB Bob Hoffman - NMFS Bill Paznokas - CDF&G	Discussion of study design, assessment models, and methods for defining the source water for the study. Description of special studies on fishes of Agua Hedionda Lagoon that will help fill in data gaps from previous studies.	Agency representatives agreed with the sampling design since it follows the same model used for the South Bay Power Plant and Huntington Beach Generating Station studies.
June 13, 2005	Tim Hemig, Sheila Henika - EPS John Steinbeck, David Mayer - Tenera John Phillips, Paul Richter - SDRWQCB Bob Hoffman - NMFS Bill Paznokas - CDF&G Scott Jenkins - Scripps	Updates on impingement and entrainment sampling, and special studies. Presentation of population model for source water target organisms that accounts for the reduced residency time in Agua Hedionda Lagoon which limits the period of time that larvae are exposed to entrainment.	Agency representatives agreed with the need for more complicated population model and approach used for special studies
Sept. 29, 2005	Tim Hemig, Sheila Henika - EPS John Steinbeck, David Mayer, John Hedgepeth - Tenera Charles Cheng - SDRWQCB Bob Hoffman - NMFS Bill Paznokas - CDF&G Scott Jenkins - Scripps	Presentation of preliminary impingement and entrainment sampling results and recommendations for target organisms that will be analyzed in final report. Presentation of results from studies on the hydrodynamics of AH Lagoon and the use of the results in assessment models.	Agreement on target organisms that will be analyzed in detail for cooling water system effects in the final report.

5.0 *Evaluation of Intake Technology Alternatives*

The EPA Phase II 316(b) regulation requires in 40 CFR 125.95(b)(1(i) that the PIC include a description of technologies which will be evaluated further to determine feasibility of implementation and effectiveness in meeting IM&E performance standards at the facility. The EPS CWIS, being located on a tidal/estuarine waterbody, must meet the performance standards for reduction in both IM&E.

A preliminary screening of technologies has been conducted to determine which alternatives offer the greatest potential for application at the EPS facility and therefore warrant further evaluation. Technologies have been screened based upon feasibility for implementation at the facility, biological effectiveness (i.e. ability to achieve reductions in both IM&E), and cost of implementation (including capital, installation, and annual operations and maintenance costs). Table 5-1 includes a list of technologies for which a preliminary screening was conducted.

Table 5-1
Fish Protection Technologies

Technology	Fish Protection Potential	
	Impingement Mortality	Entrainment
Modified traveling screens with fish return	Yes	No
Replacement of existing traveling screens with fine mesh screens	Yes	Yes
New fine mesh screening structure	Yes	Yes
Cylindrical wedge-wire screens – fine slot width	Yes	Yes
Fish barrier net	Yes	No
Aquatic filter barrier (e.g. Gunderboom)	Yes	Yes
Fine mesh dual flow screens	Yes	Yes
Modular inclined screens	Yes	No
Angled screen system – fine mesh	Yes	Yes
Behavior barriers (e.g. light, sound, bubble curtain)	Maybe	No

In a cursory analysis of the industry costs of implementing the new 316(b) Performance Rule, the EPA has selected retrofit of Fish Screens and a Fish Handling and Return Systems as an applicable technology for the EPS intake system.

The technologies selected for further consideration, which address both impingement and entrainment, as well as those determined not to warrant further consideration are discussed below.

5.1 Technologies Selected For Further Evaluation

A technology, which may be feasible for achieving performance standards, in whole or in part, for reduction in IM&E will be evaluated on the basis of the following:

- Ability to achieve required reductions in both IM&E for all species, taking into account variations in abundance of all life stages;
- Feasibility of implementation at the facility;
- Cost of implementation (including installed costs and annual O&M costs); and
- Impact upon facility operations.

The evaluation will involve the following:

- Comprehensive review of facility CWIS design and operation;
- Engineering design of proposed CWIS upgrades and/or equipment replacements;
- Development of design drawings;
- Analysis of capital and installation costs; and
- Assessment of level of IM&E reductions expected.

After reviewing the site conditions, the following design and construction technologies were selected for further evaluation for the feasibility of implementation to meet, in whole or in part, IM&E reduction standards:

- Modified traveling screens with fish return
- New fine mesh screening structure

5.1.1 Fish Screens, Fish Handling, and Return Systems

Traveling screens that are modified to enhance fish survival are designed with the latest fish removal features, including the Fletcher type buckets on the screen baskets, dual pressure spray systems (low pressure to remove fish, and high pressure to remove remaining debris), and separate sluicing systems for discarding trash and returning the impinged fish back to the water body. Impingement survival may be improved with the use of continuously operating modified traveling water screens. A fish return system is required as part of this system to transport fish washed from the screens alive back to the water body to a location where they would not be subject to re-entrainment into the intake.

Installation of modified Ristroph traveling screens at the EPS CWIS would consist of replacing the existing traveling water screens within the tunnel system with the screens as described above. A fish return system would be installed to return fish collected on the traveling water screens to the lagoon. The replacement screens would be equipped with the same 3/8 inch mesh size as the existing traveling screens.

The feasibility of replacing the existing traveling screens at the EPS CWIS with modified Ristroph traveling screens with conventional 3/8 inch mesh, fish handling and fish return systems will be evaluated. The evaluation will include an assessment of the additional reduction in IM that may be expected through implementation of this technology. Additionally, the feasibility of transporting the collected fish back to a location that would be an appropriate habitat and not result in likely re-entrainment into the intake will be assessed.

5.1.2 New Fine Mesh Screening Structure

Fine mesh traveling water screens have been tested and found to retain and collect fish larvae alive with some success. Fine mesh traveling water screens have been installed at a few large-scale steam electric cooling intakes including marine applications at Big Bend Station in Tampa, Florida (EPRI, 1986), and at an operating nuclear generating station at Prairie Island on the Mississippi River (Kuhl, 1988). Results from field studies of fine-mesh traveling water screens generally show higher survival at lower approach velocities and with shorter impingement duration (EPRI, 1986). In addition, many regulatory agencies have in the past adopted an expectation that traveling water screen approach velocities should be 0.5 feet per second (fps) or less. The National Pollutant Discharge Elimination System - Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Facilities in Section VII A states a maximum through screen design intake velocity of 0.5 fps as the acceptable design standard. This would require a screen approach velocity of 0.25 fps or less depending on the percent open area of the screen mesh used.

Application of fine mesh traveling water screen technology for EPS would likely require a complete new screen structure constructed at the south shore of the lagoon, including both trash racks and fine mesh traveling screen systems and fish collection and return systems; and would replace the existing trash rack structure with a much larger screening structure. It appears that there may be adequate space at the shore for a new fine mesh screen structure, but additional evaluation is still necessary. The approach velocities to the existing traveling screens, as discussed in subsection 2.3 above, are currently well above 0.5 fps and adding sufficient additional screens to the intake tunnel system to reduce approach velocities to 0.5 fps or less would require major modifications to the tunnel system, which may not be feasible. Additionally, an appropriate and suitable location to return collected fish, shellfish, and their eggs and larvae would have to be identified, as well as an assessment of the feasibility of constructing such a return system.

Design layouts and cost estimates for implementation and operation and maintenance will be developed for the above described fine mesh screen structure, as part of the CDS evaluation.

5.2 Technologies Considered Infeasible and Eliminated From Further Evaluation

5.2.1 Replacement of Existing Traveling Screens with Fine Mesh Screens

As discussed above in section 5.1.2, simple replacement of the existing traveling screens in the tunnel system with fine mesh Ristroph screens is not feasible due to high screen approach velocities. Therefore, further evaluation of this technology for implementation at the EPS CWIS will not be conducted.

5.2.2 Cylindrical Wedge-Wire Screens – Fine Slot Width

Wedge-wire screens are passive intake systems, which operate on the principle of achieving very low approach velocities at the screening media. Wedge-wire screens installed with small slot openings may enable a facility to meet performance standards for both IM&E. The wedge-wire screen is an EPA-approved technology for compliance with the EPA 316(b) Phase II rule provided the following conditions exist:

- The cooling water intake structure is located in a freshwater river or stream;
- The cooling water intake structure is situated such that sufficient ambient counter currents exist to promote cleaning of the screen face;
- The through screen design intake velocity is 0.5 fps or less;
- The slot size is appropriate for the size of eggs, larvae, and juveniles of any fish and shellfish to be protected at the site; and
- The entire main condenser cooling water flow is directed through the technology.

Wedge-wire screens are designed to be placed in a water body where significant prevailing ambient cross flow current velocities (≥ 1 fps) exist. This cross flow allows organisms that would otherwise be impinged on the wedge-wire intake to be carried away with the flow. An integral part of a typical wedge-wire screen system is an air burst back-flush system, which directs a charge of compressed air to each screen unit to blow off debris and impinged organisms back into the water body where they would be carried away from the screen unit by the ambient cross flow currents.

The EPS CWIS, located on the tidal AHL would not meet the first two EPA criteria discussed above. The intake is not located on a freshwater river and there are not sufficient ambient crosscurrents in the lagoon to sweep organisms and debris away from the screen units. Debris and organisms back-flushed from the screens would immediately re-impinge on the screens following the back-flush cycle because the principal water current in the outer lagoon would be the station intake flow toward the screen units. For these reasons, wedge-wire screen technology is not considered feasible for application at the EPS.

5.2.3 Fish Barrier Net

A fish net barrier, as it would be applied to a power station intake system, is a mesh curtain installed in the source water body in front of intake structures such that all flow to the intakes passes through the net, blocking entrance to the intake of all aquatic life forms large enough to be blocked by the net mesh. The net barrier is sized large enough to have very low approach and through net velocities to preclude impingement of juvenile fish with limited swimming ability. The mesh size must be large enough to preclude excessive fouling during normal station operation while at the same time small enough to effectively block entrainment of organisms into the intake system. These conditions typically limit the mesh size such that adult and a percentage of juvenile fish can be blocked. The mesh is not fine enough to block most larvae and eggs. The fish net barrier could potentially meet the performance requirements of the EPA Phase II Existing Facilities Rule for impingement; however, it would not meet the performance requirements for reduction of entrainment of eggs and larvae.

The fish net barrier technology is still experimental, with very few successful installations at power station intakes. Using a 20 gpm/ft^2 design loading rate, a net area of approximately 30,000 $feet^2$ would be required for EPS. Maintaining such a large net moored in the lagoon is not practical. In addition, the fish barrier is a passive screening device, which is subject to fouling and has no means for self-cleaning. This technology would be rapidly clogged due to fouling. The services of a diving contractor would be required to remove the net for cleaning onshore and to replace the fouled net with a clean net on each cleaning cycle. For these reasons, this technology is not practically feasible for implementation at EPS and further evaluation is not warranted.

5.2.4 Aquatic Filter Barrier

An aquatic filter barrier system, such as the Gunderboom Marine Life Exclusion System (MLES)™ (Gunderboom), is a moored water permeable barrier with fine mesh openings that is designed to prevent both impingement and entrainment of ichthyoplankton and juvenile aquatic life. An integral part of the MLES is an air-burst back flush system similar in concept to the air burst system used with wedge-wire screen systems to back flush impinged organisms and debris into the water body to be carried away by ambient cross currents.

A MLES has been installed and tested at the Lovett Station on the Hudson River. This test installation was applied to a cooling system of significantly smaller capacity than the EPS intake system and in a very different environment on the Hudson River, as opposed to the lagoon intake of the EPS.

Although the MLES has much smaller mesh openings and will block fish eggs and larvae from being entrained into the intake, these smaller organisms will be impinged permanently on the barrier due to the lack of cross currents to carry them away. This system therefore offers no significant advantage over other technologies such as the fish net barrier concept and would offer no biological improvement over the barrier net design. For these reasons, this technology is not practically feasible for implementation at EPS and further evaluation is not warranted.

5.2.5 Fine Mesh Dual Flow Screens

A modified dual flow traveling water screen is similar to the through flow design, but the screen would be turned 90 degrees so that its two faces would be parallel to the incoming water flow. When equipped with fine mesh screening media, the average 0.5 fps approach velocity to the screen face would have to be met by the dual flow screen design. Water flow enters the dual flow screen through both the ascending and the descending screen faces, and then flows out between the two faces. All of the fish handling features of the Ristroph screen design would be incorporated in the dual flow screen design. However, the dual flow screen configuration has been shown to produce low survival rates for fish larvae. This is because of the longer impingement time endured by organisms impinged on the descending face of the screen. This longer impingement time is suspected to result in higher mortality rates than similar fine mesh screens with a flow through screen design.

The primary advantage of this screen configuration is the elimination of debris carryover into the circulating water system. Also, because both ascending and descending screen faces are utilized, there is greater screening area available for a given screen width than with the conventional through-flow configuration. However, the flow pattern and therefore the velocity distribution along the screen face is not uniform and is concentrated toward the back or downstream end of the screen. The dual flow screen can also create adverse flow conditions in the approach flow to the circulating water pumps. The flow exiting the dual flow screens is turbulent with an exit velocity of greater than 3 fps. Modifications to the pump bays downstream of the screens, usually in the form of baffles to break up and laterally distribute the concentrated flow prior to reaching the circulating water pumps, are usually required. This would not be the case for EPS if a new fine mesh dual flow screen structure were constructed at the lagoon, similar to the through flow fine mesh screen structure discussed in Section 5.1 above.

For similar reasons, as discussed above for through flow fine mesh screens, implementation of this technology to the EPS CWIS would require an entirely new screen structure similar to the fine mesh through flow screen structure discussed in Section 5.1 above. The dual flow fine mesh screen configuration offers no advantages in terms reduction of impingement and entrainment mortality as compared to through flow fine mesh traveling screens discussed above and in fact would probably not perform as well as the through flow design. The design concept for the dual flow screen structure would be similar to the through flow fine mesh screen structure with trash racks, coarse mesh traveling screens and fine mesh traveling screens in each screen train. The implementation cost and operation and maintenance costs for this facility would be of the same order of magnitude as for the through flow screen structure. Dual flow screen technology does not offer a significant performance or cost advantage as compared with through flow screen technology. Therefore, further evaluation of this technology for the EPS is not warranted.

5.2.6 Modular Inclined Screens

Modular Inclined Screen (MIS) is a fish protection technology for water intakes developed and tested by the Electric Power Research Institute (EPRI) (Amaral, 1994). This technology was developed specifically to bypass fish around turbines at hydro-electric stations. The MIS is a modular design including an inclined section of wedge-wire screen mounted on a pivot shaft and enclosed within a modular structure. The pivot shaft enables the screen to be tilted to back-flush debris from the screen. The screen is enclosed within a self-contained module, designed to provide a uniform velocity distribution along the length of the screen surface. Transition guide walls taper in along the downstream third of the screen, which guide fish to a bypass flume. A full size prototype module would be capable of screening up to 800 cfs (360,000 gpm) at an approach velocity of 10 fps.

The MIS design underwent hydraulic model studies and biological effectiveness testing at Alden Research Laboratory to refine the hydraulic design and test its capability to divert fish alive. Eleven species of freshwater fish were tested including Atlantic salmon smolt, coho salmon, Chinook salmon, brown trout, rainbow trout, blueback herring, American shad and others. After some refinements in the design were made during this testing, the results showed that most of these species and sizes of fish can be safely diverted (Amaral, 1994).

Following laboratory testing the MIS design was field tested at the Green Island Hydroelectric Project on the Hudson River in New York in the fall of 1995 (Shires, 1996). In addition to the MIS, the effectiveness of a strobe light system was also studied to determine its ability to divert blueback herring from the river to the MIS. Results for rainbow trout, golden shiner and blueback herring, which were released directly into the MIS module were similar to the laboratory test results in terms of fish survivability. The limited amount of naturally entrained blueback herring did not allow reliable evaluation of test results (Amaral, 1994).

The MIS technology, as tested, does not address entrainment of eggs and larvae. Also, this technology has never been tested for, or installed in, a power station with a seawater intake system. Further research would be required to evaluate the efficacy of this technology for application to a seawater intake system. MIS is not a suitable and proven technology, at this time, for retrofit to the EPS intake system. Therefore, further evaluation of this technology for the EPS is not warranted.

5.2.7 Angled Screen System – Fine Mesh

Angled screens are a special application of through-flow screens where the screen faces are arranged at an angle of approximately 25 degrees to the incoming flow. The conventional through-flow screen arrangement would place the screen faces normal or 90 degrees to the incoming flow. The objective of the angled-screen arrangement is to divert fish to a fish bypass system without impinging them on the screens. Most fish would not be lifted out of the water but would be diverted back to the receiving water by screw-type centrifugal or jet pumps. Using fine screen mesh on the traveling screens minimizes entrainment, but increases potential for impingement of organisms that would have otherwise passed through the condenser.

Application of this technology would require construction of new angled screen structure at the south shore of the lagoon similar to the fine mesh screen structure discussed above in Section 5.1. The angled screen facility would not provide a significant performance advantage in terms of reducing IM&E as compared to the proposed fine mesh screen structure as presented above and would be at least as large and a significantly more complex structure. This facility would be potentially more costly to implement and maintain than the fine mesh screen facility. Therefore, further evaluation of this technology for the EPS is not warranted.

5.2.8 Behavior Barriers

A behavioral barrier relies on avoidance or attraction responses of the target aquatic organisms to a specific stimulus to reduce the potential of entrainment or impingement. Most of the stimuli tested to date are intended to repulse the organism from the vicinity of the intake structure. Nearly all the behavioral barrier technologies are considered to be experimental or limited in effectiveness to a single target species. There are a large number of behavioral barriers that have been evaluated at other sites, and representative examples these are discussed separately below.

Offshore Intake Velocity Cap – This is a behavioral technology associated with a submerged offshore intake structure(s). The velocity cap redirects the area of water withdrawal for an offshore intake located at the bottom of the water body. The cap limits the vertical extent of the offshore intake area of withdrawal and avoids water withdrawals from the typically more productive aquatic habitat closer to the surface of the water body.

This technology operates by redirecting the water withdrawal laterally from the intake(rather than vertically from an intake on the bottom), and as a result, water entering the intake is accelerated laterally and more likely to provide horizontal velocity cues that allow fish to respond and move away from the intake. Potentially entrainable fish are able to identify these changes in water velocity as a result of their lateral line sensory system and are able to respond and actively avoid the highest velocity areas near the mouth of the intake structure.

This technology reduces impingement of fish by stimulating a behavioral response. The technology does not necessarily reduce entrainment, except when the redirected withdrawal takes water from closer to the bottom of the water body and where that location has lower plankton abundance.

Application of this technology to the EPS CWIS, to be fully effective, would require development of an entirely new intake system with a submerged intake structure and connecting intake conduit system installed out into the Pacific Ocean similar to the offshore intake system at the El Segundo Generating Station (Weight, 1958). This is not a practically feasible consideration for the EPS. Also, this technology would probably not be capable of meeting the performance requirements of the EPA Phase II Existing Facilities Rule for reduction of entrainment of larvae, eggs and plankton. Therefore, this technology is not potentially applicable for the EPS CWIS and further evaluation of this technology is not warranted.

Air Bubble Curtain – Air bubble curtains have been tested alone and in combination with strobe lights to elicit and avoidance response in fish that might otherwise be drawn into the cooling water intake. Generally, results of testing the bubble curtain have been poor (EPRI, 1986). Tests have been conducted with smelt, alewife, striped bass, white perch, menhaden, spot, gizzard shad, crappie, freshwater drum, carp, yellow perch, and walleye. Many species exhibited some avoidance response to the air bubble or the combination air bubble and light combination. However, there has been little if no testing of species common to the AHL.

This technology has some potential to enhance fish avoidance response in some species of fish. However, there is no reliable data for the species that are subject to impingement at the EPS and no way to estimate what type of reaction fish would have to the existing intake with the addition of a bubble curtain. Unless some type of testing were conducted, this technology does not appear suitable for the EPS. As a result, there is no basis to recommend an air curtain as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

Strobe Lights – There has been a great deal of research with this stimulus over the last 15 years to guide fish away from intake structures. The Electric Power Research Institute has co-funded a series of research projects (EPRI 1988, EPRI 1990, EPRI 1992) and reviewed the results of research in this field by others (EPRI 1986, EPRI 1999). In both laboratory studies and field applications strobe lights were shown to effectively move selected species of fish away from the flashing lights. Most of the studies conducted to date have been with riverine fish species and for projects associated with hydroelectric generating facilities. One early study was conducted at the Roseton Generating Facility on the Hudson River in New York, another study was conducted on Lake Cayuga in New York, and others for migratory stages of Atlantic and Pacific salmon. Few species similar to those occurring in the AHL have been tested for avoidance response either in the lab or in actual field studies.

Laboratory testing was done for an application of strobe lights for the San Onofre Nuclear Generating Facility. Testing was conducted for white croaker, Pacific sardine and northern anchovy. Limited availability of test specimens and limited testing demonstrated no conclusive results and the California Coastal Commission (2000) found this device not useful at this station.

Before strobe lights could be seriously considered for use at the EPS CWIS, a series of lab and or field studies on their effectiveness for the species most likely to be entrained into the EPS CWIS would need to be completed. Based on studies of strobe lights conducted to date, it is likely that these studies would show differential effectiveness based on background light conditions (day vs. night), ambient seawater turbidity, and most likely there would also be great differences in species specific response. As a result there is no basis to recommend these strobe lights as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

Other Lighting – Incandescent and mercury vapor lights have also been tested as a behavioral stimulus to direct fish away from an intake structure. Mercury lights have generally been tested as a means of drawing fish to a safe bypass of the intake structure as generally the light has an attractive effect on fish. Tests have not demonstrated a uniform and clearly repeatable pattern of attraction for all fish species. The mercury lights have been somewhat effective in attracting European eel, Atlantic salmon, and Pacific salmon. But results with other species including American shad, blue back herring and alewife had more variable results. One test with different life stages of Coho salmon shows both attraction and repulsion from the mercury light for the different life stages of the coho.

Testing with incandescent, sodium vapor and fluorescent lamps was more limited but also had variable and species specific results.

Other lighting systems, as with most all the behavioral barrier alternatives, have not been tested with the species of fish common in AHL. As a result, there is no basis to recommend these lights systems as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

Sound – Sound has also been extensively tested in the last 15 years as a method to alter fish impingement rates at water intake structures. Three basic groups of sound systems including percussion devices (hammer, or poppers), transducers with a wide range of frequency output, and low frequency or infrasound generators, have all been tested on a variety of fish species.

Of all the recently studied behavioral devices the sound technology has demonstrated some clear success with at least one group of fish species. Clupeids, such as alewife, demonstrate a clear repulsion to a specific range of high frequency sound. A device has been installed in the Fitzpatrick Nuclear Generating station on Lake Ontario in New York State, which has been effective in reducing impingement of landlocked alewives. The results were repeated with alewife at a coastal site in New Jersey. Similar results with a high frequency generator also reported a strong avoidance response for another clupeid species, the blue back herring, in a reservoir in South Carolina. Testing of this high frequency device on many other species including weakfish, spot, Atlantic croaker, bay anchovy, American shad, blue back herring, alewife, white perch, and striped bass only demonstrated a similar and strong avoidance response by American shad and blue back herring.

Alewife and sockeye salmon have also been reported to be repelled by a hammer percussion device at another facility. But testing of this same device at other facilities with alewife did not yield similar results.

Although high frequency sound has potential for eliciting an avoidance response by the Alosid family of fish species, there is no data to demonstrate a clear avoidance response for the species of fish common to the AHL. Therefore there is no basis to recommend sound as a method to reduce impingement of fish at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

6.0 Evaluation of Operational Measures

The EPA 316(b) Phase II regulation [40 CFR 125.95(b)(1)(i)] requires that the PIC should include a description of operational measures which will be evaluated further to determine feasibility of implementation and effectiveness in meeting IM&E performance standards at the facility. A preliminary screening of such measures has been conducted to determine those which offer the greatest potential for application at the facility and therefore warrant further evaluation. Operational measures have been screened based upon feasibility for implementation at the facility, biological effectiveness (i.e. ability to achieve reductions in IM&E), and cost of implementation (including additional power requirements and loss in generating capacity and unit availability).

Several operational measures have been proven effective in reducing IM&E at CWIS. Such measures include:

- CWIS flow reductions (e.g. capping capacity utilization rate)
- Variable speed drives for CWIS pumps
- Other cooling water efficiency improvements

The following is a discussion of operational measures for which further evaluation will be conducted in the CDS to determine their potential for reducing IM&E at EPS. The results of the evaluation of such measures will be utilized to develop the plan for implementation of technologies, operational and/or restoration measures that will be proposed to achieve IM&E performance standards at the facility. Upon selection of the most appropriate operational measures, engineering design calculations and drawings, as well as estimates of expected reductions in IM&E and a schedule for implementation will be developed. This information will become part of the Design and Construction Technology Plan (DCTP) (or Site-Specific Technology Plan in the event that the facility chooses to seek a site-specific determination of BTA) and Technology Installation and Operation Plan (TIOP) that will be included in the CDS to be submitted for the facility. The DCTP explains the intake technologies or operational measures selected for use at EPS to meet the E&I performance standards for the Phase II Rule. The compliance with the performance standards will be measured and monitored through documentation of the TIOP.

6.1 Circulating Water Flow Reduction / Caps

Circulating water flow caps are an operational control measure which would include administratively limiting the total withdrawal of cooling water from the AHL to an agreed upon value. The flow reductions may be scheduled for periods of the year when entrainment or impingement are highest to achieve a greater reduction to impingement and entrainment. Any reduction in flow reduces both entrainment and impingement effects associated with the operation of the plant. If flow reductions are concentrated during the seasons of the year that plankton life stages of species of concern are present, the overall seasonal reductions in fisheries impacts can greatly exceed the quantity of the flow reduction. Utilizing variable speed drive technology on the circulating water pumps could be an effective means of controlling total annual flow withdrawal.

6.2 Variable Speed Drives For Circulating Water Pumps

Variable-speed drives for circulating water pumps allow reduction in cooling water flow during periods when the unit is not operating at full-rated capacity, or during known periods of high entrainment. With this technology it would be possible to vary the speed of the motor from 10% to 100% and reduce the cooling water intake flow by up to 90%. Any reduction in flow reduces both entrainment and impingement effects associated with the operation of the plant. The lower pumping capacity allows for a lower approach velocity at the traveling screens and reduces the number of entrainable organisms drawn into the cooling water system. In addition, if flow reductions are concentrated during the seasons of the year that plankton life stages of species of concern are present, the overall seasonal reductions in fisheries impacts can greatly exceed the quantity of the flow reduction. The installation of variable speed drives will be evaluated further to determine the effectiveness in reducing IM&E at the EPS CWIS.

6.3 Heat Treatment Operational Changes

Potential operational and procedural enhancements to reduce impingement during heat treatment events will also be evaluated. In the CDS, EPS will evaluate a couple of alternative biofouling control measures that might reduce the number, or eliminate the need for, heat treatments in the intake tunnels. In addition, EPS will also evaluate a couple of modifications of the existing heat treatment procedures that might reduce the numbers of fish impinged during these events, but still provide effective heat treatment removal of fouling organisms in the intake and intake tunnels.

7.0 Evaluation of Restoration Alternatives

The EPA Phase II 316(b) regulation [40 CFR 125.95(b)(1)(i)] allows the consideration of restoration measures as one of the options that may be implemented, either alone or in combination with technology and/or operational measures, to achieve performance standards for reduction in IM&E losses. Facilities may propose restoration measures that will result in increases in the numbers of fishes and shellfishes in the waterbody that would be similar to those achieved with meeting performance standards through the implementation of technologies and/or operational measures. EPS will conduct an evaluation of potential restoration measures that may be implemented in the event that it is determined that meeting performance standards through the implementation of technologies and/or operational measures alone is less feasible, less cost-effective, or less environmentally desirable than use of restoration measures.

7.1 Potential Restoration Measures

This section introduces the type of habitat restoration projects that could potentially be used to offset IM&E losses at EPS. The offsets that will later be calculated for each project will be based on a numerical comparison of IM&E losses resulting from the operation of EPS, and the expected production of equivalent adults of the affected species resulting from the restoration efforts using various habitat models.

Any specific conservation, enhancement, or restoration project that is to be used for this purpose should have a nexus (i.e. relationship between the environmental impacts and the proposed project) to the impingement and entrainment effects of the power plant. The projects that will be evaluated to offset potential EPS IM&E losses fall into three general categories:

- Projects that would directly restore or enhance habitat in AHL;
- Projects that would preserve, restore, or enhance the AHL watershed; and
- Projects that enhance the nearshore coastal environment in the vicinity of EPS Power Station.

The following is a list of some of the potential restoration measures, in each of the above categories, which will be evaluated to determine their feasibility of implementation, and potential efficacy in meeting IM&E performance standards at the EPS:

I. **Restoration or Enhancement of AHL**

- Invasive species removal and prevention
- Restoration of historic sediment elevations to promote reestablishment of eelgrass beds
- Enhancement of AHL State Reserve
- Marine fish hatchery enhancement
- Community outreach soliciting public agency and landowner participation

II. **Restoration or Enhancement of Agua Hedionda Watershed**

- Erosion control projects along upland watercourses
- Construction of catchment basins, swales, and other sediment containment features
- Land acquisition for purposes of creating conservation easements
- Minimizing runoff from development activities
- Restoration of floodplain habitat
- Invasive species removal and prevention

III. **Restoration or Enhancement of Nearshore Coastal Areas**

- Marine fish hatchery stocking program
- Artificial reef development
- Marine Protected Area establishment
- Kelp bed enhancement

The "value" of the ecological services or benefits that will result from implementation of any of these restoration projects will be assessed using various habitat models to demonstrate that the ecological "credits" gained through restoration will outweigh the ecological "debits" caused by the IM&E losses. A preliminary screening of these potential restoration measures will be conducted to determine which projects warrant further evaluation. Selected projects will be evaluated further based upon the criteria described below.

7.2 Project Selection Criteria

A set of restoration project selection criteria has been developed to aid in the evaluation of potential projects. The project selection criteria include:

- Location
- Nexus to EPS IM&E effects
- Basic need or justification for project
- Nature and extent of ecological benefits
- Stakeholder acceptance
- Consistency with ongoing resource agency work and environmental planning

- Administrative considerations
- Implementation costs
- Cost effectiveness
- Ability to measure performance
- Success of comparable projects
- Length of time before benefits accrue
- Technical feasibility
- Opportunities for leveraging of funds/availability of matching funds
- Legal requirements (e.g., permits, access)
- Likely duration of benefits

Depending on the nature of a particular project, the relative importance and weighting of these criteria may vary. As a general proposition, however, projects will be selected so as to maximize the ecological benefits to AHL and adjacent nearshore areas. This process will ensure that the most effective projects are assigned the highest priority.

8.0 Other Compliance Options for EPS

Two additional compliance alternatives that EPS may pursue in the course of developing the most appropriate CDS for the EPS CWIS include a site-specific determination of BTA and a trading approach for cooperative restoration solutions. The site-specific determination option would be undertaken if the implementation of some combination of an intake technology, operation change or restoration is significantly greater in cost than that estimated by US EPA or the costs are significantly greater than the benefits of such measures. The trading program compliance alternative would involve EPS teaming with other water users in the area to develop a more comprehensive solution to reduce or mitigate for IM&E with a cooperatively funded technology or restoration alternative. EPS has no specific plans and has not developed potential teaming partners to pursue this compliance alternative at this time. However, EPS will remain open to exploring this compliance alternative if the right opportunity is identified prior to submittal of the CDS.

8.1 Site-Specific Determination of BTA

The intent of the EPS approach to compliance is to meet the entrainment and impingement performance standards established by the EPA when the new rule was promulgated. That is, EPS hopes to demonstrate that the EPS intake has reduced the effects of entrainment by 60 to 90% and reduced the effects of station operation on impingement mortality by 80 to 95% from the calculation baseline. However, EPS also recognizes that if the costs of reaching these goals cannot reasonably be achieved that the EPA 316(b) Phase II regulation allows a somewhat lower IM&E reduction standard. Specifically the new rule would allow EPS to demonstrate that the EPS facility is eligible for a site-specific determination of BTA to minimize IM&E and that EPS has selected, installed, and is properly operating and maintaining, or will install and properly operate and maintain, design and construction technologies, operational measures, and/or restoration measures that the Director has determined to be the BTA to minimize adverse environmental impact of the EPS cooling water operations.

This compliance alternative allows the EPS facility to request a site-specific determination of BTA for minimizing IM&E if EPS can demonstrate that the costs for compliance with the new rule are significantly greater than those considered by EPA in the development of the rule (cost/cost test) or that the costs associated with compliance are significantly greater than the benefits (cost/benefit test) that would accrue to the environment.

8.1.1 Cost/Cost Test

If EPS chooses to seek a site-specific determination of BTA, a cost/cost test will be performed to compare the cost of implementing options to achieve full compliance with the 316(b) Phase II standards to costs estimated by the EPA for the EPS facility for achieving full compliance. In the 316 (b) Phase II rule, the EPA has assumed that the EPS facility would add a fish handling and return system to the existing traveling water screen system. There was no expectation in that recommendation that the EPS facility would need to meet the entrainment performance standards. Therefore EPA has projected compliance capital costs for the EPS facility of $2,841,330 (Federal Register, Vol. 69 – 7/9/2004, page 41677 – see Facility ID# AUT0625). This same source cites an expected existing baseline O&M annual cost of $104,168 and a post construction O&M annual cost of $380,113 for EPS.

If pursuit of this compliance option is justified, EPS will conduct its evaluation following a three-step method, as follows:

1. Identification of feasible options for achieving full compliance (e.g. combinations of engineering, operational, and restoration actions);
2. Estimation of the dollar costs of implementing these actions (including capital, O&M, and lost generation revenue due to extended outages); and
3. Comparison of the total estimated cost of compliance based upon the compliance options identified with EPA's estimated cost of compliance for the facility in question.

One thing that has not been fully resolved by EPA is what constitutes "significant" compared to the costs that EPA projected for the EPS. EPS will develop its perspective on what constitutes significant during the development of the CDS. It is likely that significance will be judged from the perspective of the capital and operating costs and revenues from the operation of EPS.

8.1.2 Cost/Benefit Test

A cost/benefit test may also be performed for EPS to compare the total costs of achieving compliance with the environmental benefits through implementation of the required technologies, operational, and/or restoration measures. Costs are the sum of direct costs and the indirect costs of any intake, operational or restoration mitigation actions. Direct costs include the costs of implementing compliance alternatives, including capital, O&M, and lost generation revenue due to extended outages. Indirect costs include any costs associated with impairment of navigation, higher energy prices, and negative ecological effects of the mitigation actions on the waterbody. An initial phase of the cost/benefit test will identify whether any of these indirect cost elements are relevant at the EPS. The cost/benefit test would specify the nature of the relevant direct and indirect cost components at the facility.

The benefits arise from reducing IM&E by the full amount of the 316(b) Phase II rule's performance standard relative to baseline conditions. The economic benefits of reductions in IM&E have been specified by the EPA in its evaluation of the national benefits of the rule. The classes of benefits identified by EPA in its assessment include direct use benefits (e.g. those from commercial and recreational fishing), indirect use benefits (e.g. increased forage organisms), and existence, or passive use benefits (e.g. improved biodiversity). These benefits are based on standard definitions of value used by economists in cost/benefit analysis. Methods for quantifying benefits to commercial and recreational fishing and other changes in natural resources have been widely employed by environmental and natural resource economists over the past several decades.

The exact nature of the data and methods required for a cost/benefit analysis will vary depending upon the magnitude of the potential IM&E effects on a local and regional scale, the availability of existing economic benefit studies that may be applied, as well as the comments of the regulators and natural resource agencies involved with reviewing this PIC. These can vary widely and will not really be well understood until the results of the IM&E study are complete. When the IM&E study is complete, the numbers of each species affected by operation of the intake can be quantified, and then a value for each species affected by IM&E at the EPS CWIS can be developed.

The benefit studies would be undertaken using a phased approach. Following an initial scoping phase to determine the approach to conducting a cost/benefit analysis, an outline of a benefits assessment approach will be determined. EPS will develop an approach to conducting a benefits valuation for use in supporting a site-specific determination of BTA if that becomes the selected approach for meeting compliance with the new rule. The approach will address the following requirements for such a study as outlined in the Phase II rule:

1. Description of the methodologies to be used to value commercial, recreational, and other ecological benefits;
2. Documentation of the basis for any assumptions and quantitative estimates; and
3. Analysis of the effects of significant sources of uncertainty.

If restoration is a component of the compliance approach, the ability of the restoration project(s) to generate benefits to offset impingement and/or entrainment effects must be demonstrated. This requires specification of a metric that can be used to quantify restoration benefits in a manner comparable to entrainment and impingement effects in the ecosystem.

Habitat assessment methods will be used for assessing the relative value of restoration actions. The approach taken will be to:

1. Identify the key species of concern affected by the facility;
2. Identify critical factors or habitat needs for those species;
3. Identify technically feasible and cost-effective restoration actions that address such critical factors and needs factors; and
4. Choose an appropriate ecological metric for scaling effects of mitigation and/or enhancing habitat needs within the adjacent ecosystem or area.

For example, if it is determined that the restoration project needs to compensate for entrainment of a species for which spawning habitat is a limiting factor, then creation of sufficient new spawning habitat to increase the population by the amount of entrainment would be required for full compliance with the Rule. This would then translate to acreage of created habitat with certain required structural characteristics.

If entrainment losses are of key concern, and the population of associated fish is of less concern, then biomass could also serve as the metric. The present value of the entrained biomass would be computed as the ecological debit. Then, a wetland or other habitat creation project could be scaled in size to produce the equivalent present value of biomass from the primary productivity of the wetland or new habitat.

8.1.3 Evaluation of a Site-Specific BTA

The 316(b) Phase II Rule allows facilities to seek site-specific determinations of BTA if it can be demonstrated that the costs of achieving full compliance with the IM&E performance criteria at a facility are either:

1. Significantly greater than those considered by the EPA in development of the rule (cost/cost test), or
2. Significantly greater than the net environmental benefits to be achieved (cost/benefit test).

If either of these methods is implemented, EPS may propose this as the compliance approach if the costs are significantly higher than either the expected costs at the time the rule was promulgated or, for the amount of benefits that would be derived.

8.2 Trading For Cooperative Mitigation Solutions

In the preamble to the EPA 316(b) Phase II rule, as published in the Federal Register (Vol. 69, No. 131, pgs 41576 - 41693), there is a discussion of the role of trading under the rule (VII. F.2). The preamble describes how trading "...raises complex issues on how to establish appropriate units of trade and how to measure these units effectively given the dynamic nature of the populations of aquatic organisms subject to impingement mortality and entrainment." However, EPA suggests that delegated authorities responsible for implementing the 316(b) Phase II rule wishing to develop trading options "...would be best off focusing on programs based on metric of compatibility between fish and shellfish gains and losses among trading facilities.". This section of the rule also states that if the delegated NPDES authority can demonstrate to the EPA Administrator that they have adopted a NPDES program within a watershed that provides for comparable reductions in IM&E, then the EPA Administrator must approve such alternative compliance alternative requirements.

EPS may consider a watershed-approach trading program as a possible compliance alternative if the right combination of coastal water users identify mutual goals for achieving compliance, either in whole or in part, with the new rule. EPS has not developed any specific alliance of water dependent organizations to implement such a watershed-approach trading compliance alternative. However, EPS expects that after field studies have characterized CWIS effects, that restoration may be the most feasible and cost-effective measure to meet the performance standards. This might be done alone, or in combination with other intake technologies or operational modifications. However, it might well be that different technologies implemented to achieve CWIS compliance at different electric generating facilities may result in mutual benefits for the regional ecosystem. If mutual benefits of mitigation are identified among different generating facilities, then EPS would then consider establishing a trading program with other generating facilities to achieve the lowest cost, most comprehensive and effective method to comply with the new 316 b rule.

EPS will remain open to seeking comprehensive solutions to the IM&E issues in the region and develop a plan for compliance with the possible cooperation of other water users such that the issue is addressed in the most comprehensive manner for the regional ecosystem.

9.0 Impingment Mortality & Entrainment Sampling

An IM&E sampling program was conducted to characterize the fishes and shellfishes affected by impingement and entrainment by the CWIS at the EPS. The data from the study will be used in calculating baseline levels of IM&E against which compliance with performance standards will be measured. A detailed IM&E sampling plan was developed for the IM&E studies (Attachment C) and was previously submitted to the SDRWQCB in August 2004. The sampling plan was approved by the SDRWQCB and the sampling was done for one year starting in June 2004 and continued into June 2005. The report is in the final stages of preparation.

As required in 40 CFR 125.95(b)(3), the results of the IM&E sampling program will be summarized in a report submitted as part of the CDS that includes the following:

- Taxonomic identifications of all life stages of fishes, shellfishes, and any threatened or endangered species collected in the vicinity of the CWIS and are susceptible to IM&E;
- Characterization of all life stages of the target taxa in the vicinity of the CWIS and a description of the annual, seasonal, and diel variations in IM&E; and
- Documentation of the current level of IM&E of all life stages of the target taxa.

The goal of the study was to characterize the fishes and shellfishes affected by impingement and entrainment by the EPS CWIS. The studies examined losses at the EPS resulting from impingement of juvenile and adult fishes and macroinvertebrates on traveling screens during normal operations and during heat treatment operations and entrainment of ichthyoplankton and invertebrates into the cooling water intake system. The sampling methodologies and analysis techniques were derived from recent impingement and entrainment studies conducted for the AES Huntington Beach Generating Station (MBC and Tenera 2005), and the Duke Energy South Bay Power Plant (Tenera 2004). The studies at Huntington Beach were performed as part of the CEC California Environmental Quality Act (CEQA) process for permitting power plant modernization projects, while the South Bay project was for 316(b) compliance.

9.1 Assessment of Cooling Water Intake System Effects

Considerable effort among regulatory agencies and the scientific community has been expended on the evaluation of power plant intake effects over the past three decades. Power plant intake effects occur due to impingement of larger organisms onto the intake screens and entrainment of smaller organisms through the CWIS that are smaller than the screen mesh on the intake screens. For the purposes of the EPS study we assumed that both processes lead to mortality of all impinged and entrained organisms. The variety of approaches developed to assess the CWIS impacts reflects the many differences in power plant locations and resource settings (MacCall et al. 1983). The various approaches have been divided into those that offer a judgment on the presence or absence of impact and those that describe the sensitivity of populations to varying operational conditions. These efforts have helped to establish the context for the modeling approaches being used to estimate impingement and entrainment effects at the EPS.

Impact assessment approaches that will be used in the analysis of the entrainment data include:

- Adult-Equivalent Loss (*AEL*) (Horst, 1975; Goodyear, 1978);
- Fecundity Hindcasting (*FH*) proposed by Alec MacCall, NOAA/NMFS, and is related to the adult-equivalent loss approach; and
- Empirical Transport Model (ETM), which is similar to the approach described by MacCall et al. (1983), and used by Parker and DeMartini (1989).

The application of several models to estimate power plant effects is not unique (Murdoch et al. 1989; PSE&G 1993; Tenera 2000a; Tenera 2000b). Equivalent Adult Modeling (*AEL* and *FH*) is an accepted method that has been used in many 316(b) demonstrations (PSE&G 1993; Tenera 2000a; Tenera 2000b). The advantage of demographic models like *AEL* and *FH* is that they translate losses into adult fishes that are familiar units to resource managers. Estimates of entrainment losses from these demographic models can be combined with estimated losses to adult and juvenile organisms due to impingement to provide combined estimates of cooling water system effects. The U.S. Fish and Wildlife Service proposed the empirical transport model (*ETM*) to estimate mortality rates resulting from cooling water withdrawals at power plants (Boreman et al. 1978, 1981). The *ETM* estimates the conditional mortality due to entrainment while accounting for spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The *ETM* provides an estimate of power plant effects that may be less subject to inter-annual variation than demographic model estimates. It also provides an estimate of population-level effects not provided by demographic approaches. But the *ETM* calculations require information about the composition and abundance of larval organism from the source water, necessitating the collection of samples from additional stations. A description of each of these models and how they will be used to evaluate data collected in the IM&E study is included in the study plan (Attachment C).

The assessment approach used in the final report in the CDS for the EPS will also depend upon the facility's baseline calculations and its method(s) of compliance with the 316(b) Phase II performance standards for reductions in impingement mortality and entrainment. Compliance at EPS may be achieved by implementing either singly, or in combination the following: technological or operational changes to the CWIS (TIOP), restoration methods, or site-specific BTA standards. To demonstrate compliance through the TIOP it is only necessary to analyze impingement and entrainment data to determine baseline levels and assess those levels against the improvements achieved through the implementation of the TIOP. In the case where restoration is limited to only commercially or recreationally important species (use species), impingement and entrainment data may also be adequate to assess the levels of restoration necessary to offset impingement and entrainment losses, assuming that scientifically valid population models exist for the species providing the lost benefits. In assessing compliance with the performance standard in whole or in part through restoration of habitat to include non-recreational and non-commercial species (non-use species) in addition to the losses of use species it is necessary to assess the impingement and entrainment losses also from the source water using a combination of assessment methods to determine the commensurate level of restoration. The same source water and entrainment data, and assessment methods would also be used to determine a site-specific BTA standard based on cost-benefit analysis of entrainment losses to all use and non-use species. Source water data would not be necessary for cost-benefit analysis based simply on the value of use species losses.

9.2 Target Species

Analysis of CWIS effects will be done on the most abundant organisms in the samples, and commercially or recreationally important species from entrainment and impingement samples. All fishes and shellfishes during the impingement sampling were identified and up to fifty individuals of each species of fishes, crabs, shrimp, lobsters, octopus, and squid were measured and weighed. In instances where more than fifty individual of any one species were collected, the first fifty were measured and the rest were counted and then weighted as a group. All other invertebrates were recorded as present. The following marine organisms were sorted, identified and enumerated from entrainment intake and source water plankton samples:

Vertebrates:

- Fishes (all life stages beyond egg)

Invertebrates:

- Rock crab megalopal larvae (*Cancer* spp.)
- California spiny lobster phyllosoma larvae (*Panulirus interruptus*)

These groups were also analyzed in most of the recent entrainment studies in southern California, including the AES Huntington Beach Generating Station. Fishes and rock crab larvae were selected because of their respective ecological roles or commercial and/or recreational fisheries importance. The California spiny lobster was selected because of its commercial and/or recreational importance in the area.

The organisms analyzed will be limited to taxa that are sufficiently abundant to provide reasonable assessment of impacts. For the purposes of this study plan, we will limit the analysis to the most abundant taxa that comprise 90 percent of all larvae entrained and/or juveniles and adults impinged by the EPS. The most abundant organisms are used in the assessment because they provide the most robust and reliable estimates of CWIS effects. Since the most abundant organisms may not necessarily be the organisms that experience the greatest effects on the population level, the data will be examined carefully before the final selection of target species to determine if additional species should be included in the assessment. This may include commercially or recreationally important species, and species with limited habitats.

9.3 Impingement

The following is a summary of the methods used to collect impingement samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C). Sampling was completed during both normal operations periods and tunnel recirculation (heat treatment) events.

Each normal operations impingement survey was conducted over a 24-hour period one day each week from mid June 2004 through mid June 2005. Prior to each survey any accumulated debris and organisms on the bar racks and traveling screens was removed and discarded. Each 24-hour survey was divided into six 4-hour cycles. The traveling screens at EPS take approximately 30-35 minutes to complete a complete rotation and washing. The traveling screens generally remained stationary for a period of about 3.5 hours and then are rotated and washed for 30-35 minutes depending on traveling screen rotation speed. All impinged material rinsed from the traveling screens was rinsed into its respective collection basket. The impinged material was removed from these baskets and all organisms removed from the debris. Due to the design of the intake traveling screens, there are three collection basket assemblies, one for Units 1-3, one for Unit 4, and one for Unit 5. All impinged material from each set of screens was processed and recorded separately. Length and weight of up to 50 individual of each taxa of impinged fishes, crabs, lobsters, shrimp, gastropods, some pelecypods, octopus, and squid were recorded. If more than 50 individuals of any taxa were impinged on any set of screens during a single cycle, this extra group was counted and its total bulk weight was determined and recorded. All other invertebrates were recorded as present when observed. The amount and general identity of the debris collected during each screen cycle was also recorded. The number of circulating water pumps in operation during each survey, obtained from operator logs was used to calculate the volume of water passing through the traveling screens during each survey. The number of screens rotated during each cycle was also recorded during the screen washing periods.

EPS conducts tunnel recirculations to control biofouling organisms growing on the intake conduits. During these events, all impinged organism washed off the traveling screens and rinsed into the collection baskets were removed from debris and identified, counted, and measured using the same procedures used during the normal operations surveys. A total of six tunnel recirculations took place during this 2004-2005 study period.

The abundance and biomass of the organisms impinged during the once per week normal operations sampling will be used to estimate the impingement for the entire year by first estimating the weekly impingement. This is done by combining the information on the impinged organisms with the total circulating water flow for the period between surveys. These weekly estimates are then combined to estimate the annual impingement rate during normal operations. All organism impinged during tunnel recirculation events are combined with those impinged during normal operations to generate an estimate of the overall annual impingement of the CWS.

9.4 Entrainment

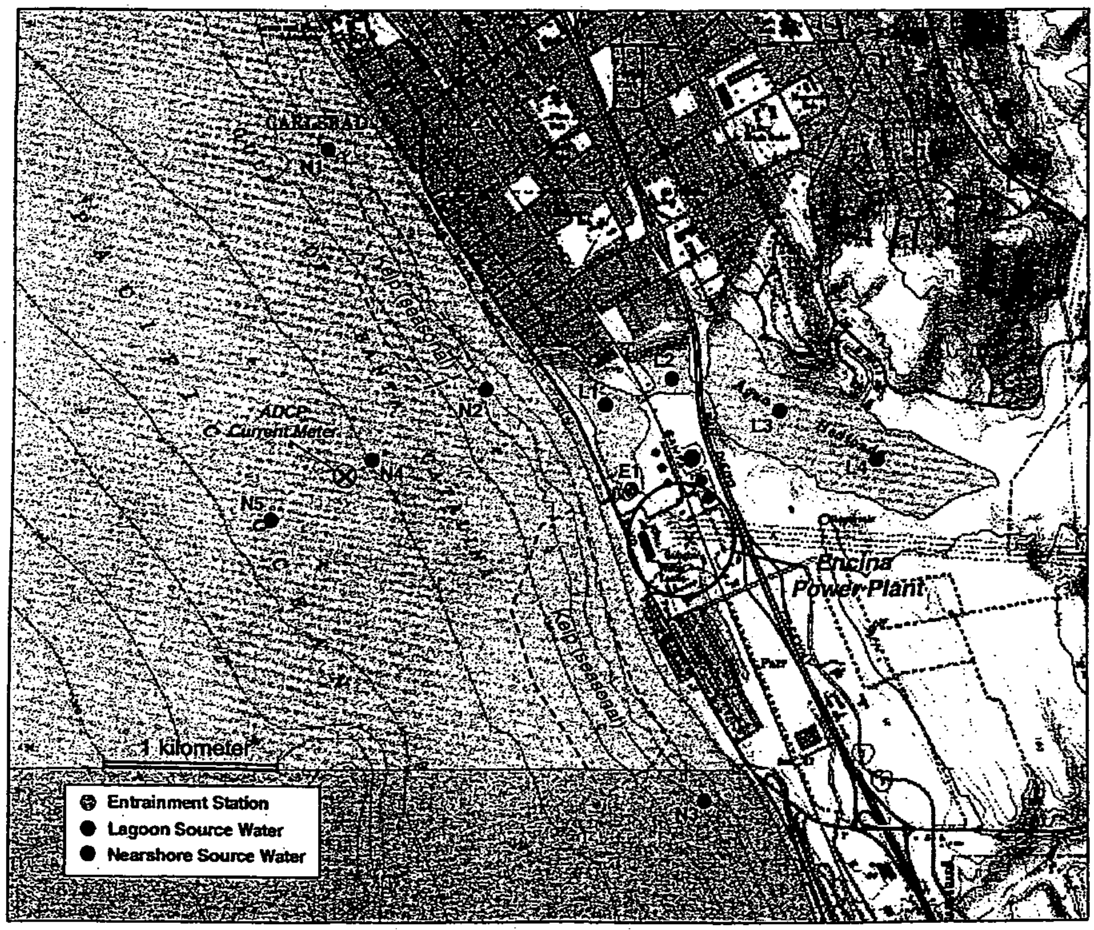
The following is a summary of the methods used to collect entrainment and source water plankton samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C).

Sampling to determine the composition and abundance of larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae at the EPS intake structure and in the local vicinity began in June 2004. The sampling was completed monthly thereafter, with the final sampling being completed in May 2005. Samples during each of these monthly surveys were collected over a 24-hour period, with sampling being divided into four 6-hour periods. Sampling was conducted near the intake structure to estimate larval entrainment, and at eight nearby stations in two sub-areas (three stations in the AHL and five stations in the nearshore) to estimate larvae in the source water (Figure 7-1).

The samples at the entrainment location (E1), at all the nearshore stations (N#), and at the Outer Lagoon station (L1) were collected using a bongo net frame equipped with two 0.71 m (2.33 feet) diameter opening with attached 335 μm (0.013 in) mesh plankton nets and codends. Each net had a calibrated flowmeter that was used to determine the volume of water filtered during sample collection. Samples were collected by first lowering the frame and nets from the surface to as close to the bottom as practical without contacting it, and then moving the boat forward and retrieving the nets at an oblique angle. The target volume of the combined volume filter through both nets was at least 2,120 feet^3 (60 m^3). After retrieving the nets from the water, all collected material was rinsed into the codend. The collected material from both nets was placed into a labeled jar and preserved.

Due to the shallow depths in the vicinity of the Middle (L2) and Inner Lagoon (L3 and L4) stations, especially during low tides, samples at these stations were collected using a different sampling protocol. These stations are sampled using a single plankton net and frame attached to the bow of a small boat that pushes the net through the water and collects a sample from approximately the upper 1 meter of water. By placing the net on the bow of the boat, the net collects a sample from undisturbed water. The collected material was rinsed into the codend and then placed into a labeled jar and preserved.

Figure 9-1
Location of EPS Entrainment (E1) and Source Water Stations (L1 through L4, and N1 through N5).



10.0 Summary

This PIC has been prepared in accordance with 40 CFR 125.95(b)(1) and is being submitted to the SDRWQCB prior to implementation of information collection activities. The following is a brief summary of the information collection activities described in this document that will be undertaken to support the development of the CDS, the plan for compliance with IM&E performance standards outlined in the EPA 316(b) Phase II Rule.

10.1 Evaluation of IM&E Reduction Measures

The EPS has selected several intake technologies, operational measures, and restoration measures that will be evaluated to determine effectiveness and feasibility of implementation, either alone or in combination, to achieve the required reductions in IM&E. In summary, these include the following:

Intake Technologies:

- Modified traveling screens with fish return
- New fine mesh screening structure

Operational Measures:

- Circulating water flow reductions / caps
- Variable speed drives for circulating water pumps
- Heat Treatment Operational Changes

Restoration Measures:

- Restoration or Enhancement of AHL various)
- Restoration or Enhancement of Agua Hedionda Watershed (various)
- Restoration or Enhancement of Nearshore coastal projects (various)

Preliminary assessments of these IM&E reduction measures will be conducted to determine those which warrant further evaluation. A more detailed evaluation of those measures will be conducted and a combination of the most feasible measures proposed to meet IM&E performance standards will be presented in the CDS.

10.2 Impingement Mortality & Entrainment Sampling Plan

The IM&E Characterization Study Plan that was the basis for the 2004-2005 EPS IM&E Study is included in Attachment C. The study plan described the collection, analysis, and evaluation methodologies for the twelve months of impingement and entrainment sampling data at the EPS.

The following are the main components of the sampling effort:

Impingement:

1. Weekly impingement sampling at each CWIS during normal plant operations
2. Impingement sampling at the CWIS during each heat treatment cycle

Entrainment:

1. Monthly entrainment sampling at the CWIS
2. Source waterbody sampling at five near shore source water locations and four lagoon source water locations

The characterization study plan also describes the sampling, quality assurance / quality control (QA/QC), and data management procedures that will be used in the study. Results of the study will be used to:

1. Determine the current level of IM&E occurring at the CWIS.
2. Compare the level of IM&E occurring due to the location, design, and operation of each existing CWIS with that which would occur if the CWIS were designed as a "calculation baseline" intake.
3. Determine the additional level of reduction in IM&E that would be required to meet performance standards.
4. Assist in the determination of the most feasible combination of intake technologies, operational measures, and/or restoration measures that may be implemented to reduce IM&E to vulnerable species.

10.3 Agency Review of PIC

As required by the EPA 316(b) Phase II regulation, this PIC is being submitted in accordance with the schedule requested by EPS in a letter dated January 6, 2005 to the SDRWQCB. The regulation requires that the SDRWQCB *"provide their comments expeditiously (i.e. within 60 days) to allow facilities time to make response modifications in their information collection plans"* (Federal Register, Vol. 69, No. 131, Pg. 41635). EPS has completed the IM&E sampling following its approved plan (Attachment C) and is working toward completing the final study report. The EPS PIC represents the rest of the requirement information to comply with the PIC requirements of Phase II 316(b) and EPS respectfully requests that SCRWQCB approve the PIC within 60 days such that work may begin on the CDS in order to meet the January 8, 2008 due date.

11.0 References

Boreman, J., C.P. Goodyear, and S.W. Christensen, 1978. *An Empirical Transport Model For Evaluating Entrainment Of Aquatic Organism By Power Plants*. United States Fish and Wildlife Service. FWS/OBS-78/90, Ann Arbor, MI.

Boreman, J., C.P. Goodyear, and S.W. Christensen, 1981. *An Empirical Methodology For Estimating Entrainment Losses At Power Plants Sited On Estuaries*. Trans. Amer. Fish. Soc. 110:253-260.

Bradshaw, J. S. and G. N. Estberg, 1973. *An Ecological Study of the Subtidal Marine Life of Agua Hedionda Lagoon*. Environmental Studies of the University of San Diego. Submitted to SDG&E, Part 1, 99 pp; Part 2. 123 pp.

Bradshaw, J. S. B. Browning, K. Smith, and J. Speth, 1976. *The Natural Resources of Agua Hedionda Lagoon*. U. S. Fish and Wildlife Service. Coastal Wetland Series #16. 109 pp.

Coastal Environments, Inc, 2005. *Agua Hedionda Lagoon Hydrodynamics Studies*. Prepared for Tenera Environmental by Coastal Environments, La Jolla, CA. 34 pp. + Appendices.

EA Engineering, Science, and Technology, 1997. *Encina Power Plant Supplemental 316(b) Assessment Report*. Prepared for San Diego Gas and Electric Company.

EPRI (Electric Power Research Institute), 1986. *Assessment Of Downstream Migrant Fish Protection Technologies For Fish Protection*. Prepared by Stone & Webster for EPRI. Report AP-4711. September.

EPRI, 1986. *Assessment of Downstream Migrant Fish Protection Technologies for Hydroelectric Application*. EPRI Report No. 2694-1.

EPRI, 1988. *Field Testing of Behavioral Barriers for Fish Exclusion at Cooling Water Intake Systems*. Central Hudson Gas & Electric Company – Roseton Generating Station. Prepared by Lawler, Matuskey & Skelly Engineers. Report CS-5995, September.

EPRI, 1990. *Fish Protection Systems for Hydro Plants. Test Results*. Prepared by Stone & Webster. EPRI Report GS-6712. February.

EPRI, 1992. *Evaluation of Strobe Lights for Fish Diversion at the York Haven Hydroelectric Project*. Prepared by Stone & Webster. Report TR-101703; November.

EPRI, 1999. Status Report on Fish Protection at Cooling Water Intakes. Prepared by Alden Research Laboratory. Report TR-114013. November.

Federal Register/Vol. 69, No. 131/Friday, July 9, 2004/Rules and Regulatory. *National Pollutant Discharge Elimination System-Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities*. July.

Goodyear, C.P, 1978. *Entrainment Impact Estimates Using The Equivalent Adult Approach.* U.S. Fish Wild. Ser. Rep. FWS/OBS-78/65. Ann Arbor, Mich.

Haaker P. L., J. M. Duffy, K. C. Henderson, and D. O. Parker, 1988. *The Speckled Scallop, Argopecten Circularis, In Aqua Hedionda Lagoon, San Diego County, California.* California Department of Fish and Game Technical Report.

Horst, T.J, 1975. *The Assessment Of Impact Due To Entrainment Of Ichthyoplankton.* Pp. 107-118 *in*: S.B. Saila (ed.), Fisheries and Energy Production: A Symposium. D.C. Heat and Co., Lexington, Mass.

Kramer, S.H., 1990. *Habitat Specificity and Ontogenetic Movements of Juvenile California Halibut, Paralichthys Californicus, and Other Flatfishes in Shallow Waters of Southern California.* Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA.

Kuhl, G.M., and K.N. Mueller, 1988. *Prairie Island Nuclear Generating Plant Environmental Monitoring Program 11988 Annual Report; Fish Mesh Vertical Traveling Screens Impingement Survival Study.* Northern States, Power Company, Minneapolis, MN.

MBC Applied Environmental Sciences and Tenera Environmental. 2005. AES Huntington Beach L.L.C. *Generating Station Entrainment and Impingement Study: Final Report.* Prepared for AES Huntington Beach L.L.C. and the California Energy Commission. April. 2005. 224 p. + Appendices.

MEC Analytical Systems, 1995. 1994 and 1995. *Field Survey Report Of The Ecological Resources Of Agua Hedionda Lagoon.* Submitted to San Diego Gas and Electric Company. 47 pp. + Appendices.

Monitoring Program, 1988 Annual Report: Fine-mesh Vertical Traveling Screens Impingement Survival Study. Prepared for Northern States Power Company.

Gunderboom Promotional Brochure.

MacCall, A.D., K.R. Parker, R. Leithiser, and B. Jesse, 1983. *Power Plant Impact Assessment: A Simple Fishery Production Model Approach.* Fishery Bulletin U.S. 81(3):613-619.

Murdoch, W.W., R.C. Fay, and B.J. Mechalas, 1989. *Final Report of the Marine Review Committee to the California Coastal Commission*, MRC Doc. No. 89-02, 346 p.

Parker, K.R. and E. DeMartini, 1989.. *Adult-equivalent loss. Technical Report to the California Coastal Commission, Marine Review Committee, Inc.* 56 p.

P. F. Shires, E. P. Taft, 1996. *Evaluation of the Modular Inclined Screen (MIS) at the Green Island Hydroelectric Project: 1995 Test Results.* Electric Power Research Institute (EPRI) Report TR-104498; May.

Public Service Electric and Gas Company. 1993. Appendix I—Modeling. Permit No. NJ0005622. Prepared by Lawler, Matusky, and Skelly Engineers, Pearl River, NY. Comments on NJPDES Draft. 82 p.

San Diego Gas and Electric (SDG&E). 1980. *Encina Power Plant Cooling Water Intake System Demonstration.* Prepared for California Regional Water Quality Control Board, San Diego Region. December 1980.

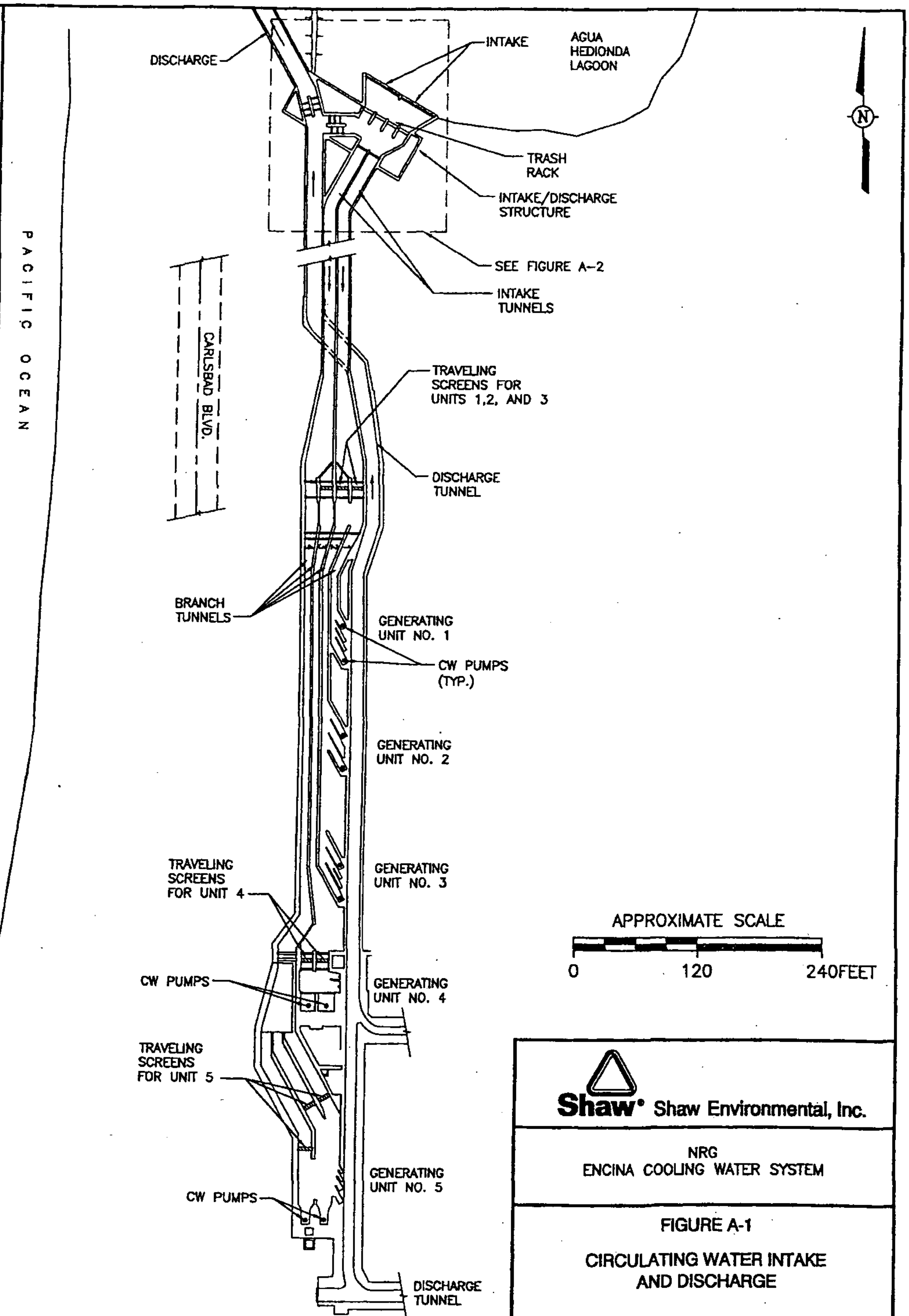
S. V. Amaral, F. C. Winchell, T. C. Cook, E. P. Taft; 1994. *Biological Evaluation of a Modular Inclined Screen for Protecting Fish at Water Intakes*; Electric Power Research Institute (EPRI) Report TR-104121; May.

Tenera Environmental. 2000a. *Diablo Canyon Power Plant: 316(b) Demonstration Report.* Prepared for Pacific Gas and Elec. Co., San Francisco, CA. Doc. No. E9-055.0.

Tenera Environmental. 2000b. *Moss Landing Power Plant Modernization Project: 316(b) Resource Assessment.* Prepared for Duke Energy Moss Landing, L.L.C., Oakland, CA.

Weight, R.H, 1958. *Ocean Cooling Water System for 800 MW Power Station*, Journal of the Power Division, Proceedings of the American Society of Civil Engineers, Dec 1958.

Attachment A
Structural Design Drawings



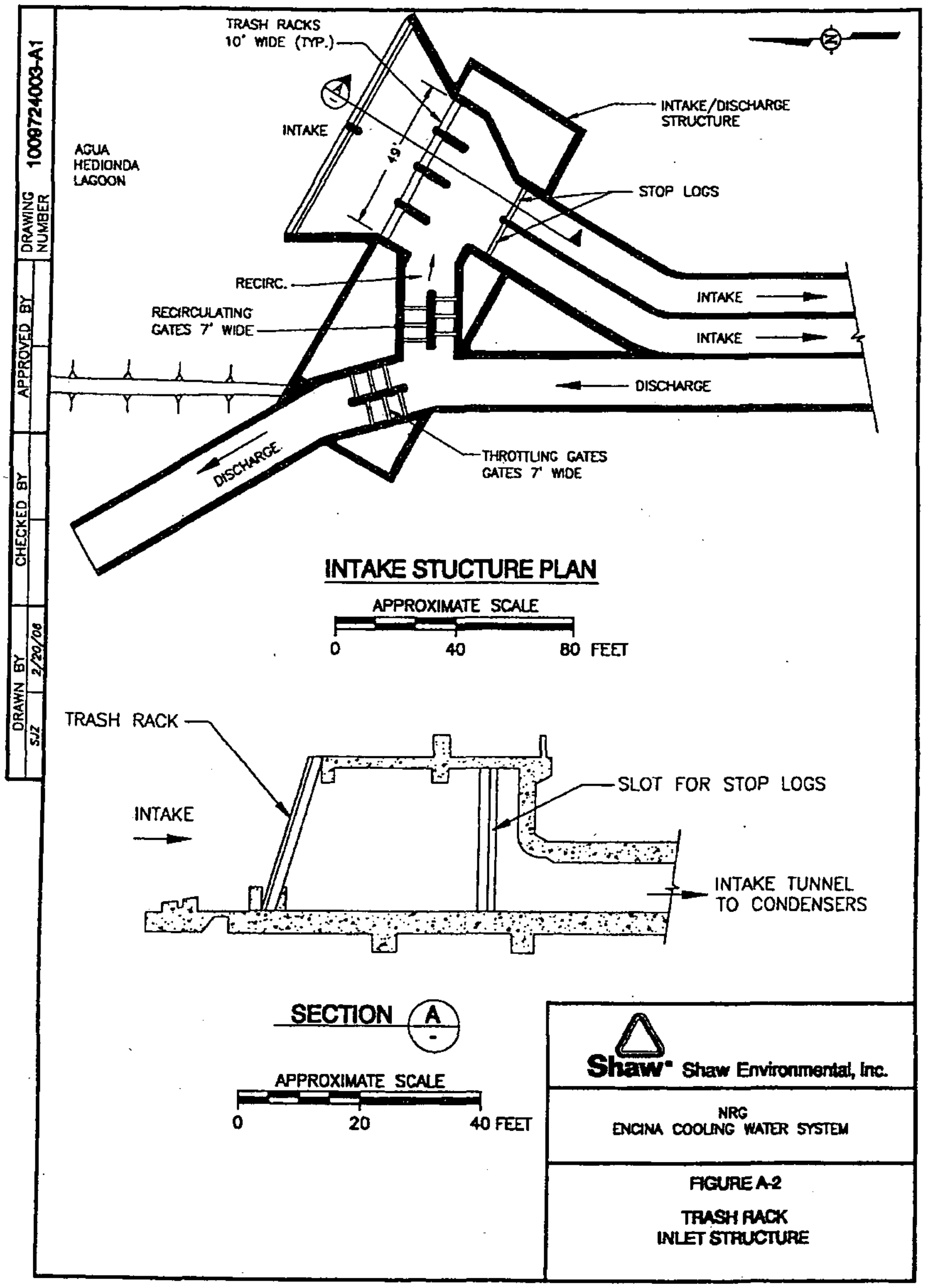
Shaw® Shaw Environmental, Inc.

NRG
ENCINA COOLING WATER SYSTEM

FIGURE A-1

CIRCULATING WATER INTAKE AND DISCHARGE

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
SJZ 2/20/06			1009724003-A1



TRASH RACKS 10' WIDE (TYP.)
INTAKE/DISCHARGE STRUCTURE
INTAKE
49'
AGUA HEDIONDA LAGOON
STOP LOGS
RECIRC.
RECIRCULATING GATES 7' WIDE
INTAKE
INTAKE
DISCHARGE
DISCHARGE
THROTTLING GATES GATES 7' WIDE
INTAKE STUCTURE PLAN
APPROXIMATE SCALE
0
40
80 FEET
TRASH RACK
INTAKE
SLOT FOR STOP LOGS
INTAKE TUNNEL TO CONDENSERS
SECTION A
APPROXIMATE SCALE
0
20
40 FEET
Shaw Shaw Environmental, Inc.
NRG
ENCINA COOLING WATER SYSTEM
FIGURE A-2
TRASH RACK
INLET STRUCTURE
DRAWING NUMBER 100987240003-A1
APPROVED BY
CHECKED BY
DRAWN BY SJZ 2/20/08

Encina Power Station
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

NRG CABRILLO POWER OPERATIONS INC.

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

**RE: Cabrillo Power I LLC – Encina Power Station;
Request for Schedule to Submit Information to Comply with the Phase II 316(b) Rule (40 CFR Part 125 Subpart J)**

Ref: NPDES Permit Number CA0001350, Order No. 2000-03

Dear Mr. Phillips,

By this letter Cabrillo Power I LLC (Cabrillo) requests a schedule for submitting the information required by EPA's new Phase II 316(b) Rule for cooling water intake structures for the Encina Power Station (EPS). For the reasons to be presented in the following letter, Cabrillo requests your approval to allow the information required by 40 CFR 125.95 to be submitted to you no later than January 7, 2008. In our circumstances, this date is as "expeditious as practicable." The basis for our request is explained below.

As you know, on July 9, 2004, EPA published its final rule prescribing how "existing facilities" may comply with Section 316(b) of the Clean Water Act.[1] For most existing facilities, this rule will require a large amount of data to establish "best technology available" for the facility's intake structure and to demonstrate compliance with the rule.

EPS is a "Phase II existing facility" within the meaning of 40 CFR 125.91. As such, it is required to comply with the Phase II rule, and in particular to submit the studies and information required by 40 CFR 125.95.

Section 125.95 of the new rule requires detailed studies and other information to establish what intake structure technology or other measures will be used to comply with the rule. Ordinarily this material is to be submitted with the facility's next application for renewal of its NPDES permit.[2] For permits that expire less than four years after the rule was published on July 9, 2004 (that is, before July 9, 2008), the facility may have up to three and half years to submit the information, so long as it is submitted "as expeditiously as practicable."[3] The facility may

[1] 69 Fed. Reg. 41575, 41683 (July 9, 2004).
[2] 40 CFR 125.95, 122.21(r)(1)(ii), 122.21(d)(2).
[3] 40 CFR 125.95(a)(2)(ii).

have even longer, until the end of the permit term, under 40 CFR 122.21(d)(2)(i), if the permitting agency agrees.

The current NPDES permit for EPS expires on February 9, 2005, well before July 9, 2008. Therefore, Cabrillo hereby requests that you authorize the information called for in 125.95 to be submitted as expeditiously as practicable, which, as explained below, will require until January 7, 2008.

In order to satisfy the "expeditiously as practicable" requirement, it should be noted that Cabrillo began the process of collecting the necessary information even before the final rule was published. Cabrillo actually began as early as 2003 to begin collecting information and conducting internal evaluations on how the, at that time draft, requirements could be complied with at EPS. Such information collection included preliminary technology assessments and research into existing data and information. Cabrillo also initiated an impingement and entrainment sampling program in June 2004 that is scheduled to conclude toward the end of 2005.

Despite our early efforts, we will still need until January 7, 2008, to complete the studies and collect the information required by 40 CFR 125.95. Our detailed explanation is presented below by first summarizing the significant number of informational requirements that must be submitted and then concludes by presenting the schedule by which the information would be submitted.

Cooling Water System Data

First, all facilities covered by the Phase II Rule must submit "cooling water system data" as required by 40 CFR 122.21(r)(5). This includes a narrative description of the operation of the cooling water system, its relationship to cooling water intake structures, the proportion of the design intake flow that is used in the system, the number of days of the year the cooling water system is in operation, and the seasonal changes in the operation of the system, if applicable. It also includes design and engineering calculations prepared by a qualified professional and supporting data to support the description of the operation of the cooling water system.[4] This information must be submitted at the same time as the Comprehensive Demonstration Study as discussed below.[5]

Proposal for Information Collection

Under 40 CFR 125.95(a)(1), Cabrillo must also submit a Proposal for Information Collection (PIC). Preparing the PIC is a large undertaking. The PIC must contain the items listed in 40 CFR 125.95(b)(1), including a description of proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated, a list and description of historical studies characterizing impingement mortality and entrainment and/or the

[4] 40 CFR 122.21(R)(5)(i) and (ii).
[5] 40 CFR 125.95(a)(2).

physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to the proposed study. For existing data, it must demonstrate the extent to which the data are representative of current conditions and that the data were collected using appropriate quality assurance/quality control procedures. The PIC must also include a summary of past or ongoing consultations with federal, state and tribal fish and wildlife agencies and a copy of their written comments, as well as a sampling plan for any new field studies describing all methods and quality assurance/quality control procedures for sampling and data analysis. As you know, Cabrillo already submitted the sampling plan portion of the PIC on September 2, 2004, which was later approved by the San Diego Regional Water Quality Control Board (Regional Board). The impingement and entrainment sampling actually commenced in June 2004 and is expected to conclude toward the end of 2005.

Because of the magnitude and specialized nature of the information to be submitted in the PIC, Cabrillo will have to contract with an outside consulting firm to obtain qualified personnel to perform the work and to handle the increased workload. Cabrillo's contractor procurement process has precise steps that must be undertaken to conform to internal policies and procedures and applicable law.

Including the time it takes to contract with a qualified consulting firm and to develop the PIC using the impingement and entrainment data collected during 2004 and 2005, Cabrillo believes a comprehensive PIC could not be submitted for the Regional Board's review and approval any earlier than April 1, 2006. Cabrillo asks that the Regional Board either approve it or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

Comprehensive Demonstration Study

The Comprehensive Demonstration Study (CDS), as described in 40 CFR 125.95(b), includes many mandatory sections that require substantial effort and time to develop and submit. Many sections of the CDS require that the information collection process described in the PIC be completed prior to being able to initiate those sections of the CDS. Because the PIC data collection will not be completed until early 2006, as described below in the Impingement Mortality and/or Entrainment Characterization Study section, much of the CDS will have to be completed during calendar years 2006 and 2007. This will most likely be a significant time constraint due to the level of work required by the Phase II 316(b) regulation. Below, ESP will describe each section of the CDS in detail, providing ample justification that Cabrillo's proposed complete CDS submission schedule is "as expeditiously as practicable."

Source Water Flow Information

Because EPS does not operate on a river or a lake, no specific source waterbody flow information is required to be submitted.[6]

Impingement Mortality and/or Entrainment Characterization Study

Cabrillo must provide, pursuant to 40 CFR 125.95(b)(3), an Impingement Mortality and/or Entrainment Characterization Study. This study must include (i) taxonomic identifications of all life stages of fish, shellfish, and any species protected under federal, state, or tribal law that are in the vicinity of the cooling water intake structures and are susceptible to impingement and entrainment; (ii) a characterization of all life stages of fish, shellfish, and any protected species, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structures, based on sufficient data to characterize annual, seasonal, and diel variations in impingement mortality and entrainment (e.g., related to climate and weather differences, spawning, feedings, and water column migration). These may include historical data that are representative of current operation of the facility and of biological conditions at the site.

Cabrillo must also document the current impingement mortality and entrainment of all life stages of fish, shellfish, and protected species and provide an estimate of impingement mortality and entrainment to be used as the "calculation baseline."[7] This may include historical data representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations must be collected during periods of representative operational flows for the cooling water intake structure, and the flows associated with the samples must be documented.

Cabrillo expects to submit, within the PIC document, justification for using the historical and representative impingement and entrainment data as well as the new data being collected during calendar years 2004 and 2005. As described above, impingement and entrainment sampling at EPS was initiated in June 2004 and is expected to continue through the end of 2005, which includes the necessary time to complete taxonomic identification, modeling, and development of draft and final reports.

Cabrillo plans on submitting its final PIC after submittal and review of the Impingement and Entrainment Characterization Study Final Report so that all of the collected information and its results can be incorporated into the development of the PIC. This appears to be the most efficient and complete way to produce the PIC, as the information from that study is necessary to complete the other components of the PIC, as described above. Since the Impingement and Entrainment Characterization Study Final Report is not expected to be complete until the end of 2005, the most expeditious submittal date for the final PIC is April 1, 2006.

---

[6] 40 CFR 125.95(b)(2) only requires source water information for facilities that withdraw water from rivers or lakes other than the Great Lakes. Although not specifically required, a characterization of the source water will be provided in the report on the results of the Impingement and Entrainment Characterization Study.
[7] 40 CFR 125.95(b)(3)(iii).

Design and Construction Technology Plan

Another analysis that must be provided is the Design and Construction Technology Plan.[8] If Cabrillo decides to use design and construction technologies and/or operational measures to comply with the Phase II rule, a plan must be submitted that provides the capacity utilization rate for the intake structure at EPS and provide supporting data (including the average annual net generation of the facility in MWh) measured over a five-year period (if available) of representative operating conditions and the total net capacity of the facility in MW, along with the underlying calculations. The plan must explain the technologies and/or operational measures that Cabrillo has in place and/or have selected to meet the requirements of the rule.

This Design and Construction Technology Plan must contain a large amount of information, as described in 40 CFR 125.95(b)(4)(A)-(D). This information includes (A) a narrative description of the design and operation of all design and construction technologies and/or operational measures, including fish handling and return systems, and information that demonstrates the efficacy of the technologies and/or operational measures; (B) a narrative description of the design and operation of all design and construction technologies and/or operational measures and information that demonstrates the efficacy of the technologies and/or operational measures for entrainment; (C) calculations of the reduction in impingement mortality and entrainment of all life stages of fish and shellfish that would be achieved by the technologies and/or operational measures we have selected; and (D) design and engineering calculations, drawings, and estimates prepared by a qualified professional to support the descriptions described above.

Technology Installation and Operation Plan (TIOP)

Assuming Cabrillo decides that the best way to comply with the Phase II rule is to use design and construction technologies and/or operational measures, in whole or in part, we must submit to you the following information, in accordance with 40 CFR 125.95(b)(4)(ii): (A) A schedule for the installation and maintenance of any new design and construction technologies; (B) a list of operational and other parameters to be monitored and the location and frequency that we will monitor them; (C) a list of activities we will undertake to ensure to the degree practicable the efficacy of installed design and construction technologies and operational measures and our schedule for implementing them; (D) a schedule and methodology for assessing the efficacy of any installed design and construction technologies and operational measures in meeting applicable performance standards or site-specific requirements, including an "adaptive management plan" for revising design and construction technologies, operational measures, operation and maintenance requirements, and/or monitoring requirements in the event the assessment indicates that applicable performance or site-specific requirements are not being met; and (E) if Cabrillo chooses the compliance alternative in 125.94(a)(4) (wedge-wire screens or a technology approved by the state), documentation that the appropriate site conditions described in 125.99(a) or (b) exist at our facility.

[8] 40 CFR 125.95(b)(4).

Restoration Plan

If Cabrillo determines that restoration measures are the best method to comply with the new rule, in whole or in part, then a Restoration Plan must be submitted in the CDS. This plan must include the information described in 40 CFR 125.95(b)(5). It must include a plan using an adaptive management method for implementing, maintaining, and demonstrating the efficacy of the restoration measures that are selected and for determining the extent to which the restoration measures, or the restoration measures in combination with design and construction technologies and operational measures, have met the applicable performance standards.

Site-Specific Requirements

If Cabrillo determines that site-specific requirements are appropriate because the cost of complying with the Phase II rule will be "significantly greater" than either the cost that EPA considered in its rulemaking or the benefits of complying with the rule, then Cabrillo will have to submit the information described in 40 CFR 125.95(b)(6). This includes a Comprehensive Cost Evaluation Study and, for the cost-benefit analysis, a Benefits Evaluation Study. Cabrillo must also include a Site-Specific Technology Plan describing and justifying the site-specific requirements.

Verification Monitoring Plan

Finally, Cabrillo must prepare a Verification Monitoring Plan as part of a complete CDS.[9] This is a plan to conduct, at a minimum, two years of monitoring to verify the full-scale performance of the proposed or already implemented technologies and/or operational measures.

PIC and CDS Schedule

The first official submittal (besides this request for a schedule) that Cabrillo will make to the Regional Board in compliance with the Phase II 316(b) regulation will be the PIC. For the reasons explained above, Cabrillo proposes to submit a comprehensive PIC for the Regional Board's review and approval by April 1, 2006. Cabrillo asks that the Regional Board either approve the PIC or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

Because Cabrillo plans to collect substantial new information as part of the expected PIC, and since the report presenting the results of the new impingement and entrainment data collected in 2004 and 2005 will not be finalized until the end of 2005, and allowing for the period of time the Regional Board has to review and approve the PIC, it is unlikely that the information needed to commence the majority of the sections of the CDS (including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the

---

[9] 40 CFR 125.95(b)(7).

Restoration Plan (if applicable), the Site Specific Requirements (if applicable), and the Verification Monitoring Plan) will be available until mid to late 2006.

Due to the step by step process by which the data must be collected, processed, evaluated, and then turned into a detailed plan of action to achieve the new Phase II 316(b) standards, Cabrillo does not believe a comprehensive CDS can be submitted earlier than January 7, 2008. It is for these important reasons that Cabrillo believes the most expeditious schedule possible for submittal of a comprehensive CDS is by January 7, 2008.

Conclusion

Collecting, generating, compiling, and analyzing the large amount of information required by the Phase II 316(b) rule will require a substantial effort. Cabrillo will have to collect and review the large volumes of already-existing data on the plant and the source waterbody, as well as integrate the substantial new biological information currently being collected.

Because the Phase II rule is new and untried, we foresee the need to coordinate closely with your department as we collect the necessary information, analyze it, and determine what combination of technology, operational measures, or restoration measures will best meet the Phase II rule for EPS. Cabrillo hopes your staff will be available to consult with us throughout this schedule as we complete these efforts.

For the above reasons, we request that we be allowed until January 7, 2008, to submit the information required for a permit application by the Phase II Rule, 40 CFR Part 125 Subpart J.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: [redacted]
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)

Attachment C
Impingement Mortality & Entrainment Characterization Study Sampling Plan

Encina Power Station
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

NRG CABRILLO POWER OPERATIONS INC.

September 2, 2004

Mr. John R. Phillips, P.E.
Senior Water Resource Control Engineer
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Subject: Cabrillo Power I LLC - Encina Power Station; Phase II 316(b) Entrainment and Impingement Sampling Plan

Dear Mr. Phillips;

Cabrillo Power I LLC (Cabrillo) is pleased to submit a plan to conduct entrainment and impingement sampling for the Encina Power Station (EPS) to comply with the US EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act. The approval of the EPS Entrainment & Impingement Sampling Plan (E&I Plan) is one of the early steps in the facility's compliance with the Phase II rule. Cabrillo requests expedited review and approval of this E&I Plan in order to optimize the sampling synergies available by virtue of the data collection efforts already underway on behalf of Poseidon Resources (Poseidon) for their proposed desalination project at EPS.

This sampling plan was prepared by Tenera Environmental (Tenera), which is the same firm that prepared the desalination sampling plan submitted to the San Diego Regional Water Quality Control Board (San Diego RWQCB) on behalf of Poseidon in July 2004. Consistent with that sampling plan, Poseidon has already collected several complete sets of entrainment and source water samples at EPS. The Poseidon study plan and collected data will produce information on the larval fish and target invertebrates contained in Poseidon's source of desalination feedwater (the power plant's cooling water discharge), as well as information on the larval fish and target invertebrates contained in the power plant's source waterbody and intake flows.

Data being collected for Poseidon on the power plant's source population of entrainable larval fish and target invertebrates is identical to the information Cabrillo will be required to collect and analyze for EPS Phase II 316(b) studies. Tenera has prepared this sampling plan to seamlessly and consistently continue the collection of the Poseidon entrainment data. In that way, Cabrillo can continue the sampling effort for compliance with the new Phase II performance standards in an efficient and cost-effective manner.

In the past five years, Tenera has completed 316(b) resource assessments for the Diablo Canyon Nuclear Power Plant, Moss Landing Power Plant, Morro Bay Power Plant and Potrero Plant. Tenera study design and assessment methods are also being employed in the ongoing 316(b) studies for the Huntington Beach Generating Station. Throughout these projects, Tenera has worked closely with State and Federal agencies in the development of their field study, impact assessment, and benefits evaluation methods. Tenera has also just recently completed a 316(b) resource assessment for the South Bay Power Plant that has been presented in final form to the San Diego RWQCB. Cabrillo's proposed E&I Plan has been developed in consideration of, and in keeping with, the 316(b) study rationales, content, sampling methodology, analysis and reporting that were used in the South Bay Power Plant 316(b) Assessment (Duke Energy South Bay, May 2004), as well as all of the power plants listed above.

This submission of the EPS E&I Plan is intended to meet part of the requirements for the Proposal for Information Collection (PIC) section of the Phase II 316(b) regulation, but not to address all of the PIC requirements at this time. All of the sampling plan requirements specified in Section 125.95(b)(1)(iv) are incorporated into the EPS E&I Plan. At a later date, Cabrillo will submit the remainder of the PIC requirements pursuant to Section 125.95(b)(1). Cabrillo requests approval of this E&I Plan specifying how new E&I data will be collected, but acknowledges that the San Diego RWQCB will be able to review the other portions of the PIC once submitted by Cabrillo.

Therefore, in order to provide continuous, efficient and cost-effective sampling at EPS, Cabrillo requests that the San Diego RWQCB expedite review and approval of this E&I Plan. Cabrillo understands that San Diego RWQCB is considering retaining an outside consultant in order to provide timely response to this request. Cabrillo is available and prepared to work with your staff and the consultant to provide any additional clarification necessary to obtain timely approval.

Please contact Tim Hemig directly at 760.268.4037 if there are any questions.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

Gregory J. Hughes

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig, Sheila Henika, John Steinbeck (Tenera)

Cabrillo Power I LLC, Encina Power Station

316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan

Submitted to the California Regional Water Quality Control Board – San Diego Region for Compliance with Section 316(b) of the Clean Water Act

September 2, 2004

Prepared by:
Tenera Environmental
971 Dewing Ave. Suite 101
Lafayette, CA 94549

225 Prado Rd. Suite D
San Luis Obispo, CA 93401

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Development of the 316(b) Sampling Plan

This document presents a sampling plan for conducting the entrainment and impingement sampling necessary for a cooling water intake assessment required under Section 316(b) of the Federal Clean Water Act (CWA). Our sampling plan is based on a survey and compilation of available background literature, results of completed Encina Power Station (EPS) intake studies, and cooling water system studies at other power plants. The data from this study will form the basis of demonstrating compliance with the new Phase II regulations recently developed by the U.S. Environmental Protection Agency (USEPA).

1.2 Overview of the 316(b) Program

Section 316(b) of the Clean Water Act requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact" (USEPA 1977). Because no single intake design can be considered to be the best technology available at all sites, compliance with the Act requires a site-specific analysis of intake-related organism losses and a site-specific determination of the best technology available for minimizing those losses. Intake-related losses include losses resulting from entrainment (the drawing of organisms into the cooling water system) and impingement (the retention of organisms on the intake screens).

1.2.1 Target Organisms Selected for Study

The USEPA in its original 316(b) lists several criteria for selecting appropriate target organisms for assessment including the following:

1. representative, in terms of their biological requirements, of a balanced, indigenous community of fish, shellfish, and wildlife;
2. commercially or recreationally valuable (e.g., among the top ten species landed—by dollar value);
3. threatened or endangered;
4. critical to the structure and function of the ecological system (i.e., habitat formers);
5. potentially capable of becoming localized nuisance species;
6. necessary, in the food chain, for the well-being of species determined in 1–4; and
7. meeting criteria 1–6 with potential susceptibility to entrapment/impingement and/or entrainment.

In addition to these USEPA criteria there are certain practical considerations that limit the selection of target organisms such as the following:

- identifiable to the species level;
- collected in sufficient abundance to allow for impact assessment, i.e., allowing the model(s) constraints to be met and confidence intervals to be calculated; and
- having local adult and larval populations (i.e., source not sink species). For example, certain species that may be relatively abundant as entrained larvae may actually occur offshore or in deep water as adults.

These criteria, results from the previous 316(b) studies at EPS completed in 1980, results from a supplemental 316(b) study completed in 1997 (EA Engineering 1997), results from more recent studies on the ecological resources of Aqua Hedionda Lagoon (MEC Analytical Systems 1995), and data collected from studies described in this document will be used to determine the appropriate target organisms that will be evaluated in detail. The final target taxa will include the fishes that are found to be most abundant in the entrainment and impingement samples. In addition to large invertebrates that may be abundant in impingement, megalopal (final) larval stage of all species of cancer crabs (*Cancer* spp., which includes the edible species of rock crabs) and the larval stages of California spiny lobster will be identified and enumerated from all processed entrainment and source water plankton samples.

1.3 Sampling Plan Organization

This sampling plan first describes the EPS environment, design, and operating characteristics. The methods for obtaining updated information on the types and concentrations of planktonic marine organisms entrained by the power plant's CWIS are then discussed. A discussion of the theoretical considerations behind the assessment methods for the entrainment and impingement data is then presented. The final 316(b) report will also include an overview of alternative intake technologies and an analysis of feasible alternatives and their cost-effectiveness to minimize adverse entrainment and impingement effects of the EPS CWIS.

2.0 Description of the Encina Power Station and Characteristics of the Source Water Body

2.1 Background

The Encina Power Station (EPS) is situated on the southern shore of the outer segment of the Agua Hedionda Lagoon in the city of Carlsbad, California, approximately 193 km (85 miles) south of Los Angeles and 16 km (35 miles) north of San Diego. EPS is a gas- and oil-fueled generating plant with five steam turbine generators (Units 1 through 5), which all use the marine waters of Agua Hedionda Lagoon for once-through cooling, and a small gas turbine generator. EPS began withdrawing cooling water from Agua Hedionda Lagoon in 1954 with the startup of commercial operation of Unit 1. Unit 2 began operation in 1956, Unit 3 in 1958, Unit 4 in 1973, and Unit 5 in 1978. The gas turbine was installed in 1968, which does not use cooling water in its operation. The combined net generation capacity of EPS is 966 megawatts electric (Mwe) (**Table 1**).

2.1.1 Plant Cooling Water System Description and Operation

Cooling water for the five steam electric generating units are supplied by two circulating and one or two service water pumps for each unit. The quantity of cooling water circulated through the plant is dependent upon the number of units in operation. With all units in full operation, the cooling water flow through the plant is 2,253 m^3/min (595,200 gallons per minutes [gpm]) or 3,244,430 m^3/day (857 million gallons per day [mgd]) based on the manufacturer ratings for the cooling water pumps (**Table 1**).

Table 1. Encina Power Station generation capacity and cooling water flow volume.

Unit	Gross Generation (MWe)	Cooling Water Flow m^3/min (gpm)	Daily Flow m^3/day (mgd)
1	107	193 (51,000)	278,000 (73)
2	104	193 (51,000)	278,000 (73)
3	110	204 (54,000)	294,350 (78)
4	300	806 (213,000)	1,161,060 (307)
5	325	856 (226,200)	1,233,010 (326)
Gas Turbine	20		
Total	966	2,252 (595,200)	3,244,430 (857)

Cooling water for all five steam-generating units is supplied through a common intake structure located at the southern end of the outer segment of Aqua Hedionda Lagoon, approximately 854 m (2,800 ft) from the opening of the lagoon to the ocean (**Figure 1**). Cooling water from the system is discharged into a small discharge pond that is located to the west of the intake structure. Water from the discharge pond flows through a culvert under Carlsbad Blvd and through a discharge canal across the beach and out to the ocean.

Seawater entering the cooling water system passes through metal trash racks on the intake structure that are spaced 8.9 cm (3½ in) apart and keep any large debris from entering the system. The trash racks are cleaned periodically. Behind the trash racks the intake tapers into two 3.7 m (12 ft) wide tunnels that further splits into four 1.8 m (6 ft) wide conveyance tunnels (**Figure 2**). Conveyance tunnels 1 and 2 provide cooling water for Units 1, 2 and 3, while conveyance tunnels 3 and 4 supply cooling water to Units 4 and 5, respectively. Vertical traveling screens prevent fish and debris from entering the cooling water system and potentially clogging the condensers. There are two traveling screens for Units 1, 2 and 3, two screens for Unit 4, and three screens for Unit 5. The mesh size on the screens for Units 1 through 4 is 0.95 cm (3/8 in), while the mesh size for Unit 5 is 1.6 cm (5/8 in).

The traveling screens can be operated either manually or automatically when a specified pressure differential is detected across the screens due to the accumulation of debris. When the specified pressure is detected the screens rotate and the material on the screen is lifted out of the cooling water intake. A screen wash system (70-100 psi), located at the head of the screen, washes the debris from each panel into a trough, which empties into collection baskets where it is accumulated until disposal.

The velocity of the water as it approaches the traveling screens has a large effect on impingement and entrainment and varies depending on the number of pumps operating, tidal level, and cleanliness of the screen faces. Approach velocities at high and low tide with all pumps operating were presented in the previous 316(b) study conducted in 1979 and 1980 (**Table 2**).

Table 2. Approach velocities at traveling screens for Encina Power Station with all circulating water and service water pumps in operation.

	Estimated Mean Approach Velocity (fps)	
Unit	**High Tide**	**Low Tide**
1	0.7	1.2
2	0.7	1.2
3	0.7	1.2
4	1.0	1.6
5	0.7	1.1

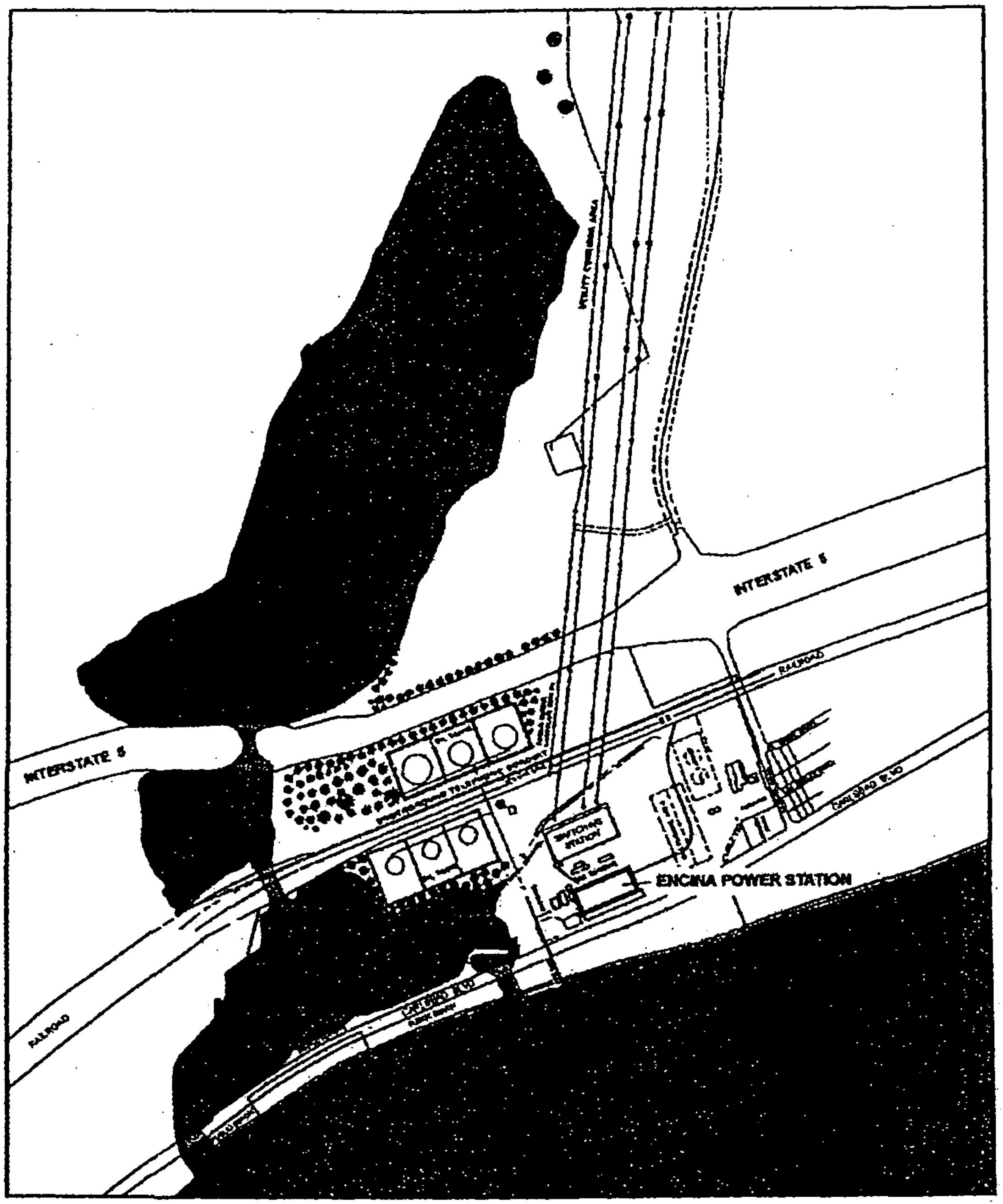


Figure 1. Location of Encina Power Station in Carlsbad, California

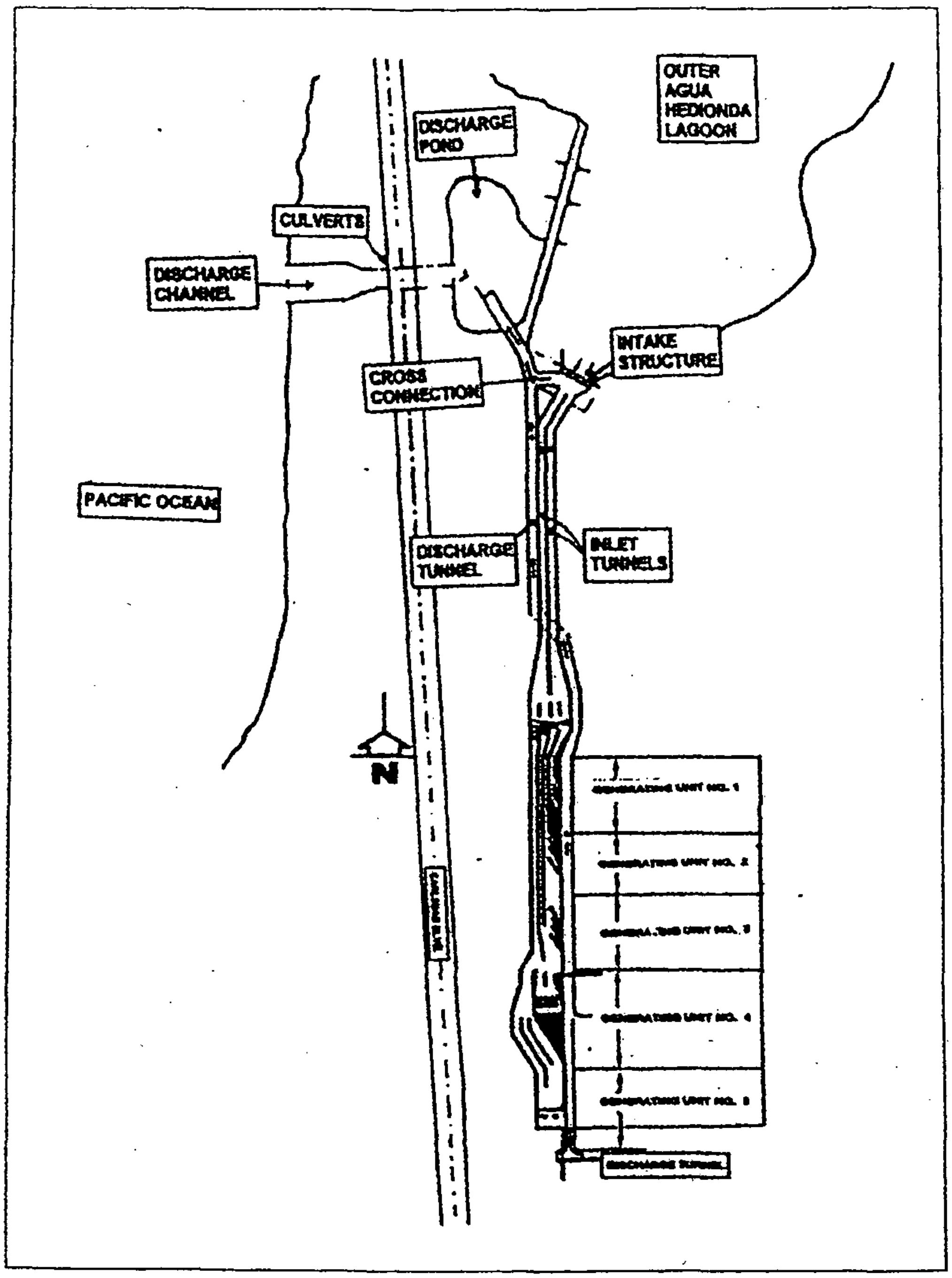


Figure 2. Schematic of Encina Power Station cooling water intake system.

2.2 Aquatic Biological Resources in the Vicinity of EPS

2.2.1 Agua Hedionda Lagoon

The Encina Power Station (EPS) is located on Agua Hedionda Lagoon, which is a man-made coastal lagoon that extends 2.7 km (1.7 miles) inland and is up to 0.8 km (0.5 mi) wide. The lagoon was constructed in 1954 to provide cooling water for the power plant. A railroad trestle and the Interstate Highway 5 bridge separate Agua Hedionda Lagoon into three interconnected segments: an Outer, Middle, and Inner lagoon. The surface areas of the Outer, Middle, and Inner lagoons are 26.7 (66 acres), 9.3 (23 acres), and 79.7 (197 acres) hectares, respectively. The lagoon is separated from the ocean by Carlsbad Boulevard and a narrow inlet 46 m [151 ft] wide and 2.7 m [9 ft] deep at the northwest end of the Outer Lagoon that passes under the highway and allows tidal exchange of water with the ocean.

Circulation and input into Aqua Hedionda Lagoon is dominated by semi-diurnal tides that bring approximately 2.0 million m^3 of seawater through the entrance to the Outer Lagoon on flood tides. Approximately half of this tidal volume flows into the Middle and Inner lagoons. On ebb tides this same tidal volume flows out through the entrance to the ocean. As a result of this tidal flushing the lagoon is largely a marine environment. Although freshwater can enter the lagoon through Buena Creek, which drains a 7,500 hectare (18,500 acres) watershed, for most of the year freshwater flow is minimal. Heavy rainfall in the winter can increase freshwater flows, reducing salinity, especially in the Inner Lagoon.

A study on the ecological resources of Agua Hedionda showed that it has good water quality and supports diverse infaunal, bird, and fish communities (MEC Analytical 1995). Eelgrass was found in all three lagoon segments, but was limited to shallower depths in the Inner Lagoon because water turbidity reduces photosynthetic light penetration in deeper areas. The eelgrass beds provide a valuable habitat for benthic organisms that are fed upon by birds and fishes. Although eelgrass beds were less well developed in areas of the Inner Lagoon, it also provides a wider range of habitats, including mud flats, salt marsh, and seasonal ponds that are not found elsewhere in Aqua Hedionda. As a result bird and fish diversity was highest in the Inner Lagoon.

A total of 35 species of fishes was found during the 1994 and 1995 sampling conducted by MEC (MEC Analytical 1995). The Middle and Inner lagoons had more species and higher abundances than the Outer Lagoon. During the 1995 survey only four species were collected in the Outer Lagoon, compared to 14 to 18 species in the Middle and Inner lagoons. The sampling did not include any surveys of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected. Silversides (Atherinopsidae) and gobies (Gobiidae) were the most abundant fishes collected. Silversides, including jacksmelt and topsmelt, that occur in large schools in shallow waters where water temperatures are warmest were most abundant in the shallower Middle and Inner lagoons. Gobies were most abundant in the Inner Lagoon which has large shallow mudflat areas that are their preferred habitat.

Special Status Species

The recent assessment of the ecological resources of Agua Hedionda did not collect any federally endangered tidewater goby (*Eucyclogobius newberryi*) that was once recorded from the lagoon (MEC Analytical 1995). The record of the occurrence may not be accurate or may predate the construction of the Outer Lagoon that provided a direct connection with the ocean. The current marine environment in the lagoon would not generally support tidewater gobies because they prefer brackish water habitats. No other listed fish species were collected in the study.

2.2.2 Pacific Ocean

Agua Hedionda Lagoon is tidally flushed through the small inlet in the Outer Lagoon by waters from the Pacific Ocean. The physical oceanographic processes of the southern California Bight that influence the lagoon include tides, currents, winds, swell, temperature, dissolved oxygen, salinity and nutrients through the daily tidal exchange of coastal seawater. Near the mouth of the lagoon the mean tide range is 3.7 ft (1.1 m) with a diurnal range of 5.3 ft (1.6 m). Waves breaking on the shore generally range in height from 2 to 4 ft (0.6 to 1.2 m), although larger waves (6 to 10 ft [1.8 to 3.0 m]) are not uncommon. Larger waves exceeding 15 ft (4.6 m) occur infrequently, usually associated with winter storms. Surface water in the local area ranges from a minimum of 57°F (13.9°C) to a maximum 72°F (22.2°C) with an average annual temperature between 63°F (17.2°C) and 66°F (18.9°C).

The outer coast has a diversity of marine habitats and includes zones of intertidal sandy beach, subtidal sandy bottom, rocky shore, subtidal cobblestone, subtidal mudstone and water column. Organisms typical of sandy beaches include polychaetes, sand crabs, isopods, amphipods, and clams. Grunion utilize the beaches around EPS during spawning season from March through August. Numerous infaunal species have been observed in subtidal sandy bottoms. Mollusks, polychaetes, arthropods, and echinoderms comprise the dominant invertebrate fauna. Sand dollars can reach densities of 1,200 per square meter. Typical fishes in the sandy subtidal include queenfish, white croaker, several surfperch species, speckled sanddab, and California halibut. Also, California spiny lobster and *Cancer* spp. crabs forage over the sand. Many of the typically outer coast species can occasionally occur within Agua Hedionda Lagoon, carried by incoming tidal currents.

The rocky habitat at the discharge canal and on offshore reefs supports various kelps and invertebrates including barnacles, snails, sea stars, limpets, sea urchins, sea anemones, and mussels. Giant kelp (*Macrocystis*) forests are an important habitat-forming community in the area offshore from Agua Hedionda. Kelp beds provide habitat for a wide variety of invertebrates and fishes. The water column and kelp beds are known to support many fish species, including northern anchovy, jack smelt, queenfish, white croaker, garibaldi, rockfishes, surfperches, and halibut.

Marine-associated wildlife that occur in the Pacific waters off Agua Hedionda Lagoon are numerous and include brown pelican, surf scoter, cormorants, western grebe, gulls, terns and loons. Marine mammals, including porpoise, sea lions, and migratory gray whales, also frequent the adjacent coastal area.

3.0 ENTRAINMENT STUDY AND ASSESSMENT METHODS

Entrainment studies were previously conducted in 1979 and 1980 at the EPS as part of the plant's initial Section 316(b) Demonstration requirement. The original study was conducted using pump sampling for plankton at the intake structure and net sampling of plankton at three source water stations in the Outer Lagoon (SDG&E 1980). For this study, plankton net sampling at the intake station and at an array of source water stations will be used to collect data for impact models that will be used to update the previous 316(b) Demonstration study. The following questions will be addressed by the entrainment and source water studies:

- What is the baseline entrainment mortality?
- What are the species composition and abundance of larval fishes, cancer crabs, and lobsters entrained by the EPS?
- What are the estimates of local species composition, abundance and distribution of source water stocks of entrainable larval fishes, cancer crabs, and spiny lobsters in Agua Hedionda Lagoon and the nearshore oceanic source waters?

The basis for estimation of entrainment effects is accurate knowledge of the composition and densities of planktonic organisms that are at risk of entrainment through the power plant cooling water system. Recent studies addressing 316(b) issues have focused on larval fishes and commercially important crustacean species (Tenera 2001, 2004). The basic study design involves the collection of plankton samples directly from the intake cooling water flow (entrainment sampling) and comparing the densities of various target species from plankton samples taken concurrently from the source water body (source water sampling). In the case of Encina Power Station (EPS), two areas contribute to the source water body; the lagoon sub-area and the nearshore sub-area, each having a unique contribution to the cooling water flows in terms of species composition and probability of entrainment.

3.1 Entrainment Study

Field data on the composition and abundance of potentially entrained larval fishes, *Cancer* spp. megalopae, and larval spiny lobster *Panulirus interruptus* will provide a basis to estimate the total number and types of these organisms passing through the power plant's cooling water intake system. For the purposes of modeling and calculations, through-plant mortality will be assumed to be 100 percent; unless otherwise determined through a San Diego RWQCB approved entrainment mortality study. Monthly entrainment and source water surveys started in June 2004 will be continued on a monthly basis through May 2005.

3.1.1 Entrainment Sampling Methods

This study was designed to quantify the composition and abundance of entrained larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae. A map of the station locations that were sampled starting in June 2004 is shown in Figure 3. These stations will continued to be sampled through May 2005 on a monthly basis.

Sample collection methods are similar to those developed and used by the California Cooperative Oceanic and Fisheries Investigation (CalCOFI) in their larval fish studies (Smith and Richardson 1977) but modified for sampling in the shallow areas of Agua Hedionda Lagoon. Two replicate entrainment samples are collected from a single station (E1) located in front of the EPP intakes by towing plankton nets from a small boat. A net frame is equipped with two 0.71 m (2.33 ft) diameter openings each with a 335 µm (0.013 in) mesh plankton net and codend. The start of each tow begins close to the intake structure, proceeds in a northerly direction against the prevailing intake current, and ends approximately 100 m from the structure. It is assumed that all of the water sampled at the entrainment station would have been drawn through the EPS cooling water system.

The tows are done by first lowering the nets as close to the bottom as practical without contacting the substrate. Once the nets are near the bottom, the boat is moved forward and the nets retrieved at an oblique angle (winch cable at approximately 45° angle) to sample the widest strata of water depths possible. Total time of each tow is approximately two minutes at a speed of 1 kt during which a combined volume of at least $60 m^3$ ($2,119 ft^3$) of water is filtered through both nets. In similar studies conducted by Tenera, this volume has been shown to typically provide a reasonable number and diversity of larvae for data modeling. The water volume filtered is measured by calibrated flowmeters (General Oceanics Model 2030R) mounted in the openings of the nets. Accuracy of individual instruments differed by less than 5% between calibrations. The sample volume is checked when the nets reach the surface. If the target volume is not collected, the tow was repeated until the targeted volume is reached. The nets are then retrieved from the water, and all of the collected material rinsed into the codend. The contents of both nets are combined into one sample immediately after collection. The sample is placed into a labeled jar and preserved in 10 percent formalin. Each sample is given a serial number based on the location, date, time, and depth of collection. In addition, the information is logged onto a sequentially numbered data sheet. The sample's serial number is used to track it through laboratory processing, data analyses, and reporting.

Entrainment samples are collected over a 24-hour period, with each period divided into four 6-hour sampling cycles. Larval fishes show day-night differences in abundances related to their vertical migratory behavior and spawning periodicity, and the 24-hr sampling regime allows these differences to be averaged for assessing entrainment abundances. Concurrent surface water temperatures and salinities are measured with a digital probe (YSI Model 30).

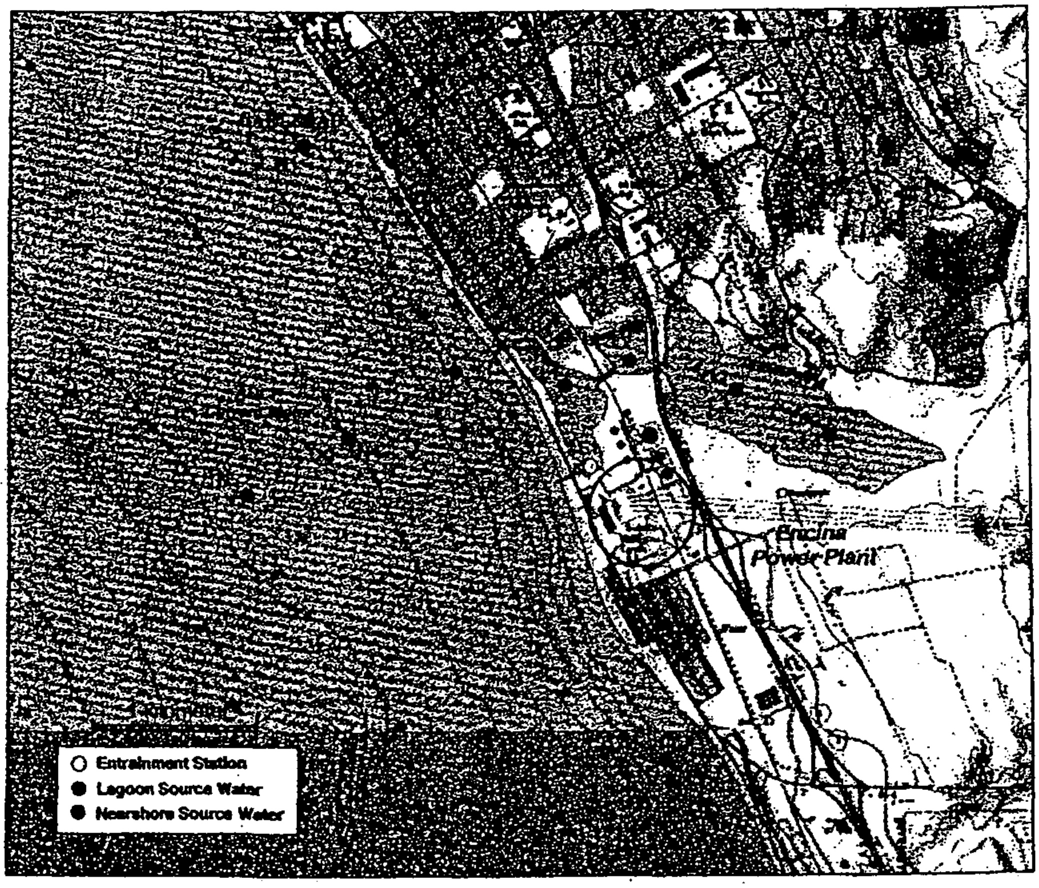


Figure 3. Location of Encina Power Station entrainment (E1) and source water stations (L1 through L4, and N1 through N5).

3.2 Source Water Study

This study was designed to quantify the local source water composition and abundance of larval fishes, *Cancer* spp. megalopae, and larval *Panulirus interruptus* in Agua Hedionda Lagoon and the nearshore source waters. The source water is partitioned into lagoon and nearshore sub-areas for modeling cooling water withdrawal effects (Figure 3). Collection methods are identical to the entrainment sample collection, with the exception that a single paired-net sample is collected at each station and the nearshore samples are be collected from a larger vessel capable of navigating open coastal waters in all weather conditions, day or night. The shallow waters in the Middle and Inner lagoons required a different sampling protocol than the oblique tows used at the Outer Lagoon and nearshore stations. The Inner Lagoon is sampled using a single frame plankton net mounted on the bow of a small boat which pushes the net through the water thereby eliminating any obstructions in front of the net during sampling. The net is raised and lowered during sampling to sample the range of depths available in the shallow Inner Lagoon.

The stations are stratified to include four lagoon stations within the inner (2), middle (1), and outer lagoons (1), and five nearshore stations that cover a depth range of 5–30 m (16–98 ft). The array of locations and depths was chosen to assure that all potential source water community types are represented. For example, stations in the inner lagoon will have a greater proportion of larvae from species with demersal eggs, such as gobies, that spawn in quiet water environments, while nearshore stations will have more larvae of species that spawn in open water such as California halibut and white seabass. The study will allow comparison to earlier larval fish studies done for the original EPS 316(b) in 1979-80 (SDG&E 1980).

A current meter is placed in the nearshore between Stations N4 and N5. The data from the meter will be used to characterize currents in the nearshore area that would directly affect the dispersal of planktonic organisms that could be entrained by the power plant. The data will be used to define the size of the nearshore component of the source water by using the current speed and the estimated larval durations of the entrained organisms.

The number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled. For example, a reduction in the number of stations may be recommended if analysis indicates that only one station is necessary to characterize the Inner Lagoon, or the Middle Lagoon is sufficiently similar to the Inner Lagoon that it does not need to be sampled separately. Analysis of current meter data may also indicate that Station N5 does not need to be sampled because the current is predominantly alongshore and can be adequately characterized using the other stations closer to shore.

3.2.1 Source Water Sampling Methods

Sampling is conducted using the same methods and during the same time period described earlier for the entrainment collections (Section 3.1.1) with target volumes for the oblique tows of approximately 60 m^3 (2–3 minute tow at approximately 1 knot).

3.3 Laboratory Processing and Data Management

Laboratory processing will remove all larval fishes, megalopal stages of *Cancer* spp., and larvae of spiny lobster from the samples. Fish eggs will not be sorted from the samples. Although many marine fish eggs are described in the scientific literature, most identifications are difficult and very time consuming, and impact models can be adequately parameterized without egg density data. Larval fishes and all species of cancer crab megalopae will be identified to the lowest taxonomic level possible by Tenera's taxonomists. In addition, the developmental stage of fish larvae (yolk-sac, preflexion, flexion, postflexion, transformation) will be recorded on the data sheet. A laboratory quality control (QC) program for all levels of laboratory sorting and taxonomic identification will be applied to all samples. The QC program will also incorporate the use of outside taxonomic experts to provide taxonomic QC and resolve identification uncertainties.

Many larval fish cannot be identified to the species level; these fish will be identified to the lowest taxonomic classification possible (e.g., genus and species are lower orders of classification than order or family). Myomere and pigmentation patterns are used to identify many species; however, this can be problematic for some species. For example, sympatric members of the family Gobiidae share similar characteristics during early life stages (Moser 1996), making identifications to the species level uncertain. Those gobiids that we are unable to identify to species will be grouped into an "unidentified goby" category.

Laboratory data sheets will be coded with species or taxon codes. These codes will be verified with species/taxon lists and signed off by the data manager. The data will be entered into a computer database for analysis.

Length measurements will be taken on a representative sample of the target larval fish taxa. Approximately 100 fish from each taxon will be measured using a video capture system and Optimus™ image analysis software. The 100 fish from each taxon will be selected from the entrainment station based on the percentage frequency of occurrence of a taxon in each survey. For example, if 20 percent of the California halibut larvae for the entire year-long study were collected from during the June survey then 20 fish will be measured from that survey.

3.4 Assessment Methods

Potential cooling water intake system (CWIS) entrainment effects will be evaluated using a suite of methods, with no single method being superior to any others. The potential entrainment effects of the EPS CWIS, assuming 100 percent through-plant mortality, will be estimated using the site-specific field data collected in this proposed study. The potential for any such CWIS effects to cause long-term population level impacts will be evaluated through the use of three analytical techniques: proportional entrainment (*PE*), adult equivalent loss (*AEL*), and fecundity hindcasting (*FH*). The results of these analytical steps will support assessments with respect to species population demographics (e.g., standing stock, age structure stability, fishery trends, and sustainable harvest management plans).

3.4.1 Demographic Approaches (FH and AEL)

The fecundity hindcasting or *FH* analysis approach (Horst 1975) compares larval entrainment losses with adult fecundity to estimate the amount of adult female reproductive output eliminated by entrainment. It thereby hindcasts the numbers of adult females effectively removed from the reproductively active population. The accuracy of these estimates of effects is dependent upon such factors as accurate estimates of age-specific mortality from the egg and early larval stages to entrainment, and also on age-specific estimates of adult fecundity, spawning periodicity, and reproductive lifespan. If it is assumed that the adult population has been stable at some current level of exploitation and that the male:female ratio is known and constant, then fecundity and mortality are integrated into an estimate of loss by converting entrained larvae back into females (i.e., hindcasting). In making this conversion, the number of eggs, derived from the number of larvae adjusted for egg to larvae mortality, are divided by the average number of eggs produced by each age class (size) of reproductive females in the stable population's ideal age structure. However this degree of information is rarely available for a population. In most cases, a simple range of eggs per females is reported without age-specificity.

An advantage of *FH* is that survivorship need only be estimated for a relatively short period of the larval stage (i.e., egg to larva). This method does not require source water sampling in addition to estimates of larval entrainment concentrations. This method assumes that the loss of a single female's reproductive potential is equivalent to the loss of adults. For the purpose of the resource assessment, if EPS-induced entrainment losses are to be equated to population level units in terms of fractional losses, it is still necessary to estimate the size of the population of interest. To this end, our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS.

The adult equivalent loss or *AEL* approach (Goodyear 1978) uses age-specific estimates of the abundance of entrained or impinged organisms to project the loss of equivalent numbers of adults based on mortality schedules and age at recruitment. The primary advantage of this approach is that it translates power plant-induced, early life-stage mortality into equivalent numbers of adult fishes, the units used by resource managers. Adult equivalent loss does not necessarily require source water estimates of larval abundance in addition to entrainment estimates, as required in *PE*. This latter advantage may be offset by the need to gather age-specific mortality rates to predict adult losses and the need for information on the adult population of interest for estimating population-level effects (i.e., fractional losses). However, the need for age-specific mortality estimates can be reduced by various approximations as shown by Saila et al. (1987), who used six years of entrainment and two years of impingement data for winter flounder *Pleuronectes americanus*, red hake *Urophycis chuss*, and pollock *Pollachius virens* at the Seabrook Station in New Hampshire. Their model assumed an adult population at equilibrium, a stable age distribution, a constant male:female ratio, and an absence of density-dependent (i.e., compensatory) mortality between entrainment and recruitment to the adult or fished stocks. Input data to their model parameters were gathered in field surveys of spawning populations, egg and larval production, and local hydrology.

Declining populations can be accounted for in both the *AEL* and *FH* approaches by using age-specific adult mortality estimates from fishery catch data and by assuming no compensatory mortality. However, we know that this is not an assumption that fits the reality of population dynamics. The removal (mortality) of any life stage will have an effect if it exceeds the number of reproductive adults required to produce that number of larvae. That is, the adult population will decline one for one with every larva lost. This is clearly not the case, nor does every larva survive to become an adult. Although we have essentially no way of estimating the degree to which a population can sustain losses and remain stable, it is an important issue when estimating long-range effects. The effect, known as density-dependence (sometimes called compensation), can affect the vital rates of impacted organisms. Density-dependence is not confined to acting through mortality; growth and fecundity may also be density-dependent. In fisheries management models, which we will take as our working models in forecasting long-term population trends, the level of compensation possible in species can be examined empirically by the response of its population to harvest rates.

Some entrainment studies have assumed that compensation is not acting between entrainment and the time when adult recruitment would have taken place, and further, that this specific assumption resulted in conservative estimates of projected adult losses (Saila et al. 1987). Others, such as Parker and DeMartini (1989), did not include compensatory mortality in estimates of equivalent adult losses because of a lack of consensus on how to include it in the models and, more importantly, uncertainty about how compensation would operate on the populations under study. The uncertainty arises because the effect of compensation on the ultimate number of adults is directly related to which of the vital processes (fecundity, somatic growth, mortality) and which life stages are being affected. In particular, Nisbet et al. (1996) showed that neglecting compensation does not always lead to conservative long-term estimates of equivalent adult losses.

3.4.2 Empirical Transport Model (ETM)

The *PE* approach (Boreman et al. 1978, Boreman et al. 1981) will provide an estimate of incremental (conditional, Ricker 1975) mortality imposed by EPS on local source water larval populations by using empirical data (plankton samples) rather than relying solely on hydrodynamic and demographic calculations. Consequently, *PE* requires an additional level of field sampling to characterize abundance and composition of larvae using results from the larval fish surveys defined in this document (Section 3.2.1). These estimates of species-specific fractional losses (entrainment losses relative to source water abundance) can then be expanded to predict regional effects on appropriate adult populations using an empirical transport model (*ETM*), as described below. Required parameters for the *PE* approach include the rate of cooling water withdrawal, estimates of entrained larval fish concentrations, and estimates of the larval fish concentrations in the source waters.

The use of *PE* as an input to the empirical transport model (*ETM*) has been proposed by the U.S. Fish and Wildlife Service to estimate mortality rates resulting from cooling water withdrawals by power plants (Boreman et al. 1978, and subsequently in Boreman et al. 1981). Variations of this model have been discussed in MacCall et al. (1983) and have been used to assess impacts at a southern California power plant (Parker and DeMartini 1989). The *ETM* has also been used to assess impacts at the Salem Nuclear Generating Station in Delaware Bay, New Jersey (PSE&G 1993) as well as other power stations along the East Coast. Empirical transport modeling permits the estimation of annual conditional mortality due to entrainment while accounting for the spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The generalized form of the *ETM* incorporates many time-, space-, and age-specific estimates of mortality as well as information regarding spawning periodicity and duration, many of which are limited or unknown for the marine taxa being investigated at EPS. The applicability of the *ETM* to the present study at EPS will be limited by a lack of either empirically derived or reported demographic parameters needed as input to the model. However, the concept of summarizing *PE* over time that originated with the *ETM* can be used to estimate entrainment effects over appropriate temporal scales either through modeling or by making assumptions about species-specific life histories. We will employ a *PE* approach that is similar to the method described by MacCall et al. (1983) and used by Parker and DeMartini (1989) in their final report to the California Coastal Commission (Murdoch et al. 1989), as an example for the San Onofre Nuclear Generating Station (SONGS). This estimate can then be summarized over appropriate blocks of time in a manner similar to that of the *ETM*.

4.0 IMPINGEMENT EFFECTS

The two primary ways cooling water withdrawal can affect aquatic organisms are through impingement and entrainment. Larger organisms are subjected to impingement on the screening system on the power plant's cooling water intake system (CWIS) that excludes debris from the circulating water pumps. EPS presently has seven sets of vertical traveling screens in three separate areas. Approach velocities vary from approximately 0.7 fps at high tide to 1.6 fps at low tide. Impingement occurs when an organism larger than the traveling screen mesh size is trapped against the screens. These impinged organisms are assumed to undergo 100 percent mortality for the purposes of this study. The following questions will be addressed by the impingement study:

- What is the baseline impingement mortality?
- What are the species composition and abundance of fishes and macroinvertebrates impinged by EPS?

4.1 Review of 1980 Impingement Study

In earlier impingement studies at EPS, fish samples were collected from screen washes during high and low impingement periods for one year (SDG&E 1980). Samples were collected over two-12 hour periods during each day to represent daytime and nighttime impingement. Since samples were collected every day the study provides a direct measure of EPS impingement. During the one-year period during normal plant operations 76 species of fishes and 45 species of macro-invertebrates totaling 85,943 individuals and weighing 1,548 kg (3,414 lb) were impinged. During the seven heat treatments conducted during the sampling period 108,102 fishes weighing 2422 kg (5,341 lb) were collected. The most abundant fishes collected in impingement samples were actively swimming, open-water schooling species such as deepbody and northern anchovy, topsmelt, and California grunion. Other abundant species included queenfish and shiner surfperch. During heat treatments larger fishes were collected that were less common during normal impingement. These larger fishes probably live in the CWIS and are able to avoid impingement during normal plant operation, but succumb to the warmer temperatures during heat treatment. Marine plants, largely eelgrass and giant kelp, made up the largest component of material in impingement samples.

Impingement losses at EPS were much less when compared with impingement at other coastal plant in southern California. Impingement was much greater at the Redondo Beach Generating Station and San Onofre Nuclear Generating Station Unit 1, even though the cooling water flows at those two facilities are less than the flow at EPS (673 and 500 MGD, respectively compared with 828 mgd at EPS). The intake approach velocities at the screenwells at EPS are lower than the velocities at these other facilities allowing most fishes to avoid impingement by continuous or burst swimming. The SDG&E report (SDG&E 1980) and a later evaluation (EA 1997) both concluded that the biological impact of EPS was insignificant in terms of impingement losses.

4.2 Impingement Study Methods

The purpose of the proposed 316(b) impingement study will be to characterize the juvenile and adult fishes and selected macroinvertebrates (e.g., shrimps, crabs, lobsters, squid, and octopus) impinged by the power plant's CWIS. The sampling program is designed to provide current estimates of the abundance, taxonomic composition, diel periodicity, and seasonality of organisms impinged at EPS. In particular, the study will focus on the rates (i.e., number or biomass of organisms per m^3 water flowing per time into the plant) at which various species of fishes and macroinvertebrates are impinged. The impingement rate is subject to tidal and seasonal influences that vary on several temporal scales (e.g., hourly, daily, and monthly) while the rate of cooling water flow varies with power plant operations and can change at any time. A review of the previous impingement study at EPS will provide context for interpreting changes in the magnitude and characteristics of the present day impingement effects. Studies of the Agua Hedionda fish assemblages independent of EPS (e.g., MEC Analytical 1995) will also provide information regarding the marine environment in southern and central Agua Hedionda Lagoon.

In accordance with procedures employed in similar studies, impingement sampling will occur over a 24-hour period one day per week. Before each sampling effort, the trash racks will be cleaned and the traveling screens will be rotated and washed clean of all impinged debris and organisms. The sluiceways and collection baskets will also be cleaned before the start of each sampling effort. The operating status of the circulating water pumps on an hourly basis will be recorded during the collection period. Each 24-hour sampling period at the traveling screens will be divided into six 4-hour cycles. The traveling screens will remain stationary for a period of 3.5 hours then they will be rotated and washed for 30 minutes. The trash racks will be cleaned once every 24 hours. The impinged material from the traveling screens will be rinsed into the collection baskets associated with each set of screens and the impinged material from the trash racks will be collected in the bin on the rake apparatus. The debris and organisms rinsed from each set of traveling screens and the trash racks will be kept separate and processed according to the procedures presented in the following section.

If the traveling screens are operating in the continuous mode, then sampling will be coordinated with the intake crew so samples can be collected safely. A log containing hourly observations of the operating status (on or off) of the circulating water pumps for the entire study period will be obtained from the power plant operation staff. This will provide a record of the amount of cooling water pumped by the plant, which will then be used to calculate impingement rates. The same procedure will be used to coordinate additional sampling efforts at the trash racks in case they need to be cleaned more frequently than once every 24 hours. The sampling at each of the three sets of traveling screens will be offset by one hour to allow screen wash and collection to occur at each set of screens separately.

Impingement sampling will also be conducted during heat treatment "tunnel shock" operations. Procedures for heat treatment will involve clearing and rinsing the traveling screens prior to the start of the heat treatment procedure. At the end of the heat treatment procedure normal pump operation is resumed and the traveling screens rinsed until no more fish are collected on the screens. Processing of the samples will occur using the same procedures used for normal impingement sampling. We anticipate that up to eight heat treatments will occur during the one-year study period.

A quality control (QC) program will be implemented to ensure the correct identification, enumeration, length and weight measurements of the organisms recorded on the data sheet. Random cycles will be chosen for QC re-sorting to verify that all the collected organisms were removed from the impinged material.

Depending on the number of individuals of a given target species present in the sample, one of two specific procedures is used, as described below. Each of these procedures involves the following measurements and observations:

1. The appropriate linear measurement for individual fishes and motile invertebrates is determined and recorded. These measurements are made in millimeters to the nearest 1 mm. The following standard linear measurements are used for the animal groups indicated:

Fishes	Total body length for sharks and rays and standard lengths (fork length) for bony fishes.
Crabs	Maximum carapace width.
Shrimps & Lobsters	Carapace length, measured from the anterior margin of carapace between the eyes to the posterior margin of the carapace.
Gastropod & Pelecypod Molluscs	Maximum shell length or maximum body length.
Octopus	Maximum "arm" spread, measured from the tip of one tentacle to the tip of the opposite tentacle.
Squid	Maximum body length, measured from the tip of one tentacle to the posterior end of the body.

2. The wet body weight of individual animals is determined after shaking loose water from the body. Total weight of all individuals combined is determined in the same manner. All weights are recorded to the nearest 1 g.

3. The qualitative body condition of individual fishes and macroinvertebrates is determined and recorded, using codes for decomposition and physical damage. These codes are shown on the attached form.

4. Other non-target, sessile macroinvertebrates are identified to species and their presence recorded, but they are not measured or weighed. Rare occurrences of other impinged animals, such as dead marine birds, are recorded and their individual weights determined and recorded.

5. The amount and type of debris (e.g., *Mytilus* shell fragments, wood fragments, etc.) and any unusual operating conditions in the screen well system are noted by writing specific comments in the "Notes" section of the data sheet.

The following specific procedures are used for processing fishes and motile invertebrates when the number of individuals per species in the sample or subsample is ≤ 29 :

1. For each individual of a given species the linear measurement, weight, and body condition codes are determined and recorded on separate lines.

The following specific subsampling procedures are used for fishes and motile invertebrates when the number of individuals per species is > 29:

1. The linear measurement, individual weight, and body condition codes for a subsample of 30 individuals are recorded on individual lines of the data sheet. The individuals selected for measurement should selected after spreading out all of the individuals in a sorting container, making sure that they are well mixed and not segregated into size groups. Individuals with missing heads or other major body parts are eliminated from consideration, since linear measurements of them are not representative.

2. The total number and total weight of all the remaining individuals combined are determined and recorded on a separate line.

4.2.1 Sampling Frequency

Results from the previous impingement study indicated that the impingement is much greater during the heat treatment "tunnel shock" events. Almost 60 percent of the total impinged fishes (over 60 percent by weight) were collected during the seven tunnel shock events. Impingement rates during normal operations were much less. Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks. The analysis will be done using the weekly data collected at EPS during this study and data from other southern California power plants with shoreline intake structures. The reduced sampling frequency may provide an adequate estimate of impingement especially since we will continue to sample impingement during each of the tunnel shock events when impingement is highest.

5.0 COOLING WATER SYSTEM IMPACT ASSESSMENT

The entrainment and impingement effects of the cooling water intake system for the EPS project will be assessed on the basis of historical studies and 12 months of recent plankton and 12 months of impingement survey information. The assessment will consider the effects of entraining larval fishes, crabs and lobsters, and impinging larger fishes and invertebrates in the CWIS. The three methods for assessing CWIS effects are fecundity hindcasting (*FH*), adult equivalent loss (*AEL*) and empirical transport modeling (*ETM*). These methods were explained in Section 3.5—Assessment Methods. The report will contain estimates of *AEL* and *FH* where data are available to parameterize these demographic approaches.

The impacts of impingement and entrainment on source water populations can be evaluated by estimating the fractional losses to the population attributable to the CWIS. Impingement rates and biomass estimates from the study will provide estimates of impingement losses that can then be translated directly to estimate potential impingement effects on local fisheries. Estimated entrainment losses are extrapolated to fishery losses using *FH* and *AEL* estimates. One constraint in the modeling approach is that life history data are available for only a portion of the entrained taxa and commercial fishery statistics will also only be available for a few of the entrained species (e.g., California halibut, northern anchovy, white croaker). Many of the fishes that have historically been entrained in highest numbers are small fishes that are not the focus of any recreational or commercial fishery.

Present-day findings on the EPS CWIS entrainment effects will be reviewed and assessed for the most abundant larval fish taxa, megalopal cancer crabs, and larval spiny lobster. By comparing the number of larvae and megalopae withdrawn by the power plant to the number available (i.e., at risk to entrainment), an estimate of the conditional mortality due to entrainment (*PE*) can be generated for each taxon or species. These estimates of conditional mortality will be combined in the *ETM* model to provide an estimate of the annual probability of mortality due to entrainment (P_m) that can be used for determining CWIS effects and the potential for long-term population declines. Fishery management practices and other forms of stock assessments will provide the context required to interpret P_m. In the case of a harvested species, P_m must be considered in addition to these harvest losses when assessing impacts and any potential for population decline.

5.1 Entrainment Effects Assessment

The assessment will focus on entrainment effects to the most abundant and to commercially or recreationally important fish taxa, cancer crab megalops and lobster larvae. Larval fishes analyzed will tentatively be the Goby complex, three Engraulid species, three Atherinopsid species, California halibut, white croaker, black croaker, spotted sand bass, and barred sand bass. These taxa likely comprise over 90 percent of all the entrained larval fishes based on earlier studies. Other species, which may occur in lower abundances, may also be included in the assessment because they represent species of commercial or recreational importance

5.2 Summary of Entrainment Effects

The length of time that a larval fish is in the plankton and subject to entrainment is a key parameter in *ETM* calculations. Length measurements taken from representative samples of the larval fish taxa presented in Section 4.0 will be used to estimate the number of days that larvae (for a specific taxon) are at risk to entrainment. Reports on larval duration from the scientific literature are likely to overestimate the period of time that larvae are exposed to entrainment. This is because ontogenetic changes during larval development result in increased swimming ability or behavioral changes, such as association with the bottom or other pre-settlement microhabitats. Possible outliers are eliminated by basing the minimum and maximum lengths on the central 98 percent of the length distribution for a taxon and excluding the lengths of the top and bottom percentiles. Estimates of larval growth rates (mm/day) are then used on this range to estimate the number of days the larvae are exposed to entrainment. The estimates of growth rates and their source from the literature will be presented in the impact assessment section for the different taxa. The average duration of entrainment risk for a taxon is calculated from the bottom percentile value to the mean value, while the maximum duration is calculated from the bottom percentile value to the 99 percentile value. Our estimates of the period of entrainment risk for cancer crabs and spiny lobster will be derived from literature values on the average age of the stages for each crustacean species.

5.3 Summary of Impingement Effects

Impingement effects in relation to source water fishery resources and potential ecological effects will be summarized based on data summarized from the earlier impingement study (SDG&E 1980), data on fish populations in Agua Hedionda Lagoon (MEC 1995), and CDF&G catch records for sport and commercial fishery resources.

6.0 LITERATURE CITED

Boreman, J., C. P. Goodyear, and S. W. Christensen. 1978. An empirical transport model for evaluating entrainment of aquatic organism by power plants. United States Fish and Wildlife Service. FWS/OBS-78/90, Ann Arbor, MI.

Boreman, J., C. P. Goodyear, and S. W. Christensen. 1981. An empirical methodology for estimating entrainment losses at power plants sited on estuaries. Transactions of the American Fishery Society 110:253-260.

EA Engineering, Science, and Technology. 1997. Encina Power Plant supplemental 316(b) assessment report. Prepared for San Diego Gas and Electric Company.

Goodyear, C. P. 1978. Entrainment impact estimates using the equivalent adult approach. USFWS Biological Services Program. FWS/OBS – 78/65. 14 pp.

Horst, T. J. 1975. The assessment of impact due to entrainment of ichthyoplankton. Pp. 107-118 *In* S. B. Saila (ed.) Fisheries and Energy Production: A Symposium. Lexington Books, D. C. Health and Company, Lexington, MA.

MacCall, A. D., K. R. Parker, R. Leithiser, and B. Jessee. 1983. Power plant impact assessment: A simple fishery production model approach. Fishery Bulletin 81(3):613-619.

MEC Analytical Systems. 1995. 1994 and 1995 field survey report of the ecological resources of Agua Hedionda Lagoon. Submitted to San Diego Gas and Electric Company. 47 pp. + Appendices.

Moser, H. G. 1996. The Early Stages of Fishes in the California Current Region. California Cooperative Oceanic Fisheries Investigations, Atlas No. 33. Allen Press Inc., Lawrence, Kansas.

Murdoch, W. W., R. C. Fay, and B. J. Mechalas. 1989. Final Report of the Marine Review Committee to the California Coastal Commission, Marine Review Committee Doc. No. 89-02, 346 pp.

Nisbet, R. M., W. Murdoch and A. Stewart-Oaten. 1996. Consequences for adult fish stocks of human-induced mortality on immatures. Pages 257-277 *In*: Schmitt, R.J and C.W. Osenberg (eds.). Detecting ecological impacts: Concepts and applications in coastal habitats. Academic Press.

Parker, K. R. and E. E. DeMartini. 1989. Chapter D: Adult-equivalent loss. Technical Report to the California Coastal Commission. Prepared by Marine Review Committee, Inc. 56 pp.

Public Service Electric and Gas Company (PSE&G). 1993. Appendix I—Modeling. Permit No. NJ0005622. Prepared by Lawler, Matusky, and Skelly Engineers, Pearl River, NY. Comments on NJPDES Draft. 82 pp.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fishery Research Board of Canada Bulletin 91. 382 pp.

Saila, S. B., X. Chen, K. Erzini, and B. Martin. 1987. Compensatory mechanisms in fish populations: Literature reviews. Volume 1: Critical evaluation of case histories of fish populations experiencing chronic exploitation or impact. EA-5200. Report prepared for the Electric Power Research Institute.

San Diego Gas and Electric (SDG&E). 1980. Encina Power Plant cooling water intake system demonstration. Prepared for California Regional Water Quality Control Board, San Diego Region.

Smith, P. E. and S. L. Richardson. 1977. Standard Techniques for Pelagic Fish Egg and Larva Surveys. FAO Fisheries Technical Paper 175:1-100.

Tenera Environmental. 2001. Morro Bay Power Plant Modernization Project 316(b) Resource Assessment. Doc. E2000-107.8. Prepared for Duke Energy Morro Bay, LLC.

Tenera Environmental. 2004. SBPP Cooling Water System Effects on San Diego Bay, Vol. II: Compliance with Section 316(b) of the Clean Water Act for the South Bay Power Plant. Doc. No. ESLO2003-037.6. Prepared for Duke Energy. August 2004.

U. S. Environmental Protection Agency (USEPA). 1977. Guidance for evaluating the adverse impact of cooling water intake structures on the aquatic environment: Section 316(b) P.L. 92-500. 58 pp.

Encina Power Station
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

NRG CABRILLO POWER OPERATIONS INC.

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Subject: Cabrillo Power I LLC Response to Comments from Tetra Tech to San Diego Regional Water Quality Control Board on the Encina *316(b) Cooling Water Intake Effects Entrainment & Impingement Sampling Plan*

Dear Mr. Phillips:

Cabrillo Power I LLC (Cabrillo) appreciates the opportunity to respond to the comments from Tetra Tech on the *316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan* for the Encina Power Station (EPS) submitted to the San Diego Regional Water Quality Control Board (Regional Board) on September 2, 2004. Tenera Environmental prepared the plan for the EPS 316(b) studies, and Cabrillo had them respond to comments from Tetra Tech. The responses from Tenera are incorporated into this letter and identified accordingly.

The Tetra Tech comments generally call for further clarification of the study plan or additions to the plan that will not affect the sampling procedures currently being used. The Tetra Tech comments (numbered the same as on the Tetra Tech memo) with specific questions of Cabrillo have responses that are highlighted in boldface type. Tetra Tech also made several suggestions that we have responded to in the final section of this letter.

TETRA TECH COMMENTS AND CABRILLO RESPONSES:

1) *Page 2*: The authors state that they will use EPA's criteria for selecting appropriate target organisms for assessment, results from previous 316(b) studies, Aqua Hedionda Lagoon ecological surveys, and results from the upcoming study to "determine the appropriate target organisms that will be evaluated in detail." Final selection of target organisms should involve consultation with the appropriate resource agencies. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

***Response*: The final selection of the specific target organisms will be made in collaboration with the Regional Board and other appropriate agencies. The**

sampling and processing is currently focused on fishes and selected macroinvertebrates; the same groups of organisms that were studied in San Diego Bay in 2001–2003 at the Duke Energy South Bay Power Plant in San Diego. The final list of target organisms will be based largely on their abundances in the entrainment and impingement samples. The impact assessment will be restricted to the most abundant taxa to ensure that there is have reasonable confidence in the results.

3) *Page 7*: The MEC Analytical (1995) ecological surveys will be used to provide "data on fish populations in Aqua Hedionda Lagoon" (see page 24) for the evaluation of EPS impingement effects in relation to source water fishery resources. The authors mention that the MEC Analytical sampling "did not include any areas of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected." It appears that the surveys focused on the Middle and Inner Lagoons. Since the MEC Analytical data will be used for impingement effects analyses, the search for and/or collection of supplemental information for Outer Lagoon fishes may be warranted (however, it should be noted that we have not reviewed the contents of the MEC Analytical report).

***Response*: The MEC study utilized multiple gear types that effectively sampled most of the habitats in Aqua Hedionda Lagoon. Cabrillo is currently evaluating if supplemental studies of the habitats not sampled in the MEC study are necessary and will propose those to the Regional Board if warranted. These habitats include the shallow mudflats areas that are common in the middle and inner lagoon, the rocky habitat that lines the boundary of the outer lagoon, and the artificial substrates on the piers, docks and floats of the outer lagoon. Gobies that occur in burrows on the mudflats and combtooth blennies, garibaldi and rockfishes that occur on the rocky habitat and artificial substrates in the outer lagoon were not effectively sampled by any of the gear types used in the MEC study. The larvae from these fishes will likely be abundant in the entrainment samples and this study will provide an estimate of their adult source water populations that will be used in the assessment of cooling water intake system (CWIS) effects.**

6) *Page 11*: The authors state that entrainment sampling began in June 2004 and will continue through May 2005. Has this proposed index period changed, or was approval received for sampling commencement prior to the preparation and review of this sampling plan (Plan is dated September 2004)? Did source water sampling also begin before this plan was written?

Response: **Both entrainment and source water sampling began in June 2004. The sampling started before a sampling plan was submitted to the Regional Board to take advantage of studies of the cooling water system that were being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources. The original proposal for the Poseidon study did not include the more extensive source water sampling in the final study plan. The scope of the study was expanded to conform to other 316(b) demonstration studies Tenera has completed in California including the study recently completed at the Duke Energy South Bay Power Plant in San Diego Bay. This provided Cabrillo the opportunity to continue the sampling in response to EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act.**

7) *Page 11*: Entrainment samples will be collected from the lagoon, near the intake structure. Is entrainment sampling not possible from a location within the EPS CWIS?

Response: **Entrainment sampling conducted at ocean and estuarine power plants over the last ten years in California has been done in the source waters as near as possible to the intakes. This sampling location has been used because studies at the Diablo Canyon Power Plant in central California showed that large losses of planktonic organisms such as larval fishes can occur as a result of filtering by biofouling organisms that grow on the surfaces inside the power plant cooling water intake system. Studies have shown reductions in densities of greater than 90 percent between intake and discharge samples that have been attributed to biofouling losses. Although the entrainment sampling proposed for the EPS with plankton nets in the source waters at the power plant intake structure requires the assumption that the densities of organisms in the source waters are representative of the densities of organisms that are entrained, sampling inside the power plant introduces additional assumptions, sampling problems, and the known problem of cropping by biofouling organisms. One of these problems involves obtaining representative, well-mixed samples and sampling in rapidly flowing water. In addition, sampling inside the plant cooling water system usually requires pump sampling methods that are different than the towed net sampling used in the source waters, therefore introducing additional assumptions affecting comparisons between density estimates. All of these issues have resulted in the recommendation that entrainment sampling be done in the lagoon using nets towed as close as practical to the intake structure.**

8) *Page 11*: As part of the description of entrainment sampling methods, the authors mention that the "accuracy of individual instruments differed by less than 5% between calibrations." This is mentioned as a statement. Is it intended to be a quality standard?

Response: **No, it is not intended as a quality standard, it is just a statement that the difference in rotor constants between calibrations was generally less than 5%. In addition to maintaining the flowmeters before and after each survey, they are calibrated every three months to recalculate a new rotor constant, which is used to calculate the flow of water through the net. If the value of a constant changes greater than 10% between calibrations, which is almost never the case, the readings from the field data sheets are reviewed to determine when the change occurred. If the change in the flowmeter can be detected from the data, the values will be adjusted using the average difference between the two flowmeters used on the bongo frame prior to that sample; otherwise the flowmeter reading for the instrument that is within the 10% calibration range will be used to estimate the volume of seawater filtered through both nets on the bongo frame.**

9) *Page 11*: The authors state that if the target volume of water is not filtered during the entrainment tow, the tow will be repeated until the targeted volume is reached. Will the tow distance be extended to accomplish this, or will the tow truly be "repeated?"

Response: **The tow will be continued at the lagoon and entrainment stations by extending the tow, covering the vertical depth of the water column until the target volume is collected. Some of the deeper nearshore samples cannot simply be extended because it would not be possible to collect an unbiased sample that extended across all depths without greatly increasing the sample volume. In these cases, or if flowmeters are fouled with kelp, the samples are discarded and the sampling is repeated at the station.**

10) *Page 12*: The source water sampling methods are said to be "identical to the entrainment sample collection" (with a few noted exceptions). Does that mean that all source water stations will be sampled concurrently with entrainment sampling, and during the same (four) six-hour cycles? Is the source water sampling index period the same as the June 2004-May 2005 entrainment period?

Response: **Yes, all of the stations, source water and entrainment, are sampled during the same four six-hour blocks on the day the survey is conducted. All of the stations are usually sampled within a 2-3 hour period. All of the**

stations have been sampled since June 2004 with a total of eight surveys collected as of December 2004.

11) *Page 13*: The Inner Lagoon will be sampled with a single pushnet. Will the targeted volume of water be the same as the paired net (oblique) samples taken in the Outer Lagoon and nearshore ocean areas?

Response: Yes. **The targeted volume for the lagoon source water and entrainment samples is approximately 50 m^3. The volumes for samples from the nearshore stations may be greater, especially at the deepest stations, N4 and N5, where the minimum sample volume may exceed 50 m^3 because the nets are lowered through the entire water column and then retrieved.**

13) *Page 13*: The authors mention that "the number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

Response: **A proposal for this or any other change in the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by Regional Board and other reviewing agencies.**

14) *Page 14*: The authors state that, "A laboratory quality control (QC) program...will be applied to all samples." Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the specific data quality objectives for laboratory processing (e.g., sorting efficiencies, taxonomic agreement, etc.)?

Response: **The laboratory QC program is an internal Tenera document that was not cited in the study plan. The QC program includes a procedure for preserving, transferring, splitting, and sorting plankton samples. There is a separate procedure for identification of the organisms from the samples. The following data quality objectives are used for sorting:**

1. **The first ten samples that are sorted by an individual are completely resorted by a designated QC sorter. A sorter is allowed to miss one target organism when the original sorted count is 1-19. For original counts above 20 a sorter must maintain a sorting accuracy of 90%.**
2. **After the sorter has passed 10 consecutive sorts, the program is switched to a '1 sample in 10' QC program for that sorter. After the sorter has**

completed another 10 samples, one sample is randomly selected by the designated QC sorter for a QC resort.

3. **If the sorter maintains the 90% accuracy sorting rate for this sample, then the sorter continues in the '1 sample in 10' QC mode.**
4. **If a sample does not meet the 90% accuracy rate their subsequent samples will be resorted until 10 consecutive samples meet the criteria.**

A similar QC procedure is used for taxonomic identification except that the taxonomist must maintain an accuracy level of 95% for the identifications.

16) *Page 15*: The FH model requires specific input parameter data (e.g., age-specific mortality) that may not be readily available. The authors state that, "...this degree of information is rarely available for a population." They also mention that "...our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS." Will adequate input parameter data be available, or is it too early in the process to tell?

Response: **The initial review of the data showed that many of the same fish taxa that were analyzed from other studies were also abundant in the EPS samples. Also, similar to other studies, the majority of the fishes were small, forage species that do not have direct commercial/recreational fishery values. Therefore, while it has been possible to parameterize the adult equivalent models (FH and AEL) for many of these species in past studies, estimates of their adult populations that were necessary to interpret the results of the modeling efforts were usually not available. The MEC study on the fishes of Aqua Hedionda Lagoon and results from supplemental studies on adult fishes will help provide some of this information.**

19) *Page 19*: The impingement study methods do not mention an index period. Has impingement sampling begun, and will the sampling period coincide with entrainment sampling (June 2004-May 2005)?

Response: **Yes, impingement sampling began in early July 2004 and will continue through June 2005. Although it does not exactly coincide with entrainment sampling, it is close enough to capture the same seasonal changes in fish and target invertebrate abundance that will be present in the entrainment sampling. The sampling was started in July to take advantage of studies at the plant being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources (See *Tenera Response* to Comment 6).**

20) *Page 20*: The authors mention a quality control (QC) program for impingement sampling. Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the "random cycles for re-sorting" and the specific quality objectives (e.g., for sorting efficiency)?

***Response*: Tenera has written procedures for conducting the impingement sampling at EPS that all participating samplers are required to follow. A quality control plan is part of this procedure. Each impingement sampling team is comprised of two qualified biologists familiar with the fish and invertebrate fauna likely to be impinged. The goal of the sampling is to correctly identify, and accurately count and weigh all impinged organisms according to the criteria in the sampling protocol. In addition to ongoing quality control checks by samplers (e.g., consultations among team members, supervisor involvement, preservation of specimens of uncertain identity), Tenera personnel will check the counts and identifications from two cycles of impinged material on a quarterly basis. Unlike the laboratory identification process where a 90% sorting accuracy objective is specified, a specific quantitative objective for the impingement QC program is not feasible because of the variability in the quantity and types of impinged material. The objective is 100% accuracy. Tenera will document the results of the QC checks and implement any corrective actions necessary to ensure compliance with the written procedures.**

21) *Page 22*: The authors state that, "Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

***Response*: See response to Comment 13.**

22) *Page 23*: The authors state that, "Fishery management practices and other forms of stock assessments will provide the context required to interpret [the estimate of the annual probability of mortality due to entrainment]." The data types mentioned may not be available for some of the most frequently entrained fishes (e.g., non-commercial /non-recreational species). Will adequate evaluation data be available, or is it too early in the process to tell?

***Response*: See response to Comment #16. The MEC study on the fishes of Agua Hedionda Lagoon will help provide this information for the small,**

estuarine, forage species that are not targeted by commercial or recreational fisheries.

23) *Page 23 and 24*: Potential target organisms are mentioned. Comment 1 (above) applies here. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

Response: **See response to Comment 1.**

SUGGESTIONS

- The governing regulatory/resource agencies should be given the opportunity to consider and approve/reject: the selection process for representative species (mentioned in comments 1 and 23, above); the possible reduction in the number of source water sampling stations (comment 13); and the possible reduced impingement sampling frequency.

  Response: **See responses to comments 1, 13, and 23. Proposals for these, or any other, change to the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by the Regional Board.**

- The temporal aspects of the study questioned in comments 6, 10 and 19 (above) need to explained in more detail.

  Response: **See responses to Comments 6 and 19.**

- The quality control program needs to be described in more detail (see comments 14 and 20), or the QA/QC plan should be cited and/or attached as an appendix.

  Response: **Procedures for the sampling and laboratory processing will be submitted as attachments to the study plan.**

- As mentioned previously, the study plan was obviously developed by qualified and experienced contractors, and we think that their study design is conceptually valid. Most comments listed above represent the need for relatively minor clarifications or additions.

Thank you again for the opportunity to respond to the comments from Tetra Tech. The study being conducted by Tenera Environmental is based on the design used for the entrainment and impingement studies at the Duke Energy South Bay Power Plant in San

Diego Bay. These studies were required for the plant's NPDES permit that was recently approved by the Regional Board. Therefore, we are confident that the study will provide the information necessary for Cabrillo Power I LLC to comply with EPA's recently published Phase II rule for Section 316(b) of the Clean Water Act. We look forward to working with you and the other Regional Board staff on this project and would be available to discuss our responses to these comments at your convenience.

If you have any questions or comments, please contact Mr. Tim Hemig at (760) 268-4037.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

Gregory J. Hughes

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig (Cabrillo)
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)

ATTACHMENT 6

COASTAL PROCESS EFFECTS OF REDUCED INTAKE FLOWS AT AGUA HEDIONDA LAGOON

Coastal Processes Effects of Reduced Intake Flows at Agua Hedionda Lagoon

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

Submitted to:

Tenera Environmental
141 Suburban Rd., Suite A2
San Luis Obispo, CA 93401

and

Poseidon Resources, Suite 840
501 West Broadway
San Diego, CA 92101

13 December 2006

Abstract:

This study evaluates the coastal processes effects 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. If this consumption rate were reduced to 304 mgd to maintain end-of-pipe salinity below 40 ppt, we find that the capture rates of littoral sediment would be reduced by 42.5%, thereby reducing the environmental impacts associated with maintenance dredging. Reduced flow rate operations will not increase the magnitude of cyclical variations in habitat or residence time that presently occur throughout each maintenance dredge cycle, but will increase the length of time over which those variations occur. Low flow rate operations will result in reductions of 8% to 10% in the fluxes of dissolved nutrients and oxygen into the lagoon through the ocean inlet, but this effect is relatively minor in comparison to the 17.4% decline in nutrient and D.O. flux

that occurs in the latter stages of each dredge cycle. On balance, low flow operations do not appear to create any significant adverse impacts on either the lagoon environment or the local beaches; and it could be argued that the reduction in capture rates of littoral sediment is a project benefit.

1.0) Introduction:

The present day Agua Hedionda Lagoon is not a natural geomorphic structure, rather it is a construct of modern dredging. Its west tidal basin (Figure 1) is unnaturally deep (-20 to – 32 ft NGVD) and the utilization of lagoon water for once-through cooling by the Encina Generating Station renders Agua Hedionda's hydraulics distinctly different from any other natural tidal lagoon. Power plant cooling water uptake (Q_{plant}) acts as a kind of "negative river." Whereas natural lagoons have a river or stream adding water to the lagoon, causing a net outflow at the ocean inlet, the power plant infall removes water from Agua Hedionda Lagoon, resulting in a net inflow of water (Q_{plant}) through the ocean inlet. This net inflow has several consequences for particulate transport into and out of the lagoon: 1) it draws nutritive particulate and suspended sediment from the surf zone into the lagoon, the latter forming bars and shoals (Figure 2) that subsequently restrict the tidal circulation, and 2) the net inflow of water diminishes or at times cancels the ebb flow velocities out of the inlet, thereby providing insufficient transport energy to flush sediments (essentially uphill) out of the deep west basin of the lagoon. Therefore, the plant demand for lagoon water strongly controls the rate at which Agua Hedionda traps sediment and other solid particulate.

This is a technical note on the potential coastal processes effects arising from reduced once-through flow rates at the Encina Generating Station, Carlsbad, CA. Specifically, we evaluate long-term, stand-alone operation of a proposed desalination plant at this site using the minimum once-through flow rate available with the existing hydraulic infrastructure that will allow the production of 50 mgd of potable water by reverse osmosis (R.O.) without exceeding 40 ppt salinity at end-of-pipe. When taken in combination with worst-case mixing conditions in the receiving water, this minimum flow rate configuration is referred to in the certified project EIR as the "unheated

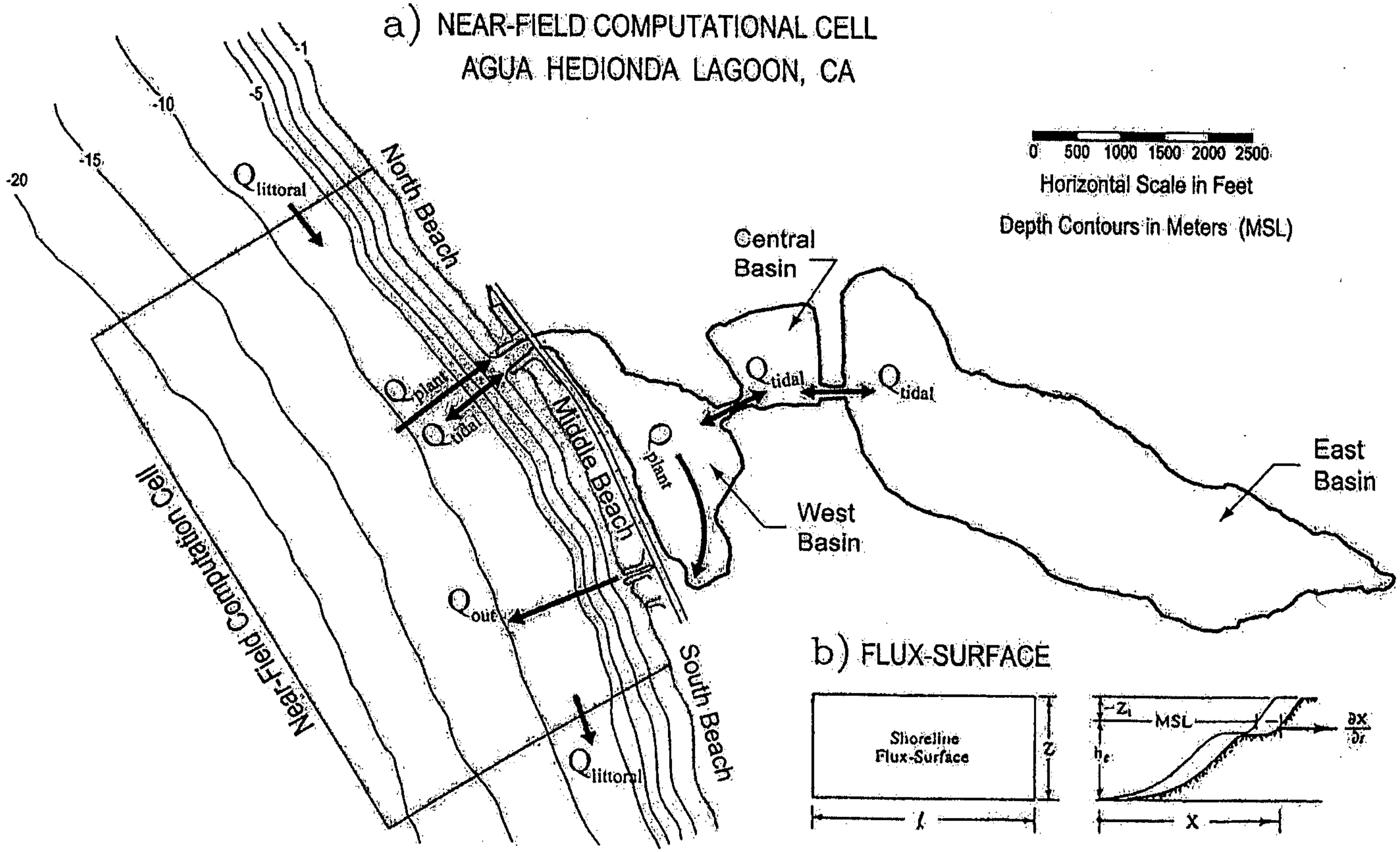


Figure 1. Near-field computational cell for calculating sediment transport at Agua Hedionda Lagoon, CA; a) Lagoon Plan View. b) Beach Cross-section.

Figure 2. West Basin of Agua Hedionda Lagoon showing inlet (flood) bar formation at low tide. Insert shows the recharge area of the lagoon where this bar forms and the preponderance of maintenance dredging is performed.

historical extreme" and involves a once through flow rate of 304 mgd at the intake structure located at the southern end of the west basin of Agua Hedionda Lagoon. Table 1 below gives various operational combinations of existing circulation and service water pumps that can provide this minimum flow rate within 5%.

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). Thus the flow rates passing through the Encina facility during stand-alone desalination operations would be about 43% less than the present average when power generation is occurring, and 62% less than the peak flow rate capability. In this technical note, we utilize data from the existing literature to deduce probable impacts that this flow rate reduction would have on sand and nutrient flux into Agua Hedionda Lagoon and implications for the neighboring beaches and nearshore morphology.

2.0) Reduced Flow Effects on Sediment Flux

The most profound and far-reaching consequence of long-term operation of the Encina facility at reduced flow rate will be on the flux of sand into the lagoon through the ocean inlet. The sand influx controls the tidal exchange in the lagoon by regulating the depth of an inlet sill associated with inlet bars that form in the West Basin of the lagoon (see Figure 2). These sand bars restrict the effective tidal range in the lagoon and ultimately threaten closure of the inlet, thereby requiring periodic maintenance dredging to mitigate that threat. The bars are formed by sands that are suspended in the surfzone and entrained by the inflowing stream of water through the inlet. During peak demand months for power, typically 46% of the daily inflow volume is due the power plant flow rate, causing the daily outflow through the inlet to be 48% less than the inflow (Elwany, et al, 2005). As a result, the transport of sand into the lagoon through the ocean inlet has a strong inflow bias (flood dominance) that scales in direct proportion to the power plant flow rate. In the review of lagoon sedimentation that follows, we will show a correlation between sand influx rates and plant flow rates, indicating that reduction of plant flow rates will reduce the influx rate of sand into the lagoon. While this is an apparent benefit

Table 1. COMBINATIONS OF PUMPS OF TOTAL CAPACITY WITHIN 5 % OF 304 MGD

Operational Condition 1 – 304.7 MGD			
Unit 1 (Both Pumps)		=	68.3 MGD
		Subtotal =	104.3 MGD (Desal Intake)
Unit 2 (2 S Pump)		=	36.0 MGD
Unit 3 (Both Pumps)		=	63.9 MGD
		Subtotal =	200.4 MGD (Dilution)
Unit 4 (4 W Pump)		=	136.5 MGD
	Total	=	304.7 MGD (0.2 % above 304 MGD)
Operational Condition 2 – 306.3 MGD			
Unit 4 (Both Pumps)		=	270.4 MGD
Unit 1 (1 S Pump)		=	35.9 MGD
	Total	=	306.3 MGD (1 % above 304 MGD)
Operational Condition 3 – 306.4 MGD			
Unit 4 (Both Pumps)		=	270.4 MGD
Unit 2 (2 S Pump)		=	36.0 MGD
	Total	=	306.4 MGD (1 % above 304 MGD)
Operational Condition 4 – 315.4 MGD			
Unit 4 (4 E Pump)		=	133.9 MGD
Unit 5 (5 W Pump)		=	157.0 MGD
Unit 2 (2 N Pump)		=	24.5 MGD
	Total	=	315.4 MGD (3.8 % above 304 MGD)
Operational Condition 5 – 315.4 MGD			
Unit 5 (Both Pumps)		=	315.4 MGD
	Total	=	315.4 MGD (3.8 % above 304 MGD)
Operational Condition 6 – 302.1 MGD			
Unit 1 (Both Pumps)		=	68.3 MGD
	Total	=	104.3 MGD (Desal Intake)
Unit 2 (2 S Pump)		=	36.0 MGD
Unit 3 (Both Pumps)		=	63.9 MGD
	Total	=	197.8 MGD (Dilution)
Unit 4 (4 E Pump)		=	133.9 MGD
	Total	=	302.1 MGD (0.6 % below 304 MGD)

of stand alone operations of a desalination plant, it raises a number of cost trade-off and regulatory issues that would ultimately need to be decided.

2.1) Lagoon Sedimentation History: Prior to the 1950's, Agua Hedionda was a slough comprised of shallow marsh channels filled with anaerobic hyper-saline water and flushed only briefly during winter months when high tides and rain runoff from Agua Hedionda Creek would broach the barrier berm across the lagoon inlet. A Southern

Pacific Railroad survey of the track across Agua Hedionda in 1889 (Figure 3) shows no extensive open water areas where the present day lagoon is situated. Instead, only winding marsh channels and marsh vegetation is apparent. Also apparent in this survey map is the closed state of the inlet on the south side of the marsh plain, and a narrow barrier beach with cobble ridge system across the entire extent of Middle Beach and portions of North Beach and South Beach. (ref. Figure 1 for beach nomenclature). Thus these were historically narrow beaches that did not retain large volumes of sand given the presence of the surveyed cobble ridges.

Over a period of 247 days beginning June 1953, a total of 4,279,000 cubic yards of mostly beach grade sediment was dredged from the Agua Hedionda Lagoon system. Referring to Figure 1, the total dredge volume was 1,025,000 cubic yards from the outer or western basin, and 3,254,000 cubic yards from the middle and east basins, see Ellis (1954). This dredged material was deposited primarily on Middle Beach with residual amounts on North and South Beach, forming a large deltaic shoreline form which had the effect of widening the beach by an additional 500 ft. In order to allow the intake and discharge flows to cross this man-made delta, the intake and discharge channels were armored with rubble mound jetty structures approximately 700-750 ft. in length as measured from the center line of the Pacific Coast Highway (Jenkins and Wasyl, 2001).

The dredge delta caused wave energy to converge on this section of shoreline inducing erosion progressively over time until the original beach width at Agua Hedionda was re-established by 1956 (Jenkins and Wasyl, 2001). As the delta eroded, the un-engineered rock structures were exposed to large breaking wave forces and the intake and discharge jetties were reduced by this storm damage to their present nominal lengths circa 1960 to 1963. Meanwhile, the 4.3 million cubic yards of sand that had made up the dredged delta formation was transported southward by the net littoral drift that predominates throughout the Oceanside Littoral Cell as shown in Figure 4. In the Oceanside Littoral Cell, the prevailing wave direction is from the northwest due to the combined effects of coastline orientation, island sheltering and the most prevalent storm track which is associated with extra tropical cyclones and cold fronts from the Gulf of

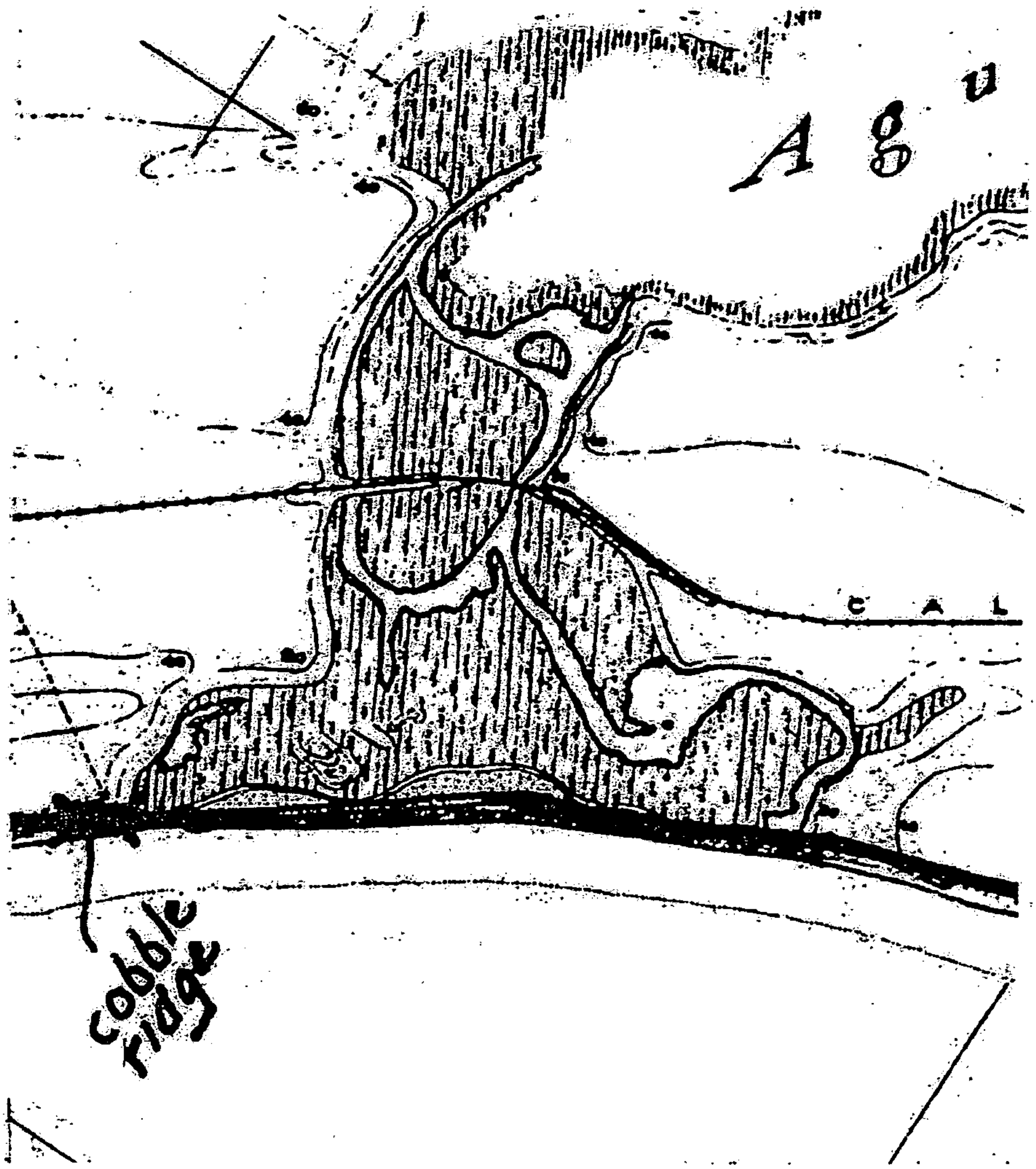


Figure 3 Railroad Survey of Agua Hedionda Lagoon, 1884.

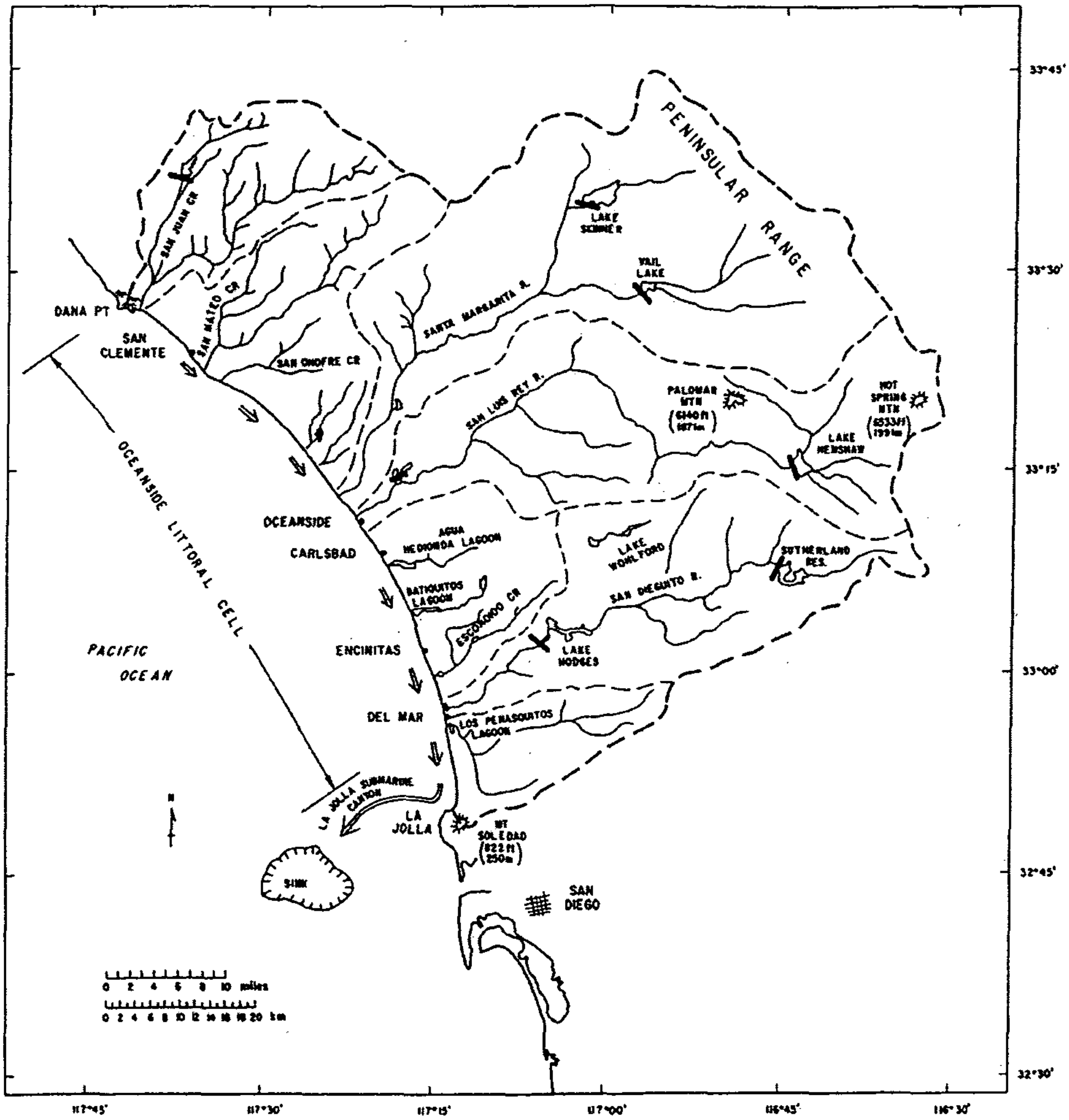


Figure 4. Oceanside Littoral Cell [Inman and Brush, 1973].

Alaska. Consequently, the long-term average littoral drift is from north to south as shown in Figure 4. This southward directed littoral drift is intercepted by submarine canyons (the La Jolla and Scripps Submarine Canyons) at the extreme southern (down-drift) end of the littoral cell where it is lost in turbidity currents that flow down the shelf rise, making the Oceanside Littoral Cell is a constant loss system. The only way the beaches can remain stable in this constant loss system is by continual replacement of these sand losses. When the inflowing stream of water into Agua Hedionda entrains sand from the littoral drift and deposits it in the west basin, the beaches down-drift of the lagoon suffer a loss of sand supply unless maintenance dredging returns those sands to the beaches. Since the inflow rates increase with the rate of consumption of cooling water, it is logical to look for a relationship between dredge quantities and cooling water consumption. To quantify this relationship we examine the historic dredge and flow rate data.

Table 2 gives a listing of the complete dredging history at Agua Hedionda Lagoon. The dredging events listed as "maintenance" in Table 2 occurred within the recharge zone of the west basin (Figure 2) and give estimates of sediment influx rates when the volumes for these events are factored against the time intervals between them. Annual sand influx rates calculated in this way are compared against the annual consumption of cooling water in Figure 5. Annual consumption of cooling water is plotted against the left hand axis in Figure 5 (black) in units of millions of gallons of seawater; while the annual sand influx volume is plotted against the right hand axis (red) in units of thousands of cubic yards. The individual data appear for each year as black diamonds for flow rate and red crosses for sand influx rates. Over-laid on these data are linear best fits to each. There is a clear trend showing that the consumption of cooling water by the power plant has increased over time (in response to expansion of generating capacity and increased user demand for power); and that the sand influx rates have followed that increase. From the best fit lines derived from the 48 year period of record in Figure 5, annual consumption of cooling water by the power plant has increased nearly 5 fold (growing on average by 3.3 billion gallons per year), while the annual influx of sand has doubled (increasing by 2 thousand cubic yards per year). Although the

Table 2. Dredging and Disposal History at Agua Hedionda Lagoon (from Jenkins and Wasyl, 2001)

Dredging And Disposal History							
Year	Dredging				Disposal	Comments	
	Date		Volume (yds^3)	Basin Dredged	Volume (yds^3)	Location Placed 1	
	Start	Finish					
1954	Feb-54	Oct-54	4,279,319	Outer, Middle, & Inner	4,279,319	N, M, S	Initial construction dredging
1955	Aug-55	Sep-55	90,000	Outer	90,000	S	Maintenance
1957	Sep-57	Dec-57	183,000	Outer	183,000	S	Maintenance
1959-60	Oct-59	Mar-60	370,000	Outer	370,000	S	Maintenance
1961	Jan-61	Apr-61	227,000	Outer	227,000	S	Maintenance
1962-63	Sep-62	Mar-63	307,000	Outer	307,000	S	Maintenance
1964-65	Sep-64	Feb-65	222,000	Outer	222,000	S	Maintenance
1966-67	Nov-66	Apr-67	159,108	Outer	159,108	S	Maintenance
1968-69	Jan-68	Mar-69	96,740	Outer	96,740	S	Maintenance
1972	Jan-72	Feb-72	259,000	Outer	259,000	S	Maintenance
1974	Oct-74	Dec-74	341,110	Outer	341,110	M	Maintenance
1976	Oct-76	Dec-76	360,981	Outer	360,981	M	Maintenance
1979	Feb-79	Apr-79	397,555	Outer	397,555	M	Maintenance
1981	Feb-81	Apr-81	292,380	Outer	292,380	M	Maintenance
1983	Feb-83	Mar-83	278,506	Outer	278,506	M	Maintenance
1985	Oct-85	Dec-85	403,793	Outer	403,793	M	Maintenance
1988	Feb-88	Apr-88	333,930	Outer	103,000	N	Maintenance
					137,860	M	Maintenance
					93,070	S	Maintenance
1990-91	Dec-90	Apr-91	458,793	Outer	24,749	N	Maintenance
					262,852	M	Maintenance
					171,192	S	Maintenance
1992	Feb-92	Apr-92	125,976	Outer	125,976	M	Maintenance
1993	Feb-93	Apr-93	115,395	Outer	115,395	M	Maintenance
1993-94	Dec-93	Apr-94	158,996	Outer	74,825	N	Maintenance
					37,761	M	Maintenance
					46,410	S	
1995-96	Sep-95	Apr-96	443,130	Outer	106,416	N	Maintenance
					294,312	M	
					42,402	S	
1997	Sep-97	Nov-97	197,342	Outer	197,342	M	Maintenance

Table 1. Continued

Dredging And Disposal History							
Year	**Dredging**				**Disposal**	**Comments**	
	Date		**Volume(yds^3)**	**Basin Dredged**	**Volume (yd^3)**	**Location Placed 1**	
	Start	Finish					
1998	Dec-97	Feb-98	60,962	Middle	60,962	M	Modification dredging
	Feb-98	Feb-99	498,736	Inner	370,297	M	Modification dredging
					128,439	S	
1999	Feb-99	May-99	202,530	Outer	202,530	N	Maintenance
2000-01	Nov-00	Apr-01	429,084	Outer	142,000	N	Maintenance
					202,084	M	
					85,000	S	
2002	Sept02	Dec 02	190,600		190,600	M	Maintenance
Total			11,482,966		11,482,966		

N = North Beach
M = Middle
S = South Beach

coefficient of determination (R-squared) is 0.68 for the cooling water relation and 0.60 for the sand influx relation, the scatter in the data about the best fit lines is due to several transient external factors. The cooling water relationship is effected by weather events and variations in climate patterns, especially the occurrence of warm humid El Niño (ENSO) events that result in protracted heat waves, increasing user demand for power to cool homes and work places. The sand influx relationship is similarly impacted since these same ENSO events also correlate with intensification of wave climate, accelerated beach erosion and transport; and consequently more suspended sediment in the neighborhood of the lagoon inlet to be entrained by the net inflowing stream. However, the sand influx rates are further impacted by beach nourishment activities up-drift of the

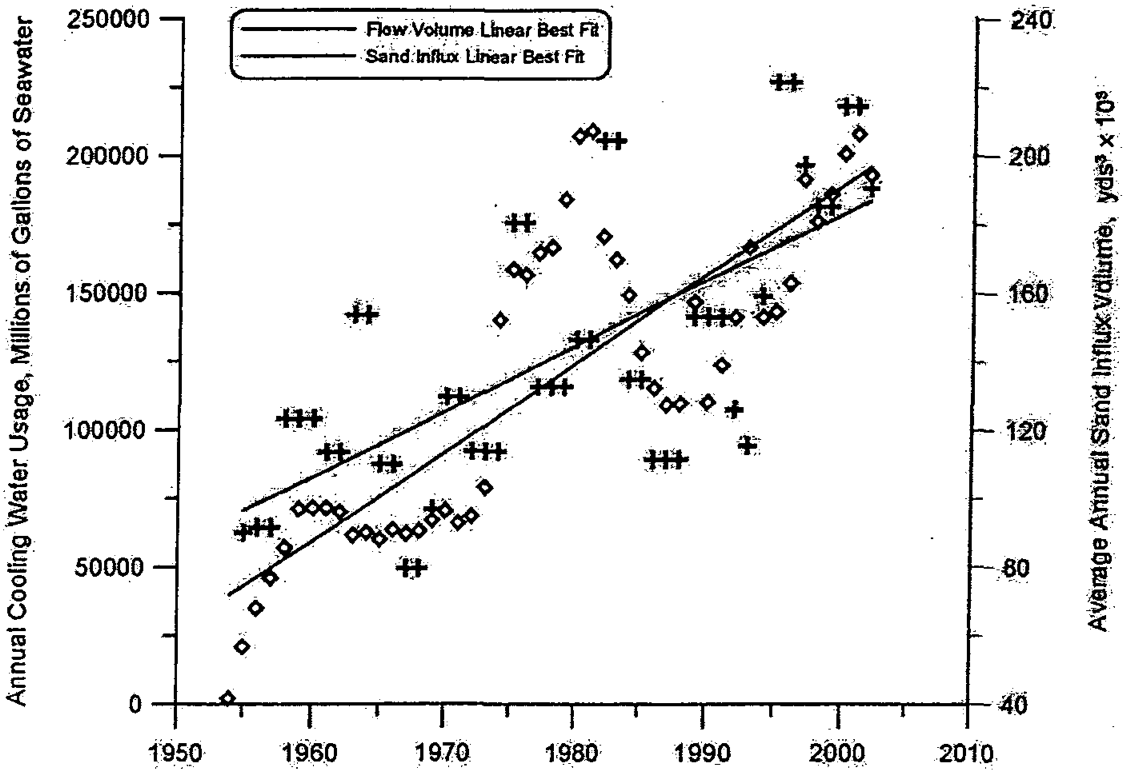


Figure 5. Time history of annual Encina cooling water usage and average annual sand influx from dredged volume for the years 1954-2002, [data from Jenkins and Wasyl, 1998 and 2003].

lagoon. Beach nourishment activities up-drift of Agua Hedionda are seen to have roughly doubled the daily influx rates to 400-600 cubic yards per day, as occurred following beach building projects in 1963, 1973, 1982, 1994 and 2001. Because of the transient impacts of beach restoration on sand influx rates, the coefficient of determination for the sand influx relation in Figure 5 is less than that for the cooling water flow rate relation. For a more detailed account of the effects of regional beach nourishment projects on sand influx rates at Agua Hedionda, see Appendix A.

2.2) Effects of Reduced Flow Operations on Sedimentation: From the flow rate and influx rate relations in Figure 5, we conclude that, on average, the lagoon presently traps 184,724 yds^3 of sand per year in response to an average daily once-through plant flow rate of 528.69 mgd. Probability analysis of inlet closure in Jenkins and Wasyl (1997,

2001) finds that the accumulated risk of inlet closure grows at 11% per year for sand influx rates of this magnitude, making inlet closure more probable than not within 4.5 years if no maintenance dredging is performed. In view of this risk, the historic dredge record in Table 2 shows that the longest interval between dredge events has been 3 years, and the predominant dredge interval has been 2 years. With in-house dredge assets home ported inside the lagoon, mobilization costs have been held to a minimum and marginal dredge costs have been running about $2.70 per cubic yard (Dyson, 2006). Thus, the costs of maintaining an open inlet (and hence, a healthy lagoon) under the present power generation operating scenario is about $499,000 per year.

If the flow rate is reduced to 304 mgd under the scenario of a stand-alone desalination plant, then the linear best fits in Figure 5 indicate that the average sand influx rates into the lagoon would be reduced to 106,218 yds^3 per year. This represents a 42.5% reduction in sand influx rates into the lagoon relative to the present power generation operating scenario. The reduction in sand influx rates reduces the accumulation of closure risk to only 6.3% per year, extending the safe interval for no dredge maintenance to 7.9 years before inlet closure would become more likely than not. Assuming the present marginal dredge cost of $2.70 per cubic yard, the annual cost of maintaining an open inlet under the reduced flow scenario would be $287,000 per year. Not factored into these cost comparisons are the costs of obtaining dredge permits and providing the pre- and post-dredging surveys and documentation necessary to obtain those permits. Dredge permits must be obtained from the City of Carlsbad, the California Coastal Commission, and the US Army Corps of Engineers on a year-to-year basis, as no blanket permits are currently issued.

Although the reduced flow rate scenario will reduce the rate of sand influx into the lagoon, it is clear that some degree of maintenance dredging must be continued for the indefinite future by whatever enterprise continues to use the lagoon for source water. While inlet closure becomes more probable than not after 7.9 years under the low flow rate scenario, it is a virtual certainty within 15 years in the absence of any form of maintenance dredging. Closure would be the consequence of about 840,000 cubic yards of sand being trapped in the west basin of the lagoon (Jenkins and Wasyl,1997, 2001), representing a permanent loss to the beaches down-drift of the lagoon. The magnitude of this loss (representing about 50% of the sand yield from the Bataquitos Lagoon Restoration) is quite significant to the down-drift beaches in Leucadia and Encinitas where chronic beach erosion has been the focus of public concern for many years. In addition to the beach impacts, inlet closure at Agua Hedionda would cause a precipitous drop in dissolved oxygen in lagoon waters (possibly even anaerobic) and a progressive transformation to hyper-saline conditions that would devastate the existing food web and related aqua culture. In time, the interior portions of the lagoon would in-fill with up-land sediments and be transformed back into the ephemeral system of marsh channels depicted in Figure 3. Hence, continued maintenance dredging of the west basin of the lagoon is vital for the continued health of the lagoon, as well as for the stability of the down-drift beaches and shoreline. The decisive question in the context of the reduced flow rate scenario is how frequently dredging should be performed.

If the presently practiced bi-annual/tri-annual dredge cycle is continued under the reduced flow rate scenario, the dredge volume will be on average 42.5 % smaller. This is a significant benefit to local beach stability (since less sand will be scavenged by the inflow from the local beach volume for any given 2 or 3 year period). However a bi-annual/tri-annual dredge cycle under reduced flow rate operations will raise the costs of maintaining an open inlet because mobilization/demobilization costs per cubic yard of dredged material will increase, and these are a major component of the total marginal dredge costs. A reasonable alternative is to base dredge scheduling on an equivalent dredge volume (~ 300 to 400 thousand cubic yards) as practiced under the existing bi-annual/tri-annual cycle, since these quantities when held and released from the lagoon appear to have an acceptable degree of impact on local beaches under present dredge permit conditions. Given these parameters, the dredge interval under the reduced flow rate scenario could be extended to once every 4 to 5 years, where rounding to nearest year gives:

$$\frac{(2yr \quad to \quad 3yr)(184{,}724\, yds^3 / yr)}{106{,}218\, yds^3 / yr} \cong 4yr \quad to \quad 5yr \qquad (1)$$

By extending the dredge cycle for low flow operations, the west basin of the lagoon will exist in a partially shoaled condition for a longer period of time. In this condition, the inlet sill depth is reduced and the inlet flow stream must proceed through constricted equilibrium tidal channels around the inlet bar. The flood flow channel forms along the north-west bank of the west basin immediately east of the HWY 101 bridge, while the ebb channel forms along the opposite bank with the inlet bar bedform lying in between. Typical morphology for this shoaled condition is shown in Figure 6 (taken from the pre-dredge survey of the west basin on 12 October 2002, prior to the 2002 maintenance dredging event). The constricted channels and reduced sill depth prevent the lagoon from fully draining during lower-low tide levels and induce hydraulic losses to friction and turbulence. These effects are referred to as *tidal muting* and reduce the tidal range throughout the interior of the lagoon system. With reduced tidal range, there is typically a reduction in inter-tidal habitat and a shift in the mix of habitat types.

3.0) Effects of Low Flow and Inlet Sedimentation on Tidal Hydraulics

To quantify potential effects associated with protracted periods of operations with a partially shoaled inlet, we perform tidal hydraulic simulations using the west bathymetry from Figure 6. The TIDE_FEM tidal hydraulics model presented in Jenkins and Inman (1999) was gridded for a computational mesh of Agua Hedionda Lagoon as shown in Figure 7, using pre- and post dredging bathymetry from the 2002 dredge event from Jenkins and Wasyl (2003). The pre-dredging bathymetry featured the inlet bar in the west basin that was mapped during the October 2002 sounding shown in Figure 6. The post-dredging survey performed in April 2003 indicated uniform deep water throughout the west basin with depths ranging from -20 ft NGVD to – 30ft NGVD, similar to that found in Figure 2-2 of Elwany, et al (2005). The lagoon model was excited at the ocean inlet by the 4.5 year maximum spring tides derived from tidal harmonic constituents for the Scripps Pier tide gage (NOAA Station #941-0230). These tides provide an assessment of the maximum tidal range effects of the pre- and post-dredging bathymetry.

Figure 8 shows how the inlet bar formation in the pre-dredging bathymetry (green) reduces the tidal range in the east basin of the lagoon relative to the tidal response for the post-dredging bathymetry (red) when that bar formation has been removed. The primary effect of the inlet bar on tidal range is to limit the degree to which the lagoon can drain during low tide. In the pre-dredge condition the lower-low water level only drops to -2.7 ft NGVD, as compared to a LLW of -4.0 ft NGVD in the post-dredge condition

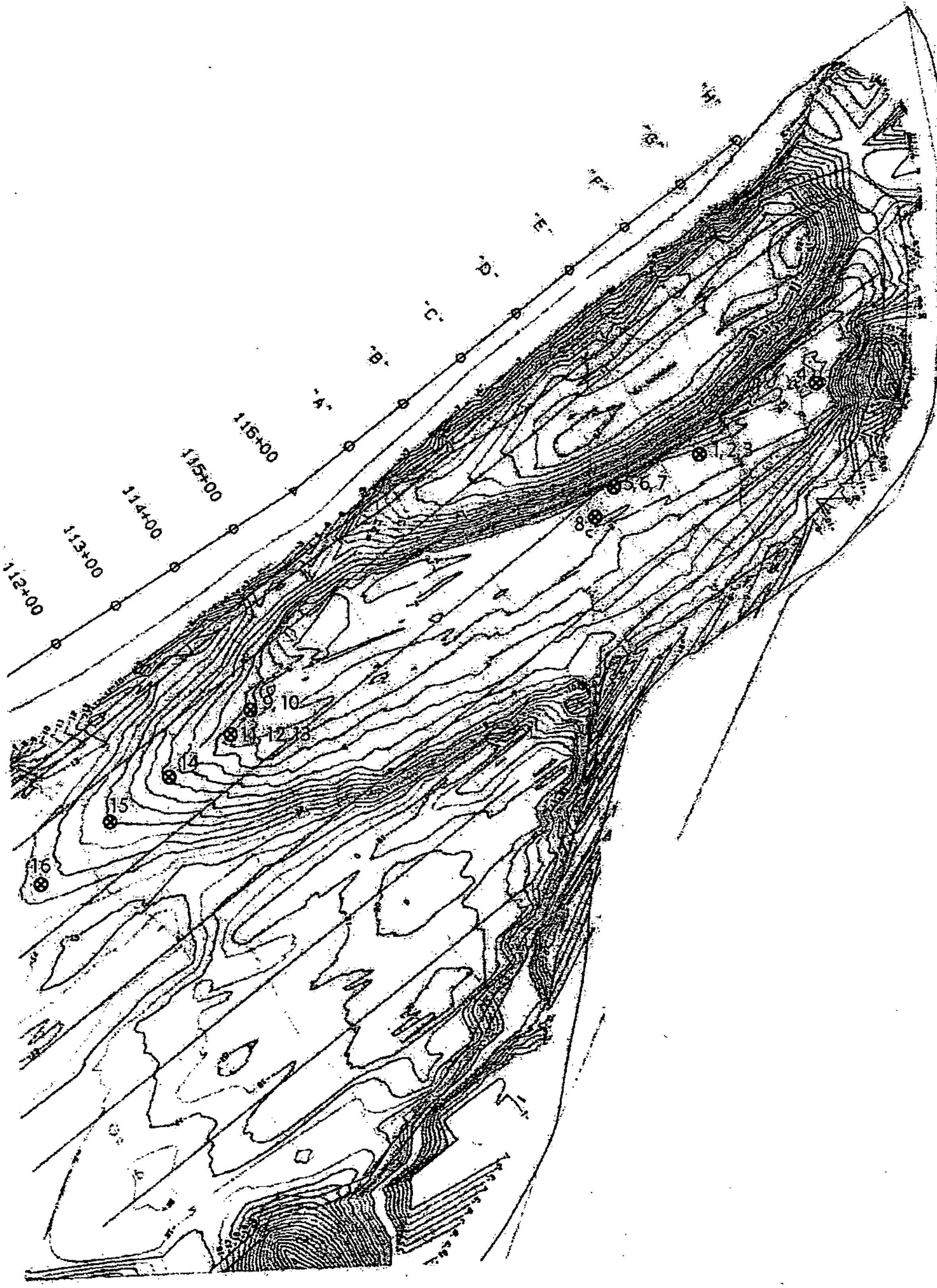


Figure 6. Location key for 12 October 2002 bottom sediment sampling.

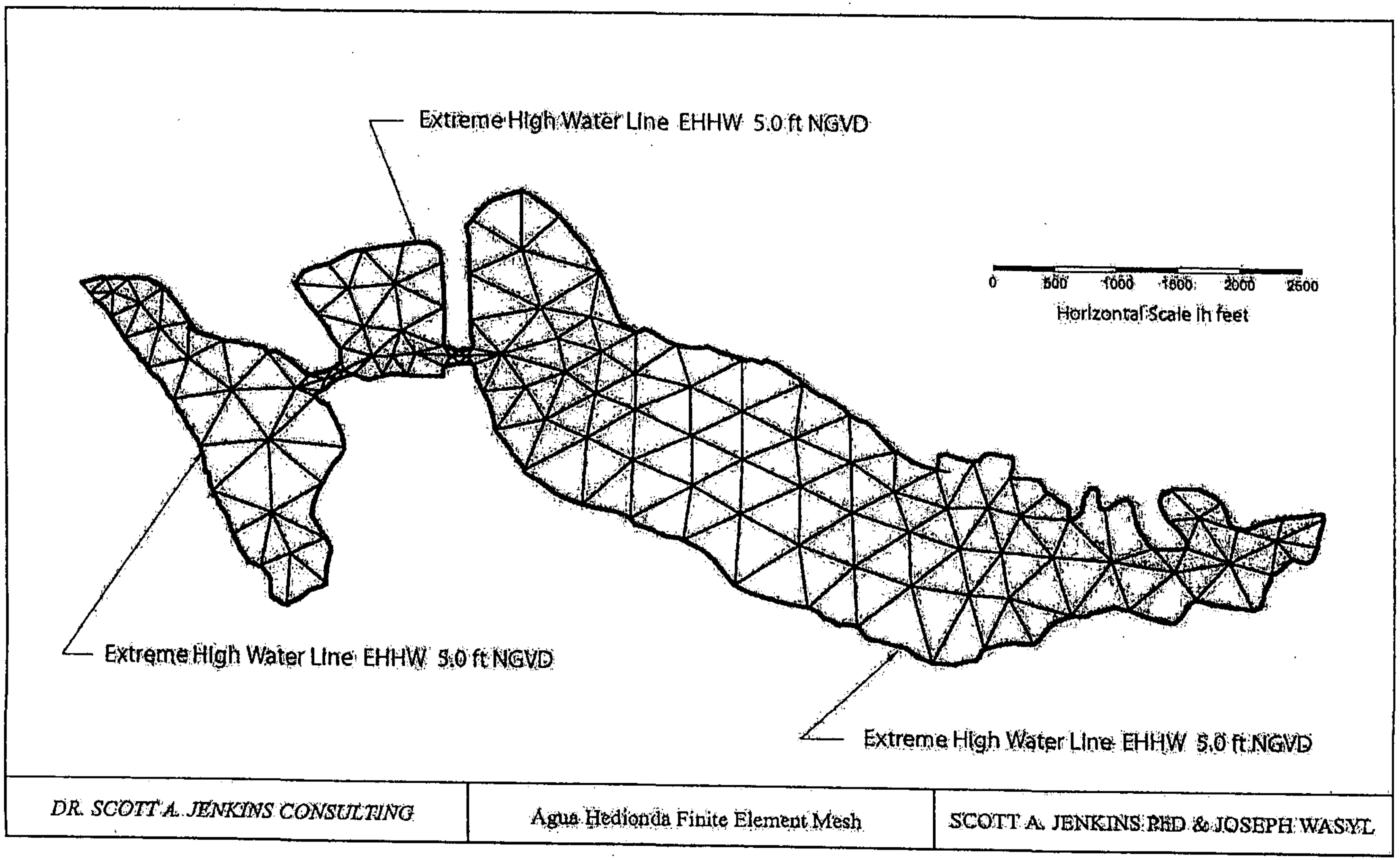


Figure 7. Computational mesh for TIDE_FEM tidal hydraulics model of Agua Hedionda Lagoon.

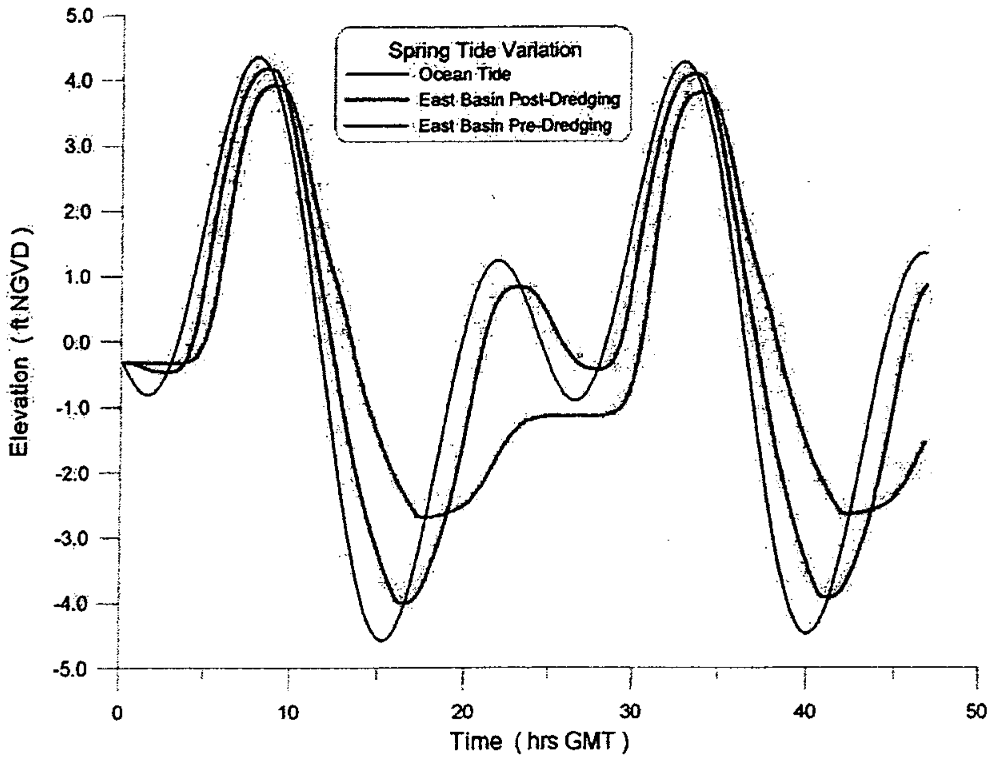


Figure 8. Effect of sedimentation on lagoon tidal range. Pre-dredging tide variation in East Basin (green); Post-dredging tides (red). Pre- and post- dredging tidal variations from TIDE_FEM simulation using ocean tides. Pre-dredging bathymetry from Jenkins & Wasyl 2003.

when the sill caused by the inlet bar is removed. The constricted inlet channels around the inlet bar also cause some muting of the higher-high water levels due to frictional losses and phase lags, with HHW for the pre-dredge condition reaching +3.9 ft NGVD as compared with +4.1 ft NGVD for HHW in the post-dredge condition. Altogether the inlet bar formation reduces the maximum diurnal tidal range by as much as 1.5 ft in the latter stages of west basin sedimentation prior to routine maintenance dredging.

To determine what effect the inlet bar exerts on lagoon habitat, we superimpose the diurnal tidal ranges obtained from hydraulic modeling on the area and volume rating functions of the lagoon derived from recent lagoon surveys by Elwany, et al (2005). Figure 9a shows that the maximum inter-tidal acreage of Agua Hedionda Lagoon is 107.9 acres due to spring tides acting on post-dredge bathymetry with no inlet bar formation. Sub-tidal acreage is 221.4 acres, giving a total lagoon habitat acreage of 329.3 acres post-maintenance dredging. Later, when shoaling develops in the west basin and a pronounced inlet bar forms, the tidal range is reduced throughout the lagoon and the maximum inter-tidal habitat is reduced by 32.9 acres to 75 acres, as indicated by the pre-dredging assessment in Figure 10a. Sub-tidal acreage is increased by 14.6 acres to 236 acres, because the reduced sill depth over the inlet bar restricts the ability of the lagoon to drain on a falling tide (Figure 8). Tidal muting of the higher-high water levels reduces the total lagoon habitat by 18.8 acres to 311 acres.

Consequently, a cyclical variation in the amount and proportions of lagoon habitat occurs throughout each dredge cycle, with the total lagoon habitat gradually declining by 5.7% following a post-dredging maximum, and reaching a minimum immediately before the mobilization of the next maintenance dredge event. This cyclical variation manifests itself most strongly in the inter-tidal habitat regime, where the habitat acreage declines by 30.5% following a post-dredging maximum. On the other hand, the sub-tidal habitat that supports the lagoon's fisheries varies inversely, with a post-dredging minimum followed by a gradual increase of as much as 6.5% prior to mobilization of the next maintenance dredge event. These variations are already built into the ecology of the present day lagoon and occur gradually enough over the existing bi-annual/tri-annual dredge cycle that significant impacts to that ecology have not been observed. What the reduced flow rate operations of a stand-alone desalination plant would do is extend the period of these variations by another 1 or 2 years (assuming the equivalent dredge volume policy of the previous section is adopted). The magnitude of the cyclical habitat variations would be the same, but those variations would evolve more slowly in time, thereby reducing the rate of cyclical decline of inter-tidal habitat and the rate of growth of sub-tidal habitat. This would give the lagoon ecology a longer response time to adapt to those cyclical changes, and presumably reduce the potential for any adverse consequences that have not yet been identified in the literature.

The other important effect of the inlet bar formation and attendant dredge cycle is on the volume exchange that occurs between the ocean and the lagoon and the residence time of water in the lagoon. Figure 9b finds that the maximum diurnal tidal prism for the post-dredge bathymetry (no inlet bar) is 2,286 acre ft. This result obtained by hydraulic simulation for the 4.5 yr spring tide maximums agrees closely with the result of 2125

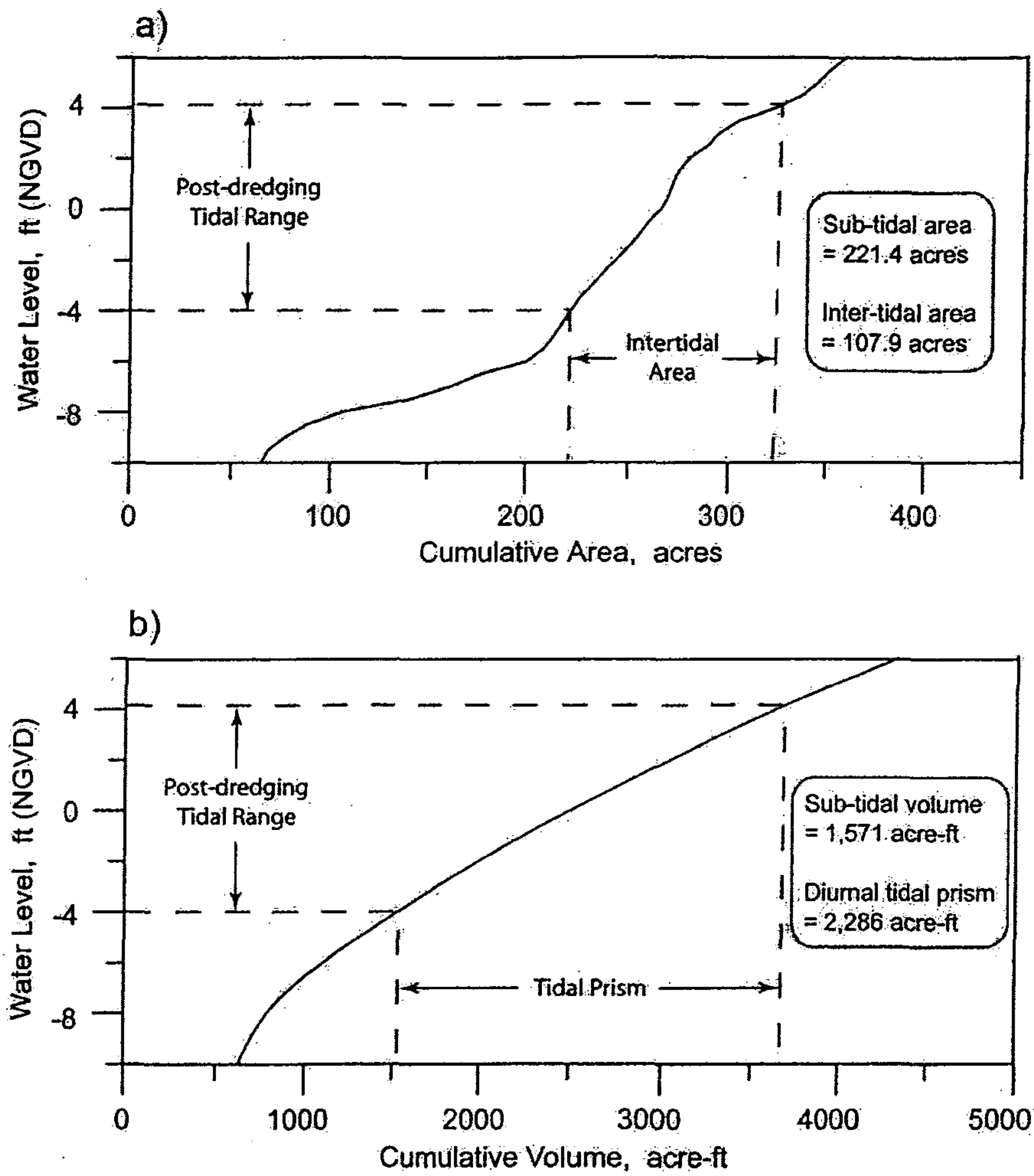


Figure 9. Post-dredging tidal hydraulics with West Basin inlet bar removed: a) Sub-tidal area and intertidal area during spring tide; b) Sub-tidal volume and diurnal tidal prism. Wetted area and volume function from Elwany et al., (2005).

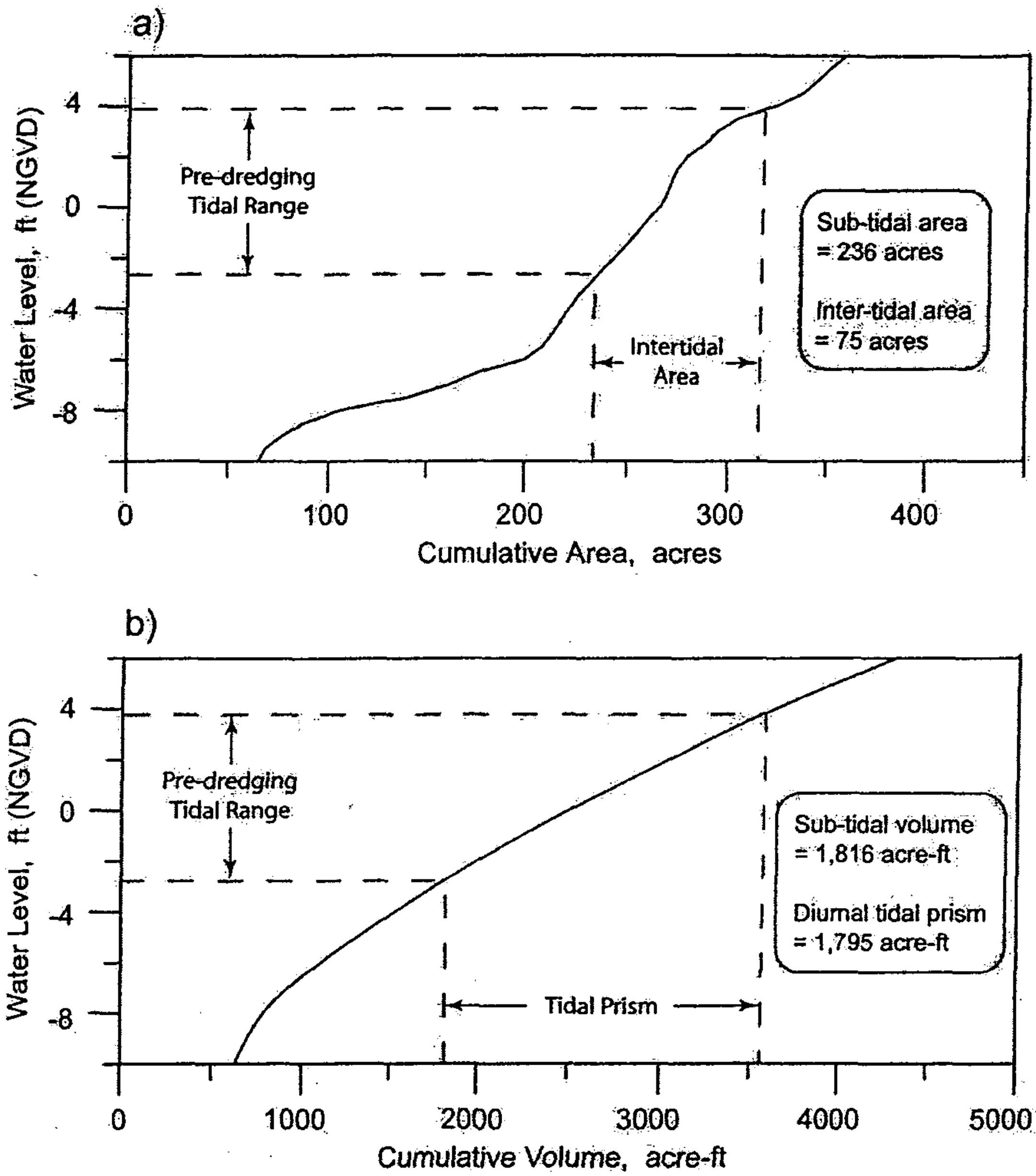


Figure 10. Pre-dredging tidal hydraulics with West Basin inlet bar per Figure 6: a) Sub-tidal area and intertidal area during spring tide; b) Sub-tidal volume and diurnal tidal prism. Wetted area and volume function from Elwany et al., (2005).

acre-ft obtained by water level measurements during spring tides in June 2005, as reported in Elwany (2005). This small discrepancy can be attributed to the larger tidal range of the ocean tides used in the hydraulic simulation in Figure 8. The hydraulic simulation in Figure 10b for the pre-dredge conditions (with well developed inlet bar) finds that the maximum diurnal tidal prism is reduced by 491 acre-ft to 1,795 acre-ft.

Thus, the west basin sedimentation diminishes the maximum diurnal prism of the lagoon by 21.5% over the course of a dredge cycle, and nearly 70% of this loss occurs in the east basin of the lagoon. Because the mass exchange between the east basin and the remainder of the lagoon is purely tidal in nature, the loss of tidal prism due to west basin sedimentation will impact the residence time of water in the highly productive east basin habitat zones. Figure 11 presents the water mass exchange rating functions of the east basin for pre- and post-dredging bathymetry. The hydraulic simulation (black) for the post-dredge bathymetry (with no inlet bar formation) gives a residence time of 3.7 days for water in the east basin. Here, residence time is taken as that point on the exchange rating curve when the percentage of old water declines to 2%. This compares with a mean value of 3.2 days reported in Elwany et al (2005) based on water level and velocity measurements over a one month period in June 2005. This is regarded as an insignificant difference that could easily be explained by differences between the 2003 bathymetry used in the hydraulic simulation versus the 2005 bathymetry that prevailed in the 2005 field measurements of Elwany et al (2005). With the reduction of tidal prism caused by the inlet bar formation, the residence time in the east basin is increased by 1 day to 4.7 days for pre-dredge bathymetry. Hence, the residence time in the largest basin of the lagoon experiences a cyclical increase of 27% of the course of the presently practiced bi-annual/tri-annual dredge cycle. This variation is not viewed to be significant as the residence time remains relatively short and oxygen deficiency or anoxic conditions have never been reported under present dredge practices. The effect of the of reduced flow operations of a stand alone desalination plant will not change the magnitude of this cyclical variation since mass exchange between the east and west basins is purely tidal. However, increasing the length of dredge cycle by 1 or 2 years under the reduced flow rate will increase the period of the residence time cycle by an equivalent duration.

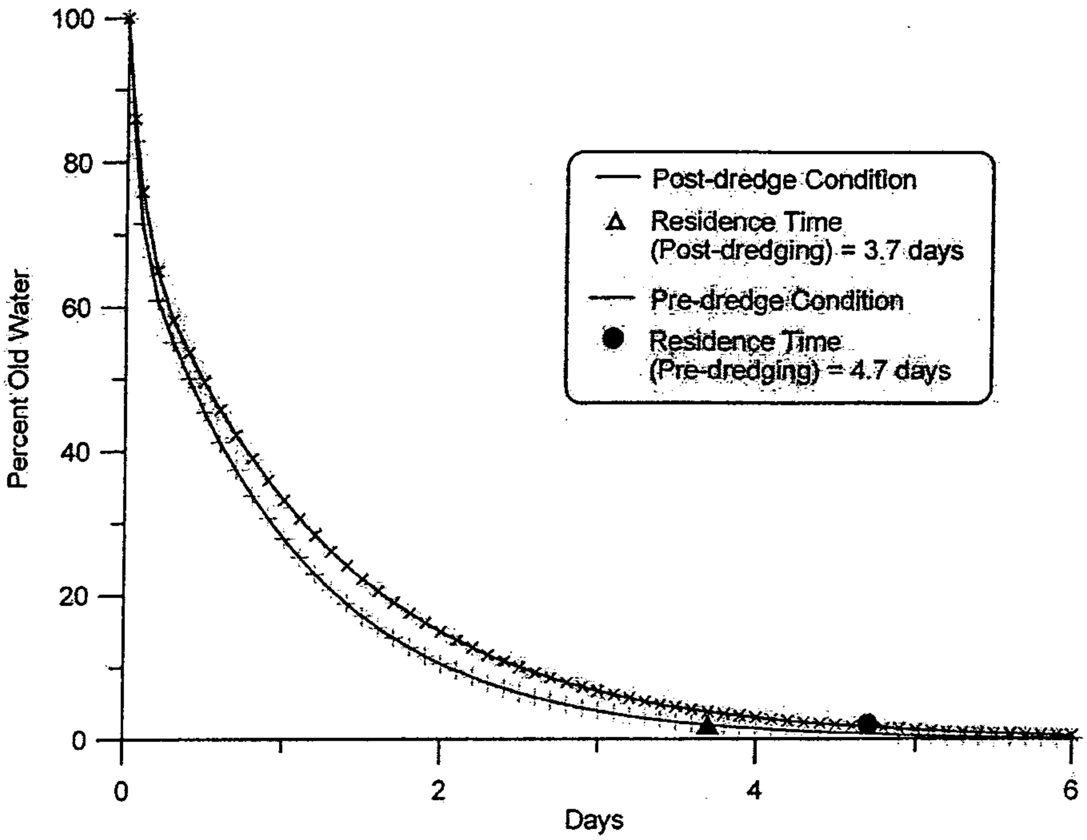


Figure 11. Water mass exchange rating function and residence time in the East Basin of Agua Hedionda Lagoon for pre-dredge (red) and post-dredge (black) bathymetry.

The effect of this longer cycle period, again, slows the rate at which biology must adapt to the cyclical increases residence time.

Reduced flow operations will affect the fluxes of nutrients and oxygen into the west basin. As commented in Section 2.2, fluxes of nutrients adsorbed to the surfaces of suspended sediment that enter the lagoon through the ocean inlet will be reduced by 42.5% under the low flow rate scenario. However, most of these sediments are sand sized and carry little if any nutrient load. The predominant nutrient load entering the lagoon through the ocean inlet is in the form of neutrally buoyant organisms and organic particles, colloids, and dissolved organic matter and oxygen. These constituents are fluxed with the inflow stream, and will be reduced by lower once-through flow rates through the plant, or by diminished tidal prism through the tidal muting effects of the inlet bar.

Elwany et al (2005) determined that on average, 46% of the daily inflow stream through the inlet was due to the power plant cooling water consumption based on water level and velocity measurements during the 5 week period between 1 June 2005 and 7 July 2005. Taking an average power plant flow rate during that period of 529 mgd and an average tidal prism of 1,700 acre ft, the flux balance obtained from this finding indicates that only 29% of the daily inflow volume would be due to the plant's circulation pumps under a low flow rate assumption of 304 mgd. This flow rate reduction would reduce the daily volume flux of new water and dissolved nutrients into the lagoon by 10.1%. However, the plants impact on dissolved nutrient influx becomes less during spring tides when a larger fraction of the inflow stream is due to pure tidal exchange (see Figure 1). The hydraulic model simulations for tidal exchange during spring tides with the post-dredge bathymetry (red line, Figure 8) indicate that only 36.4% of the daily inflow of new water is due to the power plant operating at its average annual flow rate of 529 mgd. If the plant flow rate is dropped to 304 mgd under the low flow rate scenario, then 22.7% of the daily inflow during spring tides (post-dredging) is due to the action of circulation pumps, and the nutrient flux will be reduced by 8% relative to present average pumping rates during power generation. When the west basin is in a pre-dredge configuration with a well developed inlet bar, the spring tide daily nutrient flux into the lagoon is reduced by 17.4% under present average flow rates of 529 mgd, and by 18.9% under the low flow scenario (304 mgd). Hence, inlet sedimentation and cyclical dredging causes a greater reduction on nutrient flux than would the reduction in plant flow rate under the low flow scenario of a stand alone desalination plant.

Summary and Conclusions:

Coastal processes and tidal hydraulic effects arising from reduced once-through flow rates at the Encina Generating Station, Carlsbad, CA are evaluated in the context of stand-alone operations of a co-located desalination plant. Stand alone desalination involves a once through flow rate of 304 mgd at the intake structure located at the southern end of the west basin of Agua Hedionda Lagoon. This flow rate would limit end-of-pipe salinity to no more than 40 ppt. 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 averages about 530 over the long term. Thus the flow rates passing through the Encina facility during stand-alone desalination operations would be about 43% less than the present average when power generation is occurring, and 62% less than the peak flow rate capability.

If the flow rate is reduced to 304 mgd under the scenario of a stand-alone desalination plant, then dredge records indicate that the average sand influx rates into the lagoon through the ocean inlet would be reduced to 106,218 yds^3 /yr from a present rate of 184,724 yds^3/yr. This represents a 42.5% reduction in sand influx rates into the lagoon relative to the present power generation operating scenario. The reduction in sand influx rates reduces the accumulation of inlet closure risk to only 6.3% per year, extending the safe interval for no dredge maintenance to 7.9 years before inlet closure would become more likely than not. Assuming the present marginal dredge cost of $2.70 per cubic yard, the annual cost of maintaining an open inlet under the reduced flow scenario would be $287,000 per year as compared to present maintenance costs of $499,000 per year. If dredge scheduling is based on an equivalent dredge volume (to minimize beach impacts) as practiced under the existing bi-annual/tri-annual cycle, the dredge interval under the reduced flow rate scenario could be extended to once every 4 to 5 years.

Under existing conditions with high flow rate power generation activity, a cyclical variation in the amount and proportions of lagoon habitat occurs throughout each dredge cycle, with the total lagoon habitat gradually declining by 5.7% following a post-dredging maximum, and reaching a minimum immediately before the mobilization of the next maintenance dredge event. This cyclical variation manifests itself most strongly in the inter-tidal habitat regime, where the habitat acreage declines by 30.5% following a post-dredging maximum. On the other hand, the sub-tidal habitat that supports the lagoon's fisheries varies inversely, with a post-dredging minimum followed by a gradual increase of as much as 6.5% prior to mobilization of the next maintenance dredge event. These variations are already built into the ecology of the present day lagoon and occur gradually enough over the existing bi-annual/tri-annual dredge cycle that significant impacts to that ecology have not been observed. What the reduced flow rate operations of a stand-alone desalination plant would do is extend the period of these variations by another 1 or 2 years (assuming the equivalent dredge volume policy as stated above). The magnitude of the cyclical habitat variations would be the same, but those variations would evolve more slowly in time, thereby reducing the rate of cyclical decline of inter-tidal habitat and the rate of growth of sub-tidal habitat. This would give the lagoon ecology a longer response time to adapt to those cyclical changes.

The dredge cycle under existing high flow rate operations also impacts the volume exchange that occurs between the ocean and the lagoon, causing a cyclical variation in the residence time of water in the lagoon. West basin sedimentation diminishes the maximum diurnal prism of the lagoon by 21.5% over the course of a dredge cycle, and nearly 70% of this loss occurs in the east basin of the lagoon. With the reduction of tidal prism caused by the inlet bar formation, the residence time in the east basin is increased by 1 day to 4.7 days. Hence, the residence time in the largest basin of the lagoon experiences a cyclical increase of 27% over the course of the presently practiced bi-annual/tri-annual dredge cycle. This variation is not viewed to be significant as the residence time remains relatively short and oxygen deficiency or anoxic conditions have never been reported under present dredge practices. The effect of the of reduced flow operations of a stand alone desalination plant will not change the magnitude of this cyclical variation since mass exchange between the east and west basins is purely tidal. However, increasing the length of dredge cycle by 1 or 2 years under the reduced flow rate scenario will increase the period of the residence time cycle by an equivalent duration. The effect of this longer cycle period, again, slows the rate at which biology must adapt to the cyclical increases residence time.

Reduced flow operations will affect the fluxes of nutrients and oxygen into the west basin. Flow rate reductions to 304 mgd would reduce the average daily volume flux of new water and dissolved nutrients into the lagoon by 10.1%, (assuming a mean tidal range). However, the plant's impact on dissolved nutrient influx becomes less during spring tides when a larger fraction of the inflow stream is due to pure tidal exchange. Under the low flow rate scenario, nutrient flux will be reduced by 8% relative to present average pumping rates during power generation. When the west basin is in a pre-dredge configuration with a well developed inlet bar, the spring tide daily nutrient flux into the lagoon is reduced by 17.4% under present average flow rates of 529 mgd, and by 18.9% under the low flow scenario (304 mgd). Hence, inlet sedimentation and cyclical dredging causes a greater reduction on nutrient flux than would the reduction in plant flow rate under the low flow scenario of a stand alone desalination plant.

In conclusion, the reduced flow rate operations of a stand alone desalination plant co-located at Encina Generating Station will reduce the capture rates of littoral sediment that presently occur under higher flow rates associated with power generation, thereby reducing the environmental impacts associated with maintenance dredging. Reduced flow rate operations will not increase the magnitude of cyclical variations in habitat or residence time that presently occur throughout each maintenance dredge cycle, but will increase the length of time over which those variations occur. Low flow rate operations will result in reductions of 8% to 10% in the fluxes dissolved nutrients and oxygen into the lagoon through the ocean inlet, but this effect is relatively minor in comparison to the 17.4% decline in nutrient flux that occurs in the latter stages of each dredge cycle. On balance, low flow operations do not appear to create any significant adverse impacts on either the lagoon environment or the local beaches; and it could be argued that the reduction in capture rates of littoral sediment is a project benefit.

Bibliography

Abbott, M. B., A. Damsgaard and G. S. Rodenhuis, 1973, ASystem 21, Jupiter,@ *Jour. Hydraulic Res.*, v. 11, n. 1.

Connor, J. J. and J. D. Wang, 1973, AFinite element modeling of two-dimensional hydrodynamic circulation,@ *MIT Tech. Rpt.*, #MITSG 74-4, p. 1-57.

Elwany, M. H. S., A. L. Lindquist, R. E. Flick, W. C. O'Reilly, J. Reitzel and W. A. Boyd, 1999, "Study of Sediment Transport Conditions in the Vicinity of Agua Hedionda Lagoon," submitted to California Coastal Commission, San Diego Gas & Electric, City of Carlsbad.

Elwany, M. H. S., R. E. Flick, M. White, and K. Goodell, 2005, "Agua Hedionda Lagoon Hydrodynamic Studies," prepared for Tenera Environmental, 39 pp. + appens.

Ellis, J.D., 1954, "Dredging Final Report, Agua Hedionda Slough Encina Generating Station," San Diego Gas and Electric Co., 44pp.

Gallagher, R. H., 1981, *Finite Elements in Fluids*, John Wiley & Sons, New York, 290 pp.

Inman, D. L., M. H. S. Elwany and S. A. Jenkins, 1993, "Shorerise and bar-berm profiles on ocean beaches," *Jour. Geophys. Res.*, v. 98, n. C10, p. 18,181-199.

Inman, D. L. & S. A. Jenkins, 1999, "Climate change and the episodicity of sediment flux of small California rivers," *Jour. Geology,* v. 107, p. 251–270.

Inman, D. L. & S. A. Jenkins, 2004, "Scour and burial of objects in shallow water," p. 1020–1026 in M. Schwartz, ed., *Encyclopedia of Coastal Science*, Kluwer Academic Publishers, Dordrecht, Netherlands.

Jenkins, S. A. and D. W. Skelly, 1988, "An Evaluation of the Coastal Data Base Pertaining to Seawater Diversion at Encina Power Plant Carlsbad, CA," submitted to San Diego Gas and Electric, Co., 56 pp.

Jenkins, S. A., D. W. Skelly, and J. Wasyl, 1989, "Dispersion and Momentum Flux Study of the Cooling Water Outfall at Agua Hedionda," submitted to San Diego Gas and Electric, Co., 36 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1993, "Numerical Modeling of Tidal Hydraulics and Inlet Closures at Agua Hedionda Lagoon," submitted to San Diego Gas and Electric, Co., 91 pp.

Jenkins, S. A. and J. Wasyl, 1994, "Numerical Modeling of Tidal Hydraulics and Inlet Closures at Agua Hedionda Lagoon Part II: Risk Analysis," submitted to San Diego Gas and Electric, Co., 46 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1995, "Optimization of Choke Point Channels at Agua Hedionda Lagoon using Stratford Turbulent Pressure Recovery," submitted to San Diego Gas and Electric, Co., 59 pp.

Jenkins, S. A. and J. Wasyl, 1997, "Analysis of inlet closure risks at Agua Hedionda Lagoon, CA and potential remedial measures, Part II," submitted to San Diego Gas and Electric, Co., 152 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1998a, Analysis of Coastal Processes Effects Due to the San Dieguito Lagoon Restoration Project: Final Report, submitted to Southern California Edison Co., 333 pp.

Jenkins, S. A. and J. Wasyl, 1998b, Coastal Processes Analysis of Maintenance Dredging Requirements for Agua Hedionda Lagoon, submitted to San Diego Gas and Electric Co., 176 pp. + appens.

Jenkins, S. A. and D. L. Inman, 1999, A Sand transport mechanics for equilibrium in tidal inlets, *Shore and Beach*, vol. 67, no. 1, pp. 53-58.

Jenkins, S. A. and J. Wasyl, 2001, Agua Hedionda Lagoon North Jetty Resoration Project: Sand Influx Study, submitted to Cabrillo Power LLC., 178 pp. + appens.

Jenkins, S. A. and J. Wasyl, 2003, Sand Influx at Agua Hedionda Lagoon in the Aftermath of the San Diego Regional Beach Sand Project, submitted to Cabrillo Power LLC., 95 pp. + appens

Jenkins, S. A. and J. Wasyl, 2005, Hydrodynamic Modeling of Dispersion and Dilution of Concentrated Sea Water 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, 97 pp.

Jenkins, S. A. and D. L. Inman, 2006, "Thermodynamic solutions for equilibrium beach profiles", *Jour. Geophys. Res.*, v.3, C02003, doi:10.1029, 21pp.

Leendertse, J. J., 1970, AA water quality model for well-mixed estuaries and coastal seas,@ vol. I, *Principles of Computation*, Memorandum RM-6230-RC, The Rand Corporation, Santa Monica, California, Feb.

Liebeck, R. H., 1976, "On the design of subsonic airfoils of high lift," paper no. 6463, McDonnell Douglas Tech. Report, 25 pp.

Liebeck, R.H., and Ormsbee, A.I., "Optimization of Airfoils for Maximum Lift," *AIAA*

Journal of Aircraft, v. 7, n. 5, Sept-Oct 1970.

McCormick, B., 1979, *Aerodynamics, Aeronautics and Flight Mechanics*, John Wiley & Sons, New York, 652 pp.

NOAA, 1998, AVerified/Historical Water Level Data@ http://www.opsd.nos.noaa.gov/data_res.html

Stratford, B.S., 1959, The Prediction of Separation of the Turbulent Boundary Layer, *Jour. Fluid Mech.*, v. 5.

Stratford, B.S., 1959, An Experimental Flow with Zero Skin Friction Throughout its Region of Pressure Rise, *Jour. Fluid Mech.*, v. 5.

Weiyan, T., 1992, *Shallow Water Hydrodynamics*, Water & Power Press, Hong Kong, 434 pp.

APPENDIX-A: Beach Nourishment Projects Near Agua Hedionda Lagoon

The lagoon prior to the late 1980's typically ingested 200-300 cubic yards per day unless major up-drift nourishment occurred along Oceanside and Carlsbad beaches. Table 3 gives a listing of all dredge disposal and beach nourishment activities occurring in the neighborhood of Agua Hedionda due to activities outside the lagoon's operation. Major beach building projects at Oceanside and Carlsbad were undertaken in 1963, 1973, 1982, 1994 and 2001. The most dramatic example of this updrift nourishment impact resulted from the massive beach nourishment projects in 1982 when 923,000 cubic yards of new sand was truck hauled from the San Luis Rey River and placed on Oceanside beaches. Coincidentally, the 1983-85 biannual maintenance dredging cycle of the west basin of Agua Hedionda yielded 447,464 cubic yards. This corresponded to an average daily influx rate of 613 cubic yards per day during that two year period. Such high daily influx rates had not been seen since 1960 when 841,200 cubic yards of beach nourishment was placed on Oceanside beaches following new construction dredging and enlargement of Oceanside Harbor facilities.

After the late 1980's there was only one minor new beach nourishment project in Oceanside, involving 40,000 cubic yards in 1994. However beginning in 1988, the City of Carlsbad imposed conditions requiring back-passing defined fractions of the Agua Hedionda dredge volume north of the inlet. In 1988, 103,000 cubic yards were back-passed from Agua Hedionda to North Beach (Figure 1), resulting in an influx of 458,793 cubic yards into Agua Hedionda Lagoon by 1990, for an influx rate of about 630 cubic yards per day. During 89 days of dredging operations between December 20, 1993 and April 26, 1994, there were 74,825 cubic yards placed immediately north (updrift) of the Agua Hedionda Lagoon and inlet jetty at the North Beach disposal site. The daily influx rate during this 89 day period rose to an average of 782 cubic yards per day. In 1996 there was 106,416 cubic yards of back-passing dredged sands from Agua Hedionda to North Beach and influx rates increased to 540 cubic yards per day in the year that followed. Although the volume of back-passing has been small relative to prior nourishment efforts in Oceanside, its effect on influx was large due to the close proximity of North Beach to the inlet of Agua Hedionda and the low retention of sand on this beach in the presence of rocky substrate immediately offshore, Elwany et al. (1999) .

Table 3: Dredge Disposal and Beach Nourishment Occurring Outside of Agua Hedionda Lagoon Operations

Year	Amt. Dredged (yd^3)	Material Source	Disposal Location	Comments
1942	500000	Del Mar Boat Basin	Increase grade around Boat Basin	Material was not placed on the beach
1944	200000	Entrance Channel	Upland	Material was not placed on the beach
1955	800,000	Harbor Construction	Oceanside Beach	Dredged Material
1960	41,000	Entrance Channel	Oceanside Beach	Dredged Material
1961	481,000	Channel	Oceanside Beach	Dredged Material
1963	3,800,000	Harbor	Oceanside Beach	1.4myd3 was new
1965	111,000	Entrance Channel	Oceanside Beach	Dredged Material
1966	684,000	Entrance Channel	2nd St.-Wisconsin St.	Dredged Material
1967	178,000	Entrance Channel	3rd St.-Tyson St.	Dredged Material
1968	434,000	Entrance Channel	River-Wilconsin St.	Dredged Material
1969	353,000	Entrance Channel	River-3rd	Dredged Material
1971	552,000	Entrance Channel	3rd-Wisconsin St.	Dredged Material
1973	434,000	Santa Margarita R.	Tyson-Wisconsin St.	New Material-Beach
1974	560,000	Entrance Channel	Tyson-Whitterby	Dredged Material
1976	550,000	Entrance Channel	Tyson-Whitterby	Dredged Material
1977	318,000	Entrance Channel	Tyson-Whitterby	Dredged Material
1981	403,000	Entrance Channel	6th St.-Buccaneer	Dredged Material
1981	403,000	Offshore Borrow Site	Oceanside Beach	Dredged Material
1982	923,000	San Luis Rey R.	Oceanside Beach	New Material-Beach
1983	475,000	Entrance Channel	Tyson Street	Dredged Material
1986	450,000	Entrance Channel	Tyson Street	Dredged Material
1988	220,000	Entrance Channel	Tyson Street	Dredged Material
1990	250,000	Entrance Channel	Tyson Street	Dredged Material
1992	106,700	Bypass System	Tyson Street	Dredged Material
1993	483,000	Modified Entrance	Tyson Street	Dredged Material
1994	40,000	Santa Margarita R.	Wisconsin St.	New Material-Beach
1994	161,000	Entrance Channel	Nearshore Wisconsin	Dredged Material
1994	150,000	Bataquitos Lagoon	Inlet South Side	New Material-Beach

Table 3: (continued)

Year	Amt. Dredged (yd ^{3})	Material Source	Disposal Location	Comments
1995	1,600,000	Bataquitos Lagoon	Ponto Beach	New Material-Beach
1996	162,000	Entrance Channel	Nearshore Wisconsin	Dredged Material
1997a	150,000	Entrance Channel	Nearshore Oceanside	
1997b	100,000	Entrance Channel	Wisconsin St.	Dredged Material
	17,316,700	**Total**		
	178,017	**Average (only including maintenance dredging)**		

Following the east basin dredge project, 202,530 cubic yards were back-passed to North Beach in April 1999. A dredge survey in July 2000 determined that 360,800 cubic yards had influxed into the lagoon, increasing the daily rate to an average of 846 cubic yards per day. Altogether the percentage of lagoon dredging that has been back-passed to North Beach averages 14.7% of the total dredge volume during the 1981-2000 model period. The remaining fraction of dredge volume that was not back-passed was divided between the Middle and South Beach disposal sites. This fraction was historically split in an 85% to 15% ratio between Middle and South Beach.

In 1994-95 a major beach building effort was conducted at Ponto Beach immediately to the south of Agua Hedionda, where 1,750,000 cubic yards of beach fill was placed using dredged material from the construction of the Bataquitos Lagoon Restoration. The most recent beach building project to impact Agua Hedionda was the San Diego Regional Beach Sand Project completed in September 2001. This project placed 1.83 million cubic yards of on beaches between Oceanside and Torrey Pines, of which 921,000 cubic yards were placed in the nearfield of Agua Hedionda. Within one year following completion of the 2001 maintenance dredging of the lagoon, it was necessary to dredge the lagoon again to remove an additional 196,000 cubic yards from the west basin of the lagoon, despite an extremely dry year with below normal wave climate. During this one year period, the average wave height was only 0.8 m, which in the absence of the San Diego Regional Beach Sand Project, should have produced a sand influx volume of only 103,500 cubic yards (Jenkins and Wasyl, 2003).

Table 3 indicates that, historically, sand influx rates rise dramatically in years during and immediately following beach nourishment activities in Oceanside or back-passing in Carlsbad. This is additional evidence to validate conclusions of Inman & Jenkins (1983) that longshore transport rate in this region is sand supply limited. In other words, there is more potential transport than the available sand supply can sustain. Any artificial intervention to increase up-drift sand supply will apparently increase longshore transport rates, and thereby increase the rate of sand influx into the lagoon.

ATTACHMENT 7

LONG-TERM WEST BASIN WATER LEVEL ANALYSIS FOR ASSESSING THRESHOLD IMPINGEMENT EFFECTS OF REDUCED INTAKE FLOWS AT AGUA HEDIONDA LAGOON

JENKINS AND WASYL

JANUARY 2007

Long-Term West Basin Water Level Analysis for Assessing Threshold Impingement Effects of Reduced Intake Flows at Agua Hedionda Lagoon

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, Suite 840
501 West Broadway
San Diego, CA 92101

21 January 2007

1) Introduction:

This study evaluates the long term water level variation in the West Basin of Agua Hedionda Lagoon. The objective of this analysis is to determine the persistence of water levels occurring higher than the threshold elevation for impingement losses during reduced flow rate operations of a stand alone desalination plant co-located at Encina Generating Station. There are two threshold water levels of interest for reduced flow operations ranging from 149.8 mgd to 304 mgd. These thresholds are -0.687 ft MSL and + 4.83 ft MSL. The persistence analysis of these thresholds is performed by hydrodynamic model simulation of the water elevation history in the West Basin due to tidal forcing at the ocean inlet by historic ocean water levels measured at the nearby Scripps Pier tide gage (NOAA # 931-0230) during the period of record 1980-2000. This time period was chosen because it coincides with the period of record used in the hydrodynamic studies in

Appendix E of the certified EIR (Jenkins and Wasyl, 2005). The verified ocean water level data on which this analysis is based was obtained from NOAA (2006).

Because of tidal muting by frictional losses through the ocean inlet of Agua Hedionda, it is not possible to use the Scripps Pier tide gage measurements directly to determine persistence analysis of. Such a simple approach would err on the side of over-estimating the percentage of time the water elevation in the West Basin of the lagoon met or exceeded the two threshold elevations of interest. Instead the tidal muting of the measured ocean water levels was determined through computer simulation of the lagoon tidal hydraulics. The TIDE_FEM tidal hydraulics model presented in Jenkins and Inman (1999) was gridded for a computational mesh of Agua Hedionda Lagoon as shown in Figure 1, using pre- and post dredging bathymetry from the 2002 dredge event from Jenkins and Wasyl (2003). The pre-dredging bathymetry featured the inlet bar in the west basin that was mapped during the October 2002 sounding shown in Figure 2. The post-dredging survey performed in April 2003 indicated uniform deep water throughout the west basin with depths ranging from -20 ft NGVD to – 30ft NGVD, similar to that found in Figure 2-2 of Elwany, et al (2005). The lagoon model was excited at the ocean inlet by the ocean water level elevation time series measured by the Scripps Pier tide gage for the period 1980-2000. The simulated lagoon water levels in the west basin of Agua Hedionda were then sampled at 1 hour intervals, resulting in 183,432 separate outcomes of water elevation that could be subject to statistical analysis of persistence at or above the threshold elevations of interest.

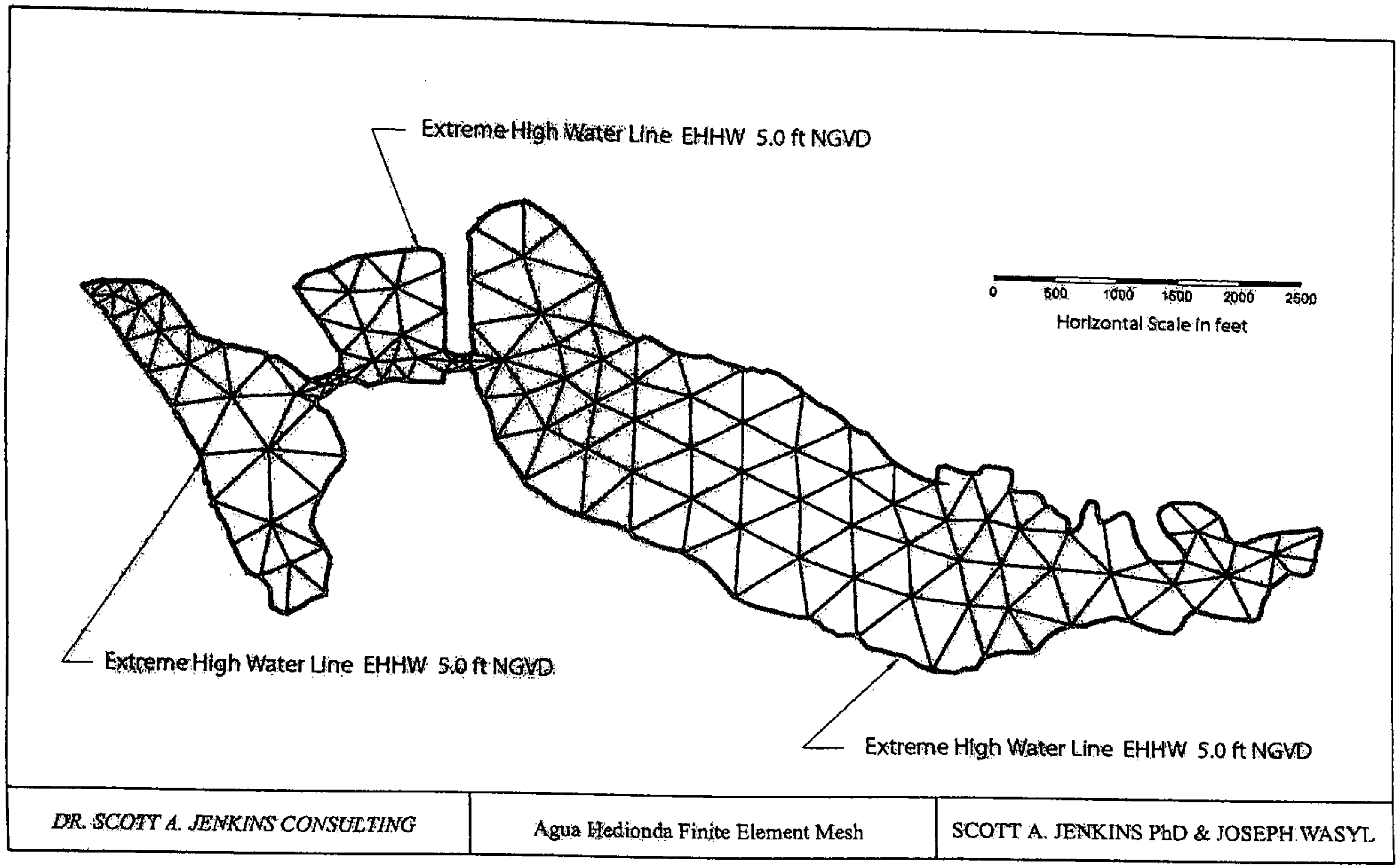


Figure 1. Computational mesh for TIDE_FEM tidal hydraulics model of Agua Hedionda Lagoon.

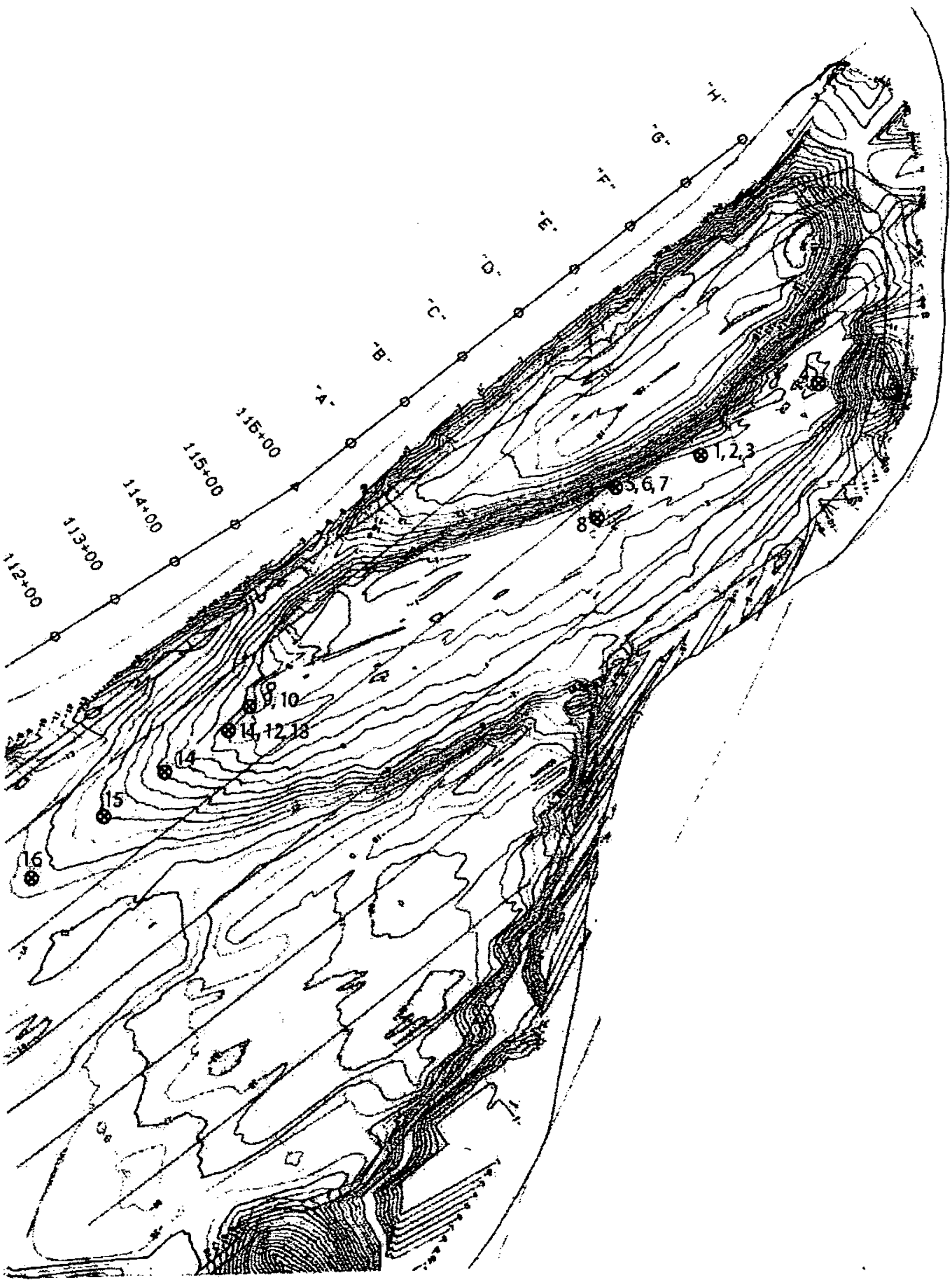


Figure 2. Location key for 12 October 2002 bottom sediment sampling.

2) **Results:**

Time series of the simulated West Basin water levels for each from 1980 through 2000 are given in the upper panel of Figures A-1 through A-21 in Appendix-A. The lower panel of these Figures gives the west basin water level variation for the month containing the highest water level occurring that particular year. Figure 3 presents the probability density function (defined by red histogram bars) resulting from the 183,432 hourly realizations of West Basin water level. The blue curve in Figure 3 is the cumulative probability that the water level will be greater than or equal to a particular water level. The vertical dashed green line in Figure 3 defines the water elevation at -0.687 ft MSL, above which intake flow velocities at the Unit 1 intakes are below the impingement threshold. From the cumulative probability curve, we find that water elevations equal or exceed the -0.687 ft MSL threshold 67% of the time during this 21 year period of record. Thus it is more probable that impingement would not occur at the Unit 1 intakes. On the other hand, there was only one hourly outcome in the 21 year period of record when water elevations exceeded the Unit 5 threshold elevation at +4.83 (light blue dashed vertical line); and hence impingement would remain a definite possibility for nearly any tidal regime around the Unit 5 intake.

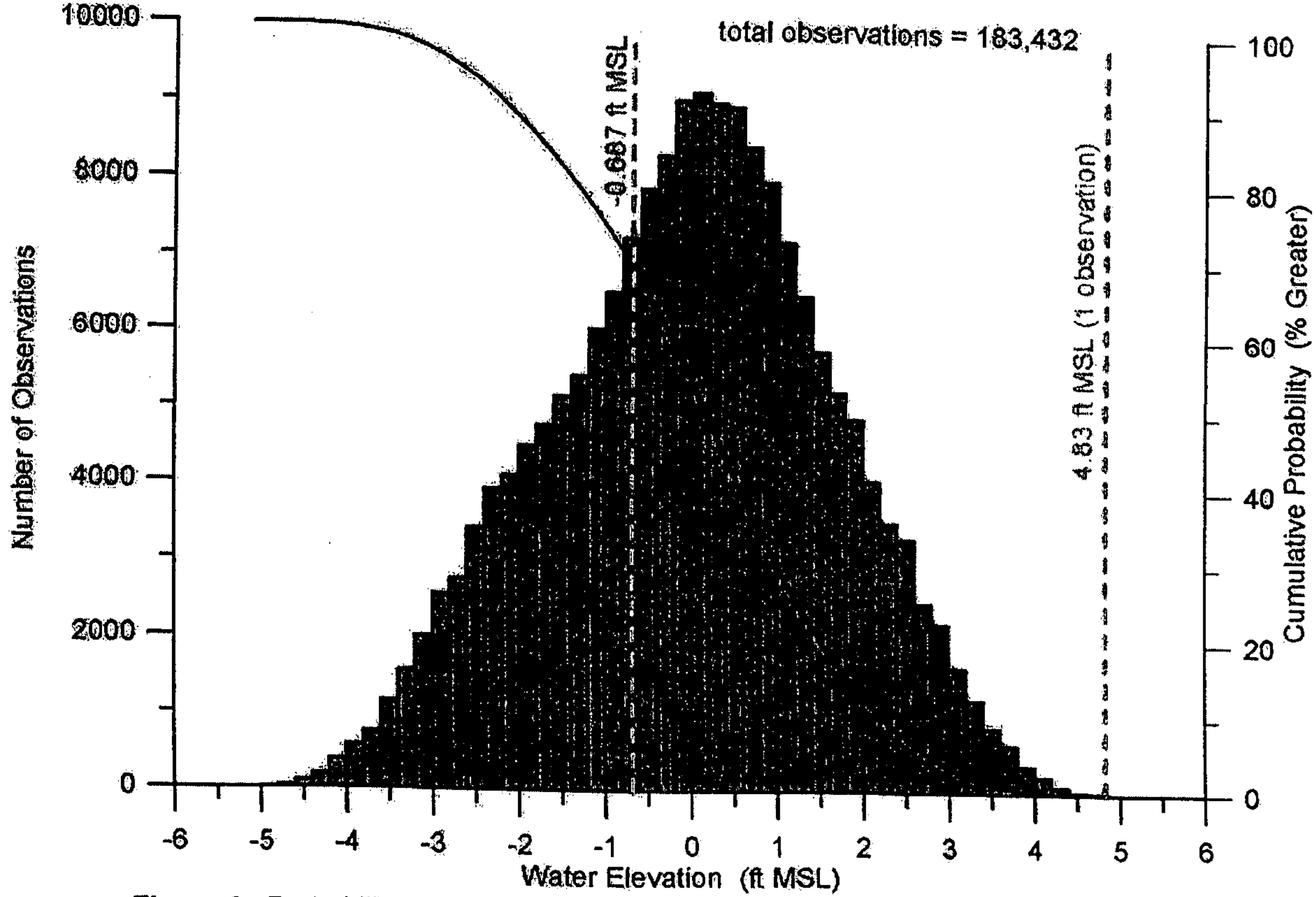


Figure 3. Probability density function and cumulative probability of the water level in the West Basin of Agua Hedionda Lagoon for the period of record 1980-2000.

Reference:

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

Elwany, M. H. S., R. E. Flick, M. White, and K. Goodell, 2005, "Agua Hedionda Lagoon Hydrodynamic Studies," prepared for Tenera Environmental, 39 pp. + appens.

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.

Jenkins, S. A. and D. W. Skelly, 1988, "An Evaluation of the Coastal Data Base Pertaining to Seawater Diversion at Encina Power Plant Carlsbad, CA," submitted to San Diego Gas and Electric, Co., 56 pp.

Jenkins, S. A., D. W. Skelly, and J. Wasyl, 1989, "Dispersion and Momentum Flux Study of the Cooling Water Outfall at Agua Hedionda," submitted to San Diego Gas and Electric, Co., 36 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1993, "Numerical Modeling of Tidal Hydraulics and Inlet Closures at Agua Hedionda Lagoon," submitted to San Diego Gas and Electric, Co., 91 pp.

Jenkins, S. A. and J. Wasyl, 1994, "Numerical Modeling of Tidal Hydraulics and Inlet Closures at Agua Hedionda Lagoon Part II: Risk Analysis," submitted to San Diego Gas and Electric, Co., 46 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1995, "Optimization of Choke Point Channels at Agua Hedionda Lagoon using Stratford Turbulent Pressure Recovery," submitted to San Diego Gas and Electric, Co., 59 pp.

Jenkins, S. A. and J. Wasyl, 1997, "Analysis of inlet closure risks at Agua Hedionda Lagoon, CA and potential remedial measures, Part II," submitted to San Diego Gas and Electric, Co., 152 pp. + appens.

Jenkins, S. A. and J. Wasyl, 1998a, Analysis of Coastal Processes Effects Due to the San Dieguito Lagoon Restoration Project: Final Report, submitted to Southern California Edison Co., 333 pp.

Jenkins, S. A. and J. Wasyl, 1998b, Coastal Processes Analysis of Maintenance Dredging Requirements for Agua Hedionda Lagoon, submitted to San Diego Gas and Electric Co., 176 pp. + appens.

Jenkins, S. A. and D. L. Inman, 1999, A Sand transport mechanics for equilibrium in tidal inlets, *Shore and Beach*, vol. 67, no. 1, pp. 53-58.

Jenkins, S. A. and J. Wasyl, 2001, Agua Hedionda Lagoon North Jetty Resoration Project: Sand Influx Study, submitted to Cabrillo Power LLC., 178 pp. + appens.

Jenkins, S. A. and J. Wasyl, 2003, Sand Influx at Agua Hedionda Lagoon in the Aftermath of the San Diego Regional Beach Sand Project, submitted to Cabrillo Power LLC., 95 pp. + appens

Jenkins, S. A. and D. L. Inman, 2006, "Thermodynamic solutions for equilibrium beach profiles", *Jour. Geophys. Res.,* v.3, C02003, doi:10.1029, 21pp.

NOAA, 2006, Verified/Historical Water Level Data@ http://www.opsd.nos.noaa.gov/data_res.html

APPENDIX-A: Time Series of West Basin Water Levels

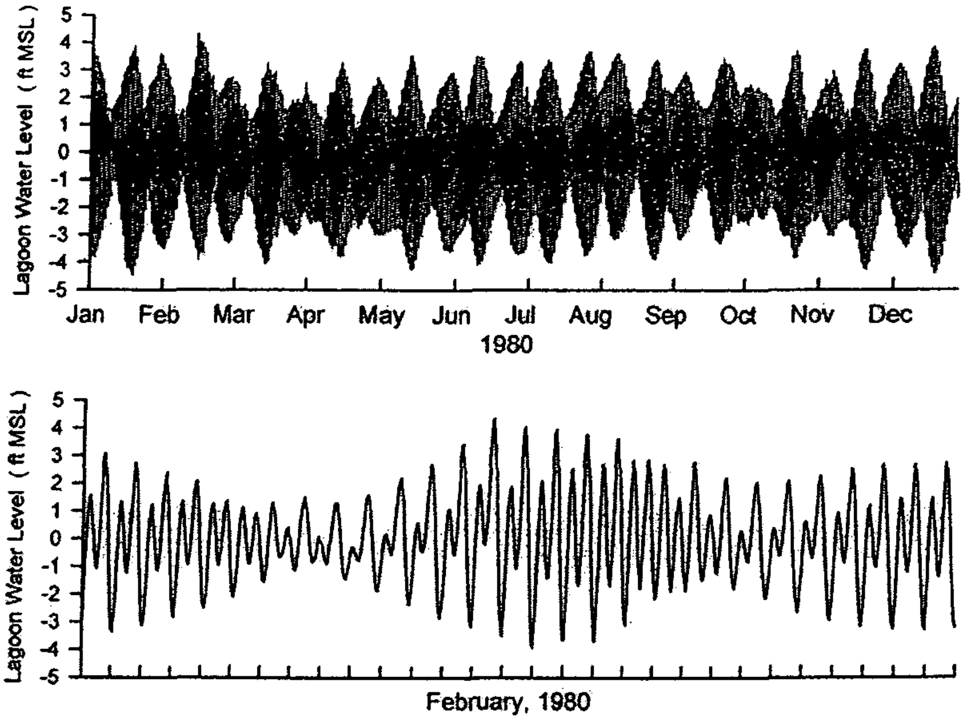


Figure A-1. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1980 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

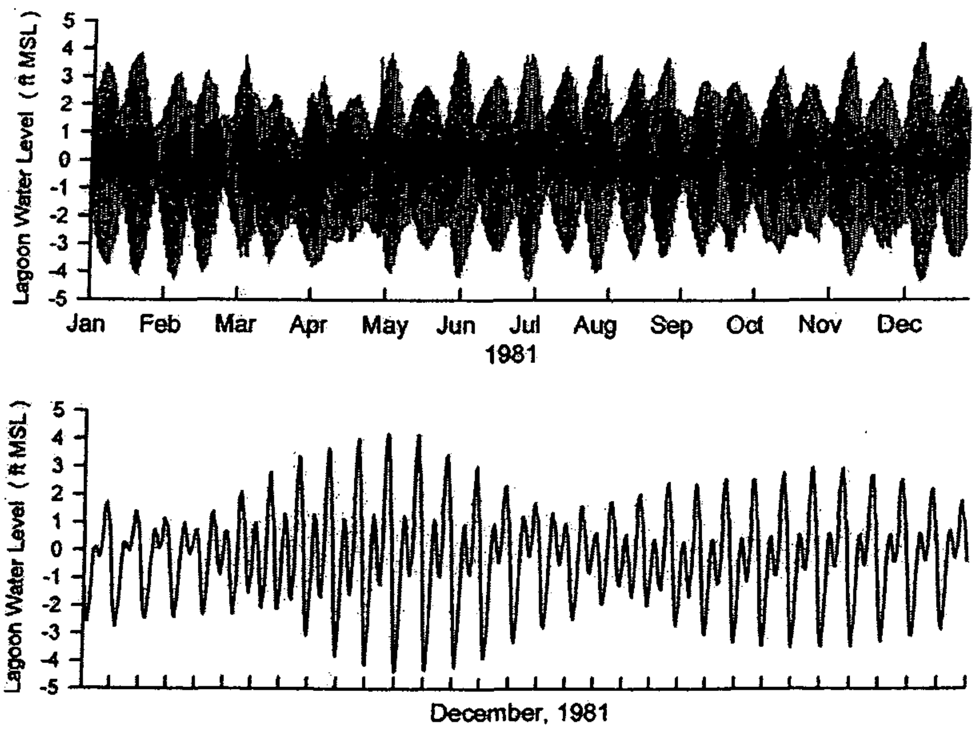


Figure A-2. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1981 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

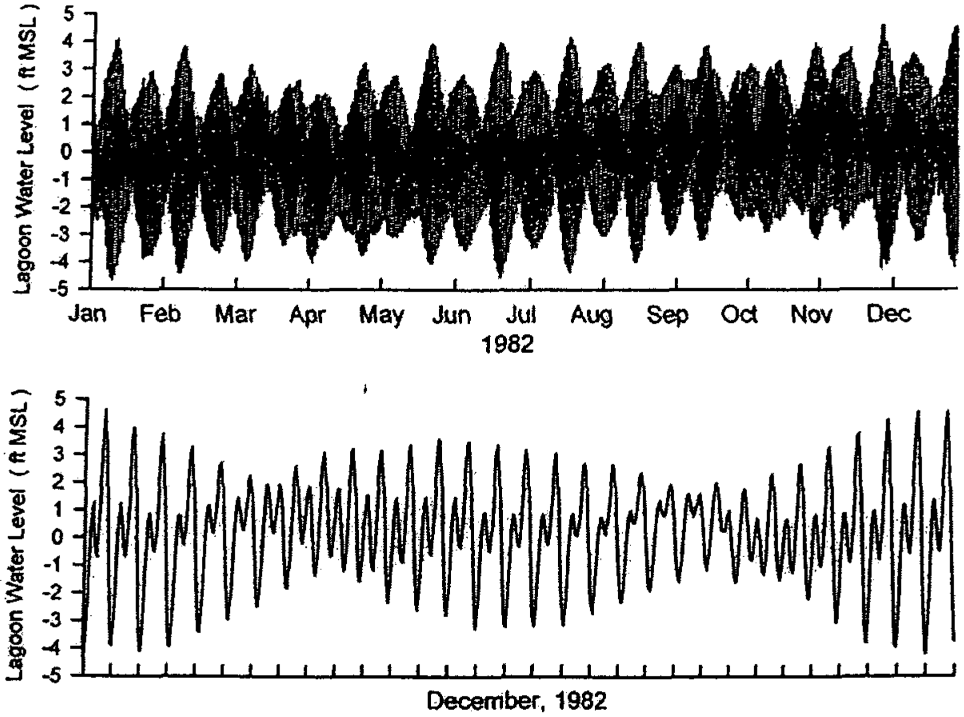


Figure A-3. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1982 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

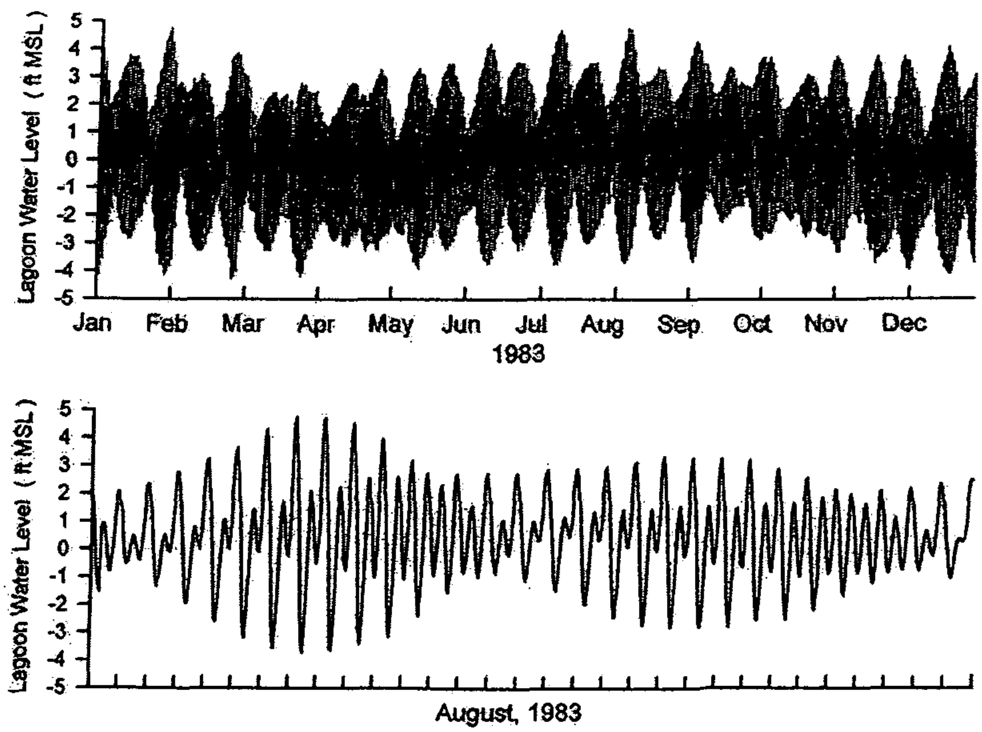


Figure A-4. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1983 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

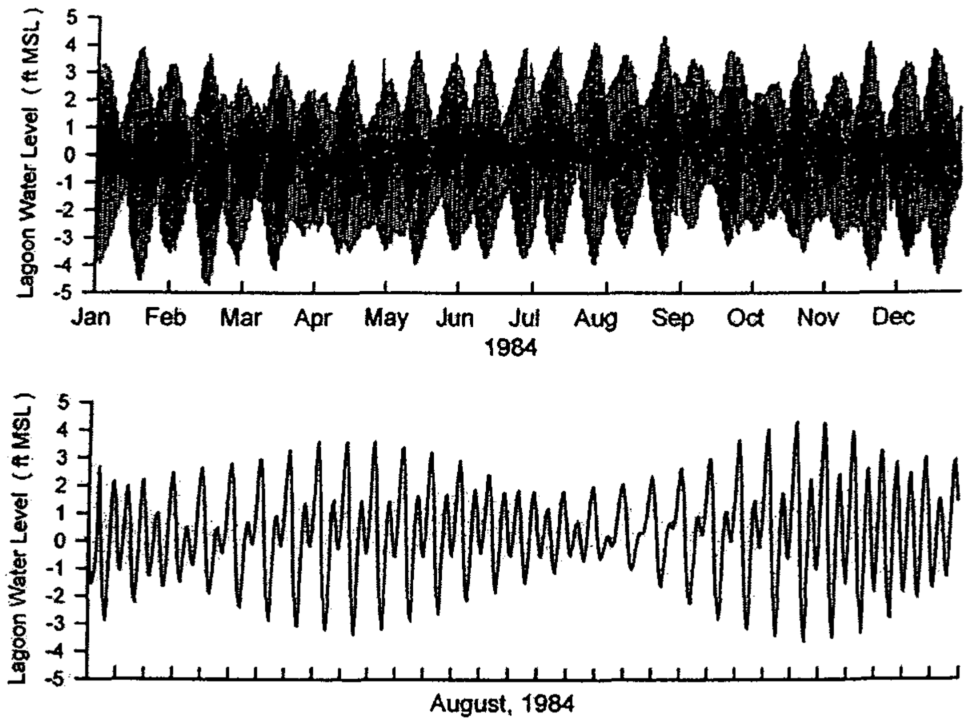


Figure A-5. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1984 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

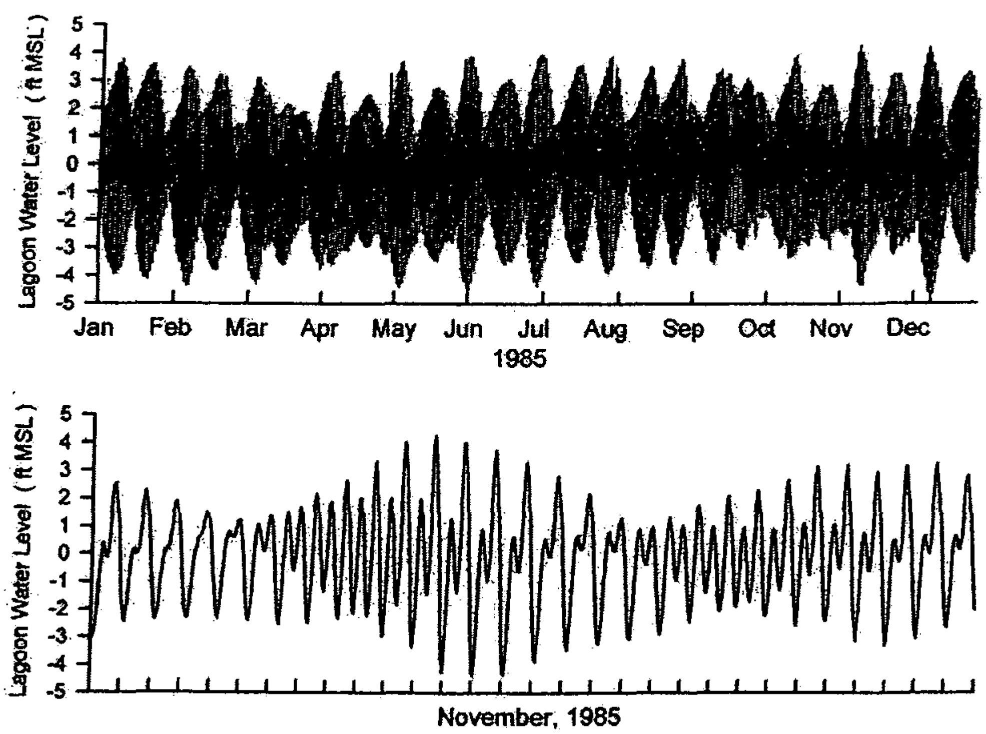


Figure A-6. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1985 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

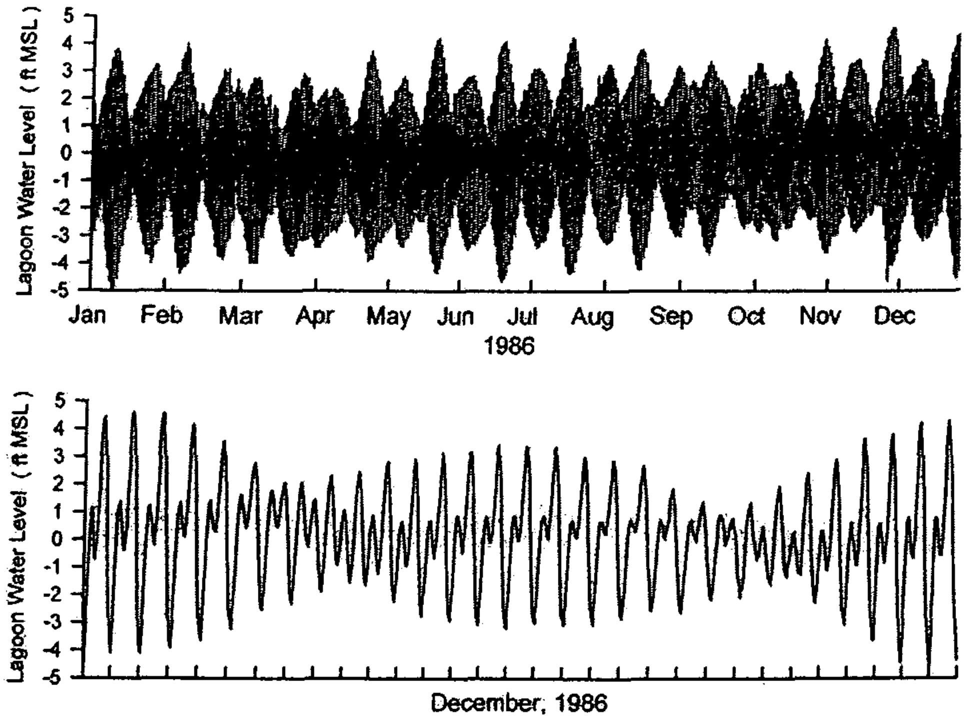


Figure A-7. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1986 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

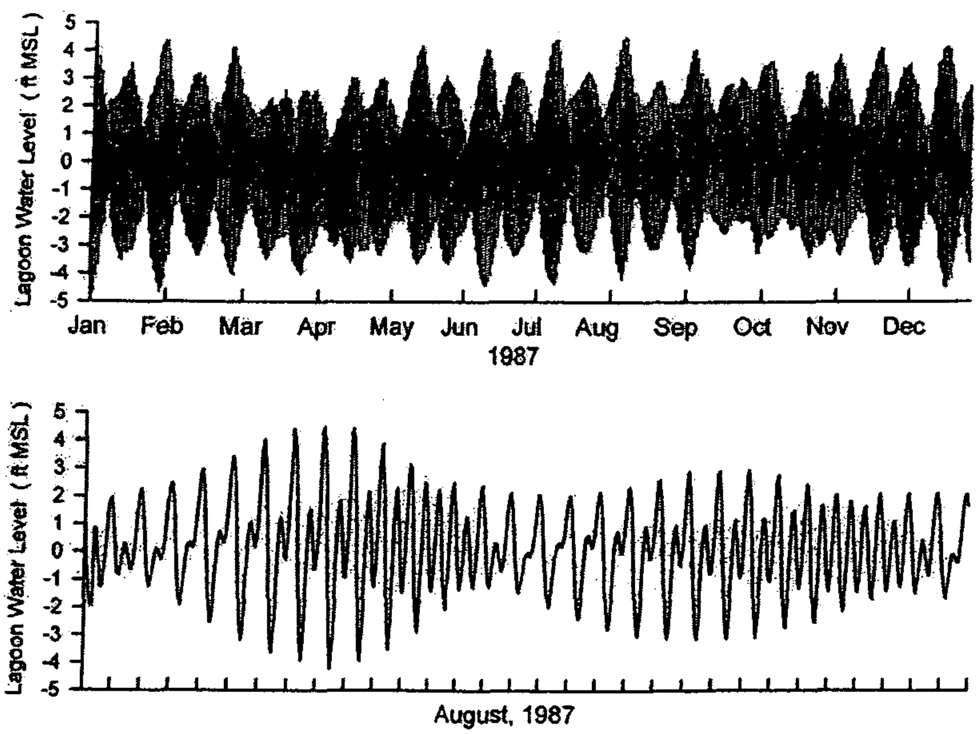


Figure A-8. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1987 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

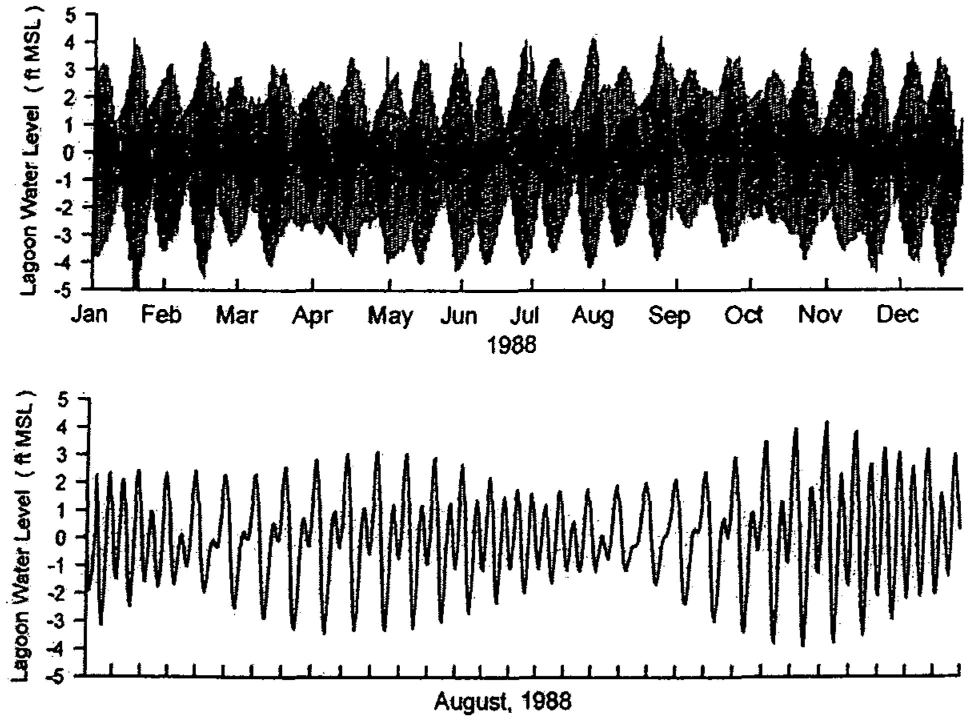


Figure A-9. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1988 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

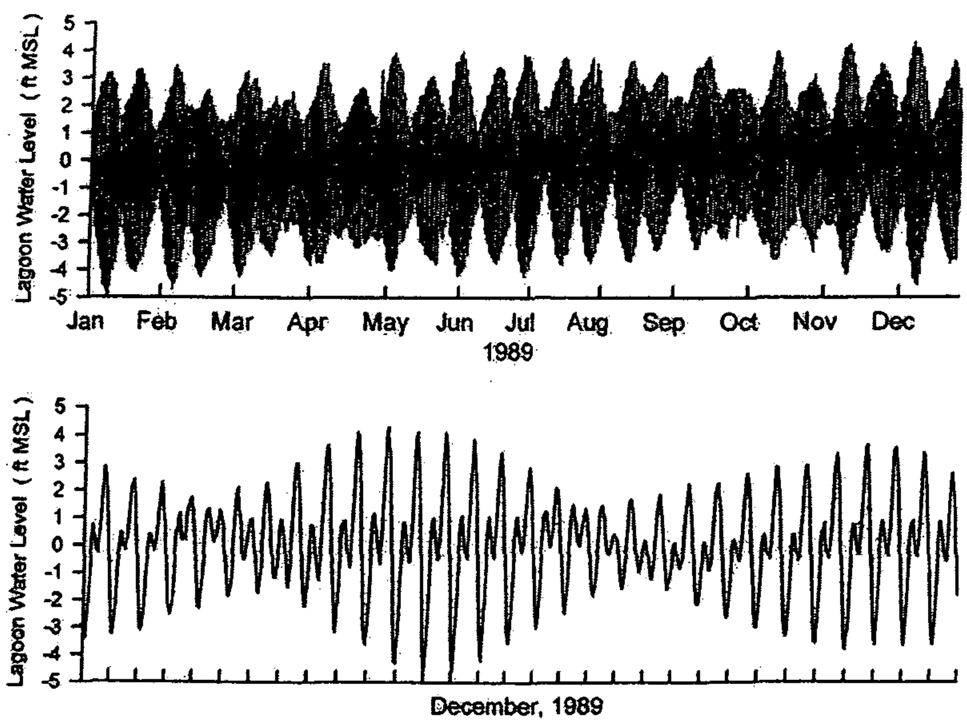


Figure A-10. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1989 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

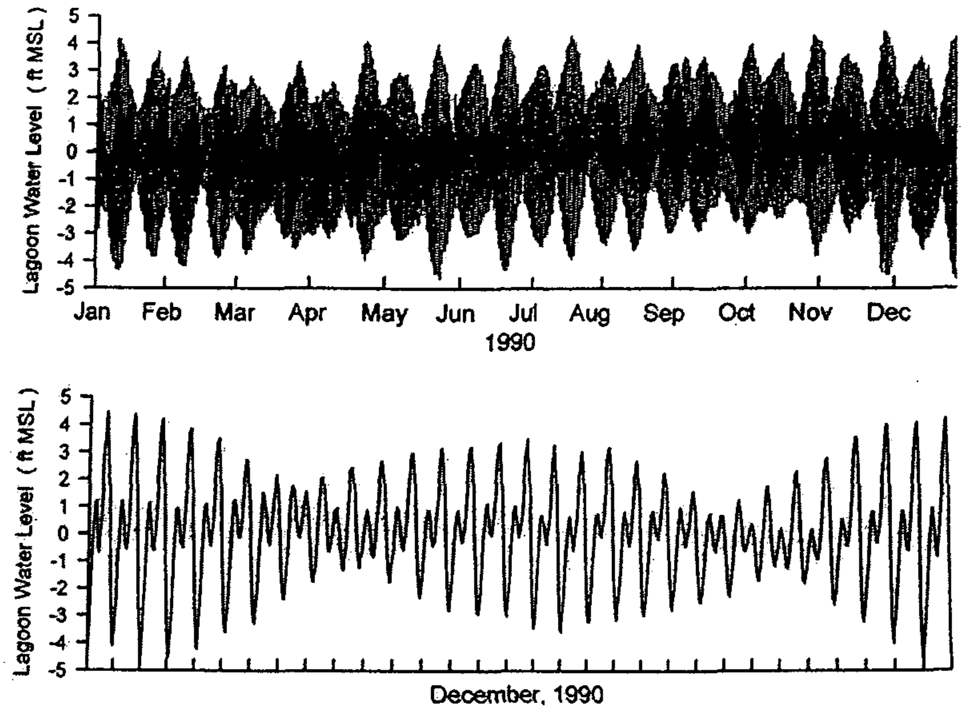


Figure A-11. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1990 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

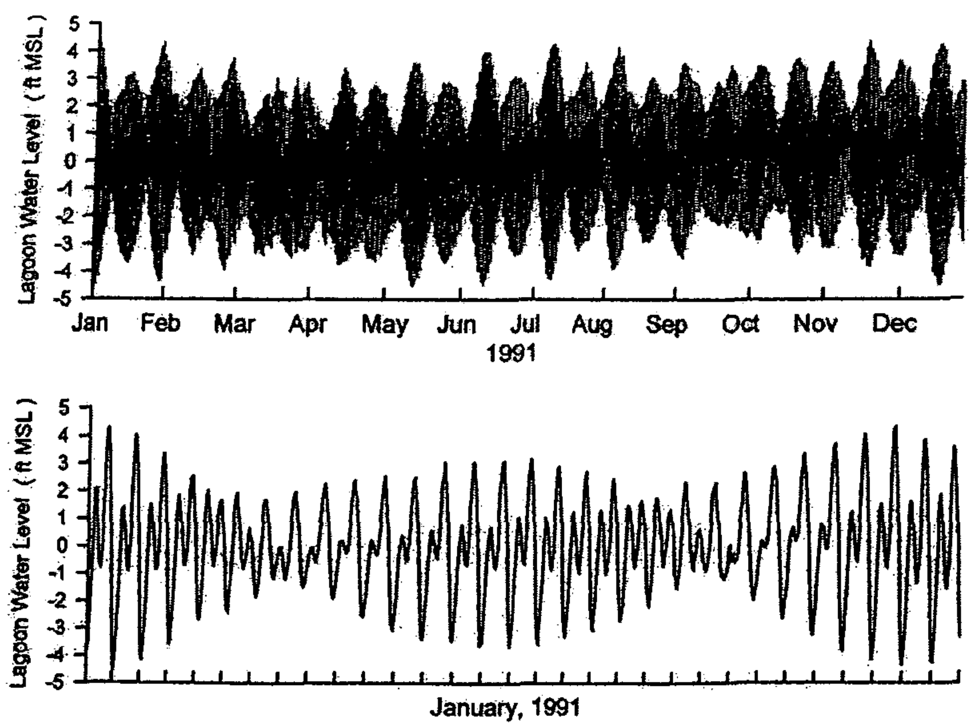


Figure A-12. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1991 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

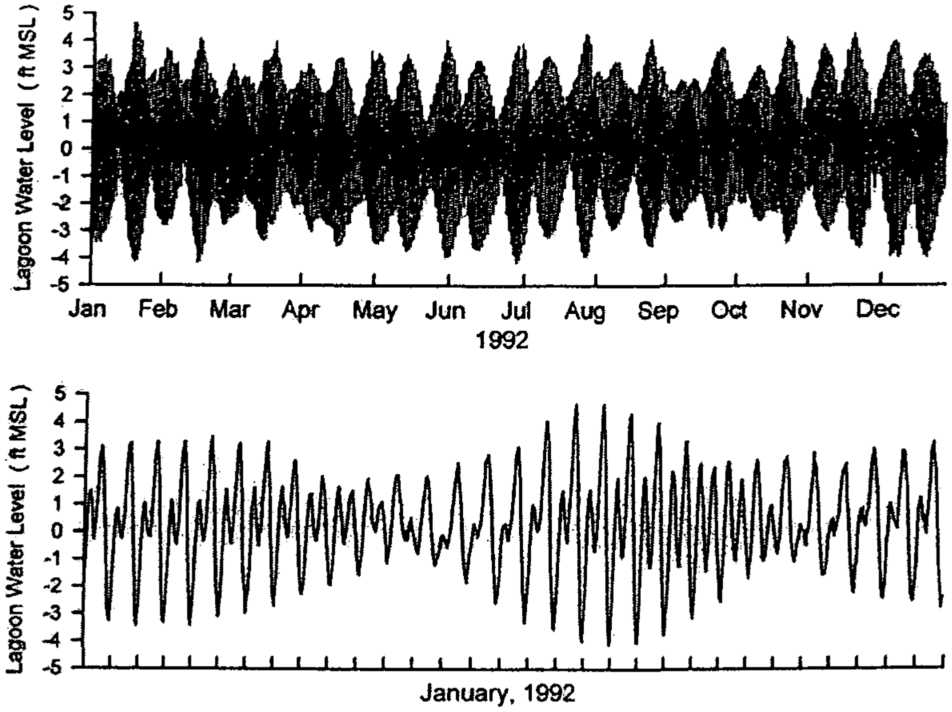


Figure A-13. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1992 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

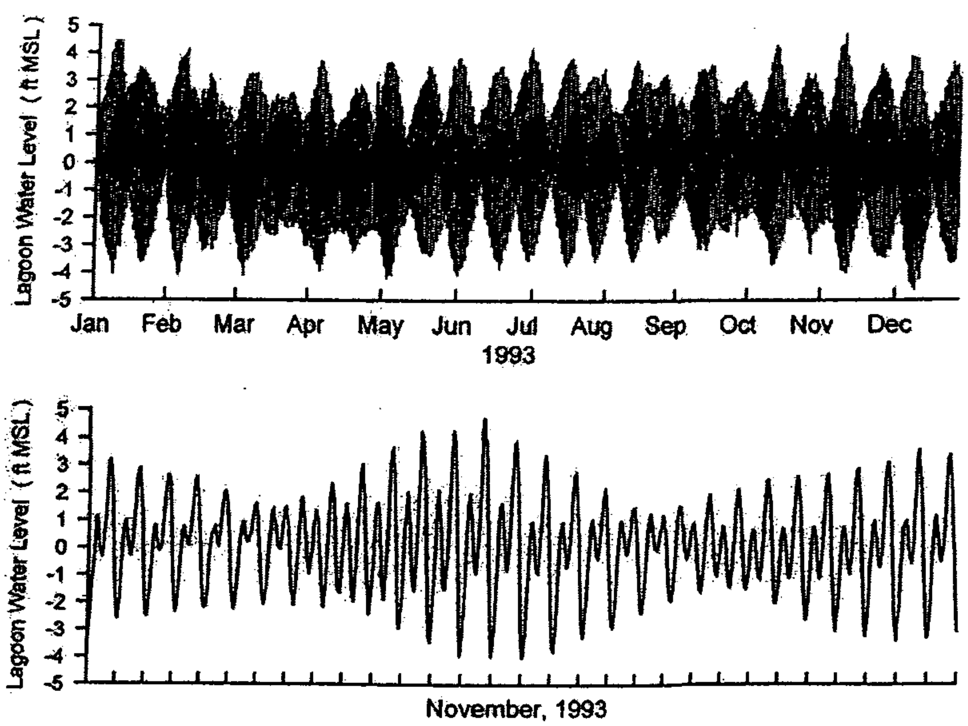


Figure A-14. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1993 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

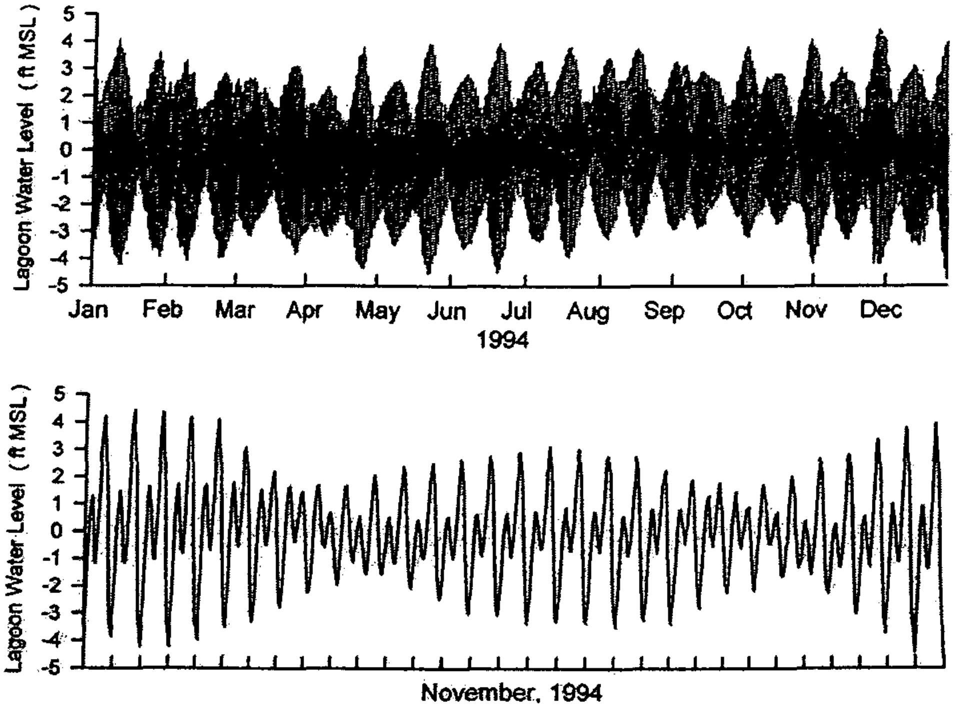


Figure A-15. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1994 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

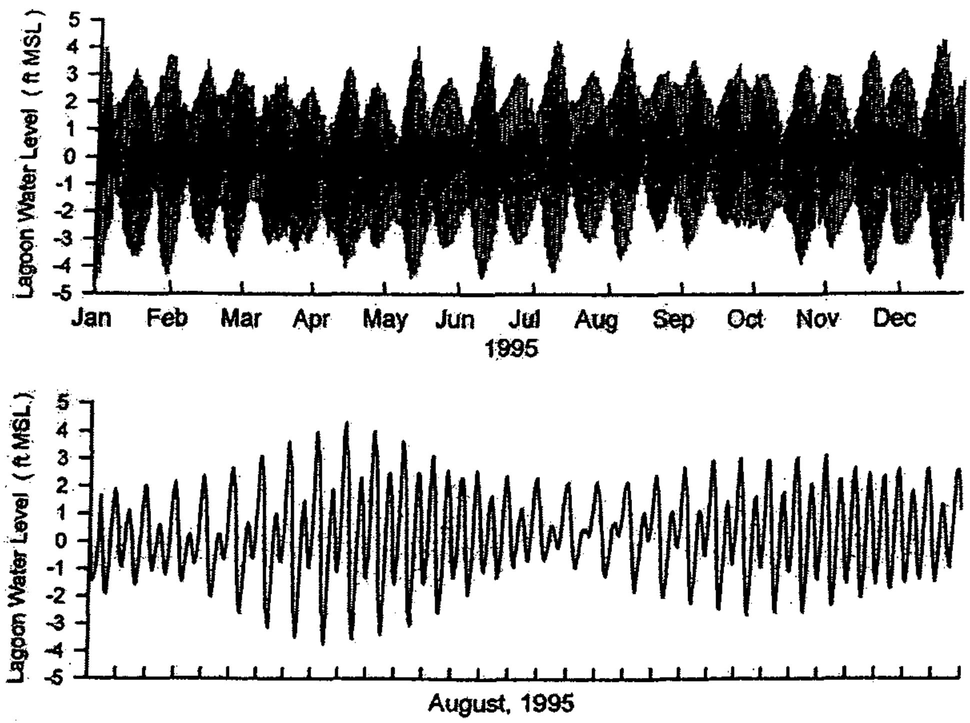


Figure A-16. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1995 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

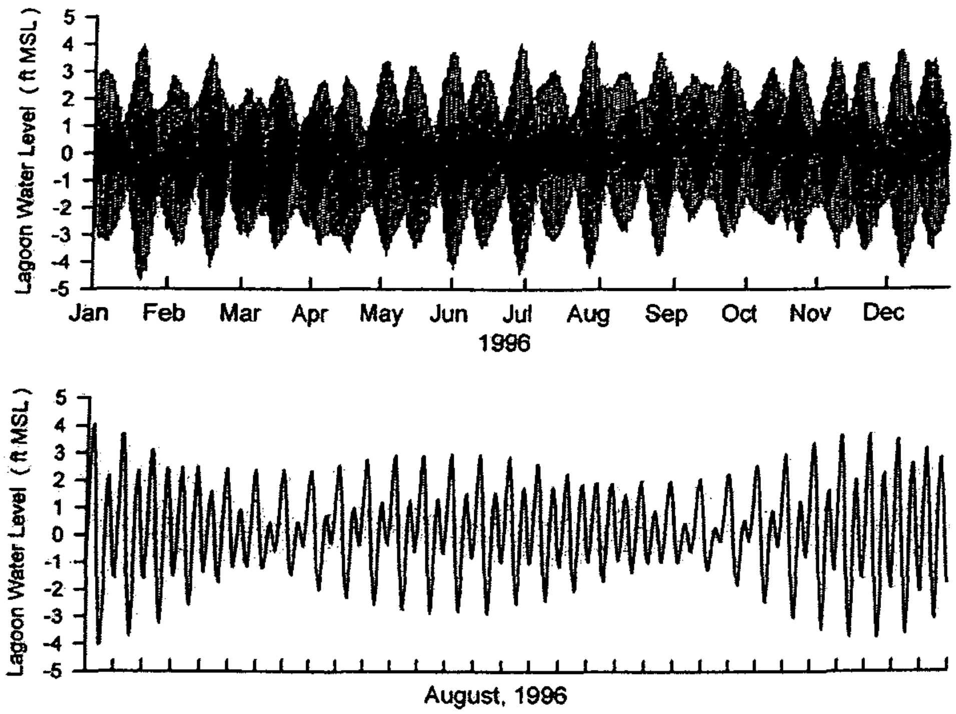


Figure A-17. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1996 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

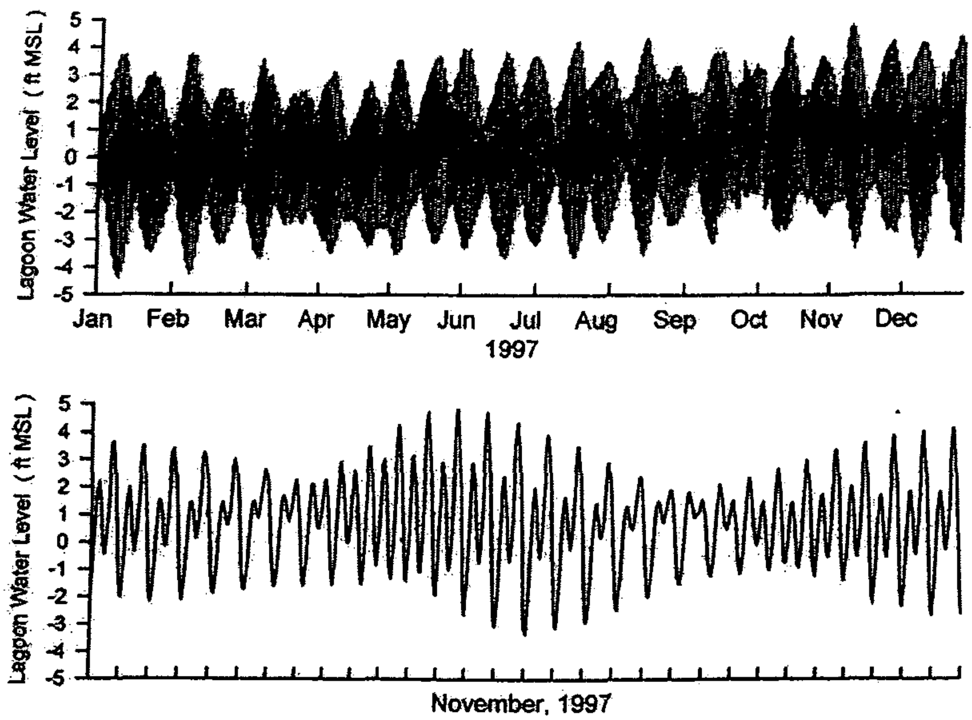


Figure A-18. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1997 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

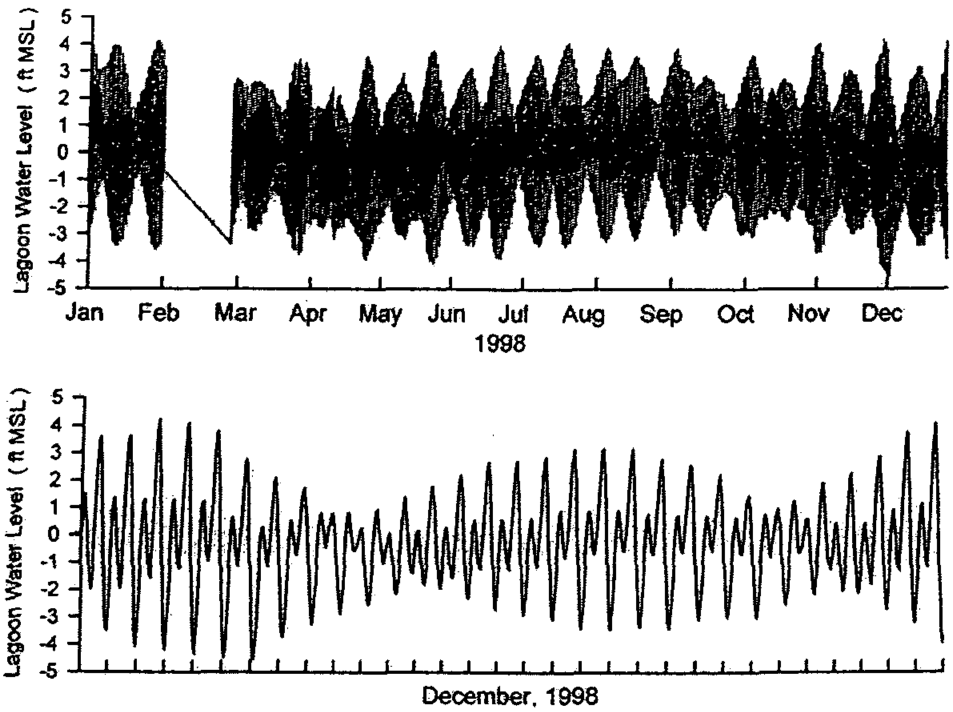


Figure A-19. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1998 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

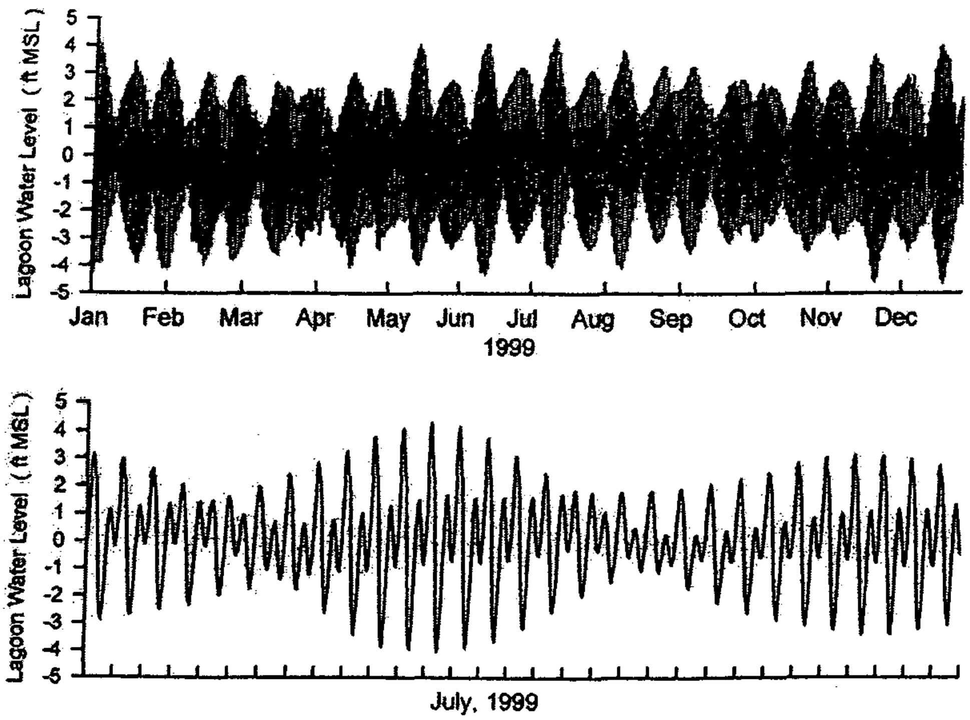


Figure A-20. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 1999 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

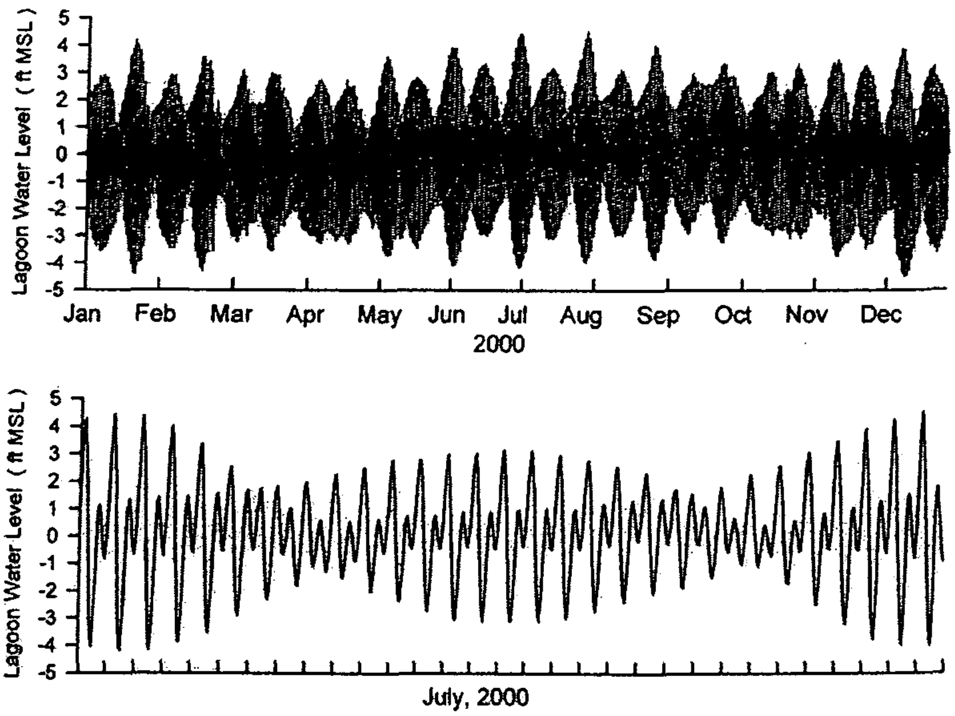


Figure A-21. Water level in West Basin of Agua Hedionda Lagoon derived from TIDE_FEM simulation using 2000 ocean water level measurements from Scripps Pier tide gauge (NOAA # 931-0230).

ATTACHMENT 8

POTENTIAL ADVERSE CHANGES IN AGUA HEDIONDA LAGOON RESULTING FROM ABANDONMENT OF THE LAGOON INTAKE

STEVE LE PAGE
MAY 18, 2007

POTENTIAL ADVERSE CHANGES IN AGUA HEDIONDA LAGOON RESULTING FROM ABANDONMENT OF THE LAGOON INTAKE

STEVE LE PAGE, M-REP CONSULTING

MAY 18, 2007

Introduction:

This technical memorandum analyses the potential for adverse changes in Agua Hedionda water quality, ecology, and natural resources as a result of abandoning the outer lagoon intake structure either by a no desalination project alternative or a no power plant facility operation. Adverse changes are also analyzed for a reduction in the amount of seawater pumped for a stand alone desalination project. The main emphasis of this study is the rate of beach-sand-infilling on the lagoon's ocean connection, seawater exchange and ecology due to discontinuance of dredging. The memorandum contains detailed analyses and descriptions of the potential changes of reduced seawater pumping on the lagoon's hydrodynamics circulation.

Background:

Agua Hedionda Lagoon is not a natural geomorphic formation. The current hydrological unit is approximately 54 years old. Prior to this time, Agua Hedionda was a slough comprised of shallow marsh channels filled with anaerobic hyper-saline water and flushed only briefly during winter months when high tides and rain runoff from Agua Hedionda Creek would broach the barrier berm across the lagoon inlet (Appendix 1.) This lagoon was originally built for the sole purpose of providing a retention basin to hold cooling water for the Encina Power plant. This man made lagoon is a shallow coastal embayment located within the city limits of Carlsbad, California and is wholly owned by Cabrillo Power LLC. This lagoon is bounded to the west by Carlsbad Boulevard, to the north by the city of Carlsbad, to the east by hill slopes and bluffs, and to the south by cultivated fields and the Encina Power Plant property. A railroad trestle and the Interstate 5 freeway bridge divide the lagoon into three interconnected segments; an outer segment, a middle segment, and an inner segment. At the northwest end on the Outer Lagoon, a rock jetty inlet (46 m wide and 2.7 m deep) allows free exchange of water between the ocean and the lagoon system. This inlet and the lagoon system are kept open by a routine maintenance dredging program preformed by Cabrillo Power.

The Outer Lagoon segment covers approximately 66 acres and has an averaged dredged depth of 4.6 m. This lagoon segment serves as a conveyance of cooling water from the ocean to the Encina Power Plant. Bottom sediments consist of coarser gravels and sands, in areas of higher tidal velocities and fine sands or silt/mud in lower flow areas. Much of the inter-tidal area has been lined with riprap to minimize the effects of erosion. Elsewhere, the shoreline of this segment consists primarily of fine sand with interspersed cobble patches. The Middle Lagoon is the smallest segments with a total surface area of approximately 27 acres. The bottom consists largely of clay, silt, or silty sand and a small intermittent freshwater creek drains into the northwest corner of this segment. Most of the inter-tidal zone in this segment consists of mud containing shell hash. The Inner Lagoon is the largest of the three segments with a total surface area of approximately 295 acres. The bottom sediments in this segment consist largely of finer sands, silts, clays and organic detritus especially in the far eastern lagoon section. The inter-tidal zone in this lagoon segment ranges from narrow sandy beaches to mud-clay banks except near the bridges where rip-rap has been used to stabilize the banks. Agua Hedionda Creek empties into the east end of this segment, providing intermittent freshwater infusion into the lagoon. Near the entrance of Agua Hedionda Creek are the degraded remnants of a once extensive salt marsh totaling approximately 100 acres. This former marsh now consists principally of mudflats and high marsh interspersed with salt flats and an alluvial fan.

HYDROLOGY

Circulation within the California Bight is seasonally dominated by the California Current which flows towards the southeast as an extension of the Japanese and Aleutian currents. Inshore of the California Current, the Davidson Current diverges off and forms a nearly permanent Southern California Eddy (Jones, 1971). The Davidson Current flows in a northward direction on a seasonal basis. This countercurrent tends to dominate coastal circulation patterns from September to February. Following this interval is a period of upwelling, which brings colder, nutrient rich waters into coastal environments, and leads to a period of increased biological productivity. This upwelling is typically strongest during May and June of each year as a result of northerly or northwesterly wind stresses (Dailey et. al., 1993). The combination of current and wind-induced factors leads to a general net surface circulation in inshore areas towards the southeast in the months of April, May, and June and towards the north-northwest in September, October, and December.

These general circulation patterns are sometimes disrupted by the global climatic events known as El Nino. This phenomenon results in a decrease in upwelling with resulting higher temperatures and lower biological productivity in nearshore waters. This phenomenon can occur every few years and can last from 1 to 3 years. Prolonged El Nino events can lead to dramatic changes, in the biological communities in the inshore waters of the Southern California Bight.

In the immediate vicinity of the coastline, water movements are dominated by long-shore currents, which are largely driven by prevailing winds and oceanic swell. These longshore currents typically average less than 0.1 in per sec. Oceanic swell impinging on the coast typically approach the shore from the northwest and west in winter and spring as a result of more intense Northern Hemisphere storms. In the summer and fall, oceanic swell typically approaches from the south resulting from hurricanes off the Mexican coast and Southern Hemisphere storms. Locally, wind waves typically come from the northwest and west.

Within Agua Hedionda Lagoon, circulation is dominated tidally and to a lesser extent, prevailing winds and freshwater flows from rain events. Tides exhibit a mixed semidiurnal pattern. On the flood tide, approximately 528 million gallons enter through the seaward entrance of the Outer Lagoon. Approximately half of this volume (264 million gal.) flows into the Middle and Inner lagoon segments and approximately 198 million gallons is withdrawn by the plant for cooling purposes and discharged to the ocean. The remainder (66 million gal.) remains within the outer segment. On the ebb tide, the volume of water which flowed in the middle and upper segments (264 million gal.) return through the outer segment. Approximately half of this volume (132 million gal.) leaves the lagoon to the ocean. The remainder (132 million gal.) together with the flood tide remaining within the Outer Lagoon (66 million gal.) provides the 338 million gallons need for cooling purposes by the plant during this part of the tidal cycle (EA, 1997).

Freshwater enters the lagoon from Agua Hedionda Creek, which, together with its major tributary Buena Creek, drains an 18,525 acre watershed. For most of the year flow from this watershed is minimal and the lagoon remains essentially a negative estuary (salinity gradient increases moving from the ocean to the back reaches of the lagoon) . Occasional heavy rainfall events, generally between December and April, can lead to reduced salinity in the Inner Lagoon.

PHYSICAL AND CHEMICAL WATER ENVIRONMENT

The climate in the coastal area near the Encina Power Plant is characterized as sub-tropical and semi-arid with a strong oceanic influence. The mean annual air temperature is approximately 17.2° C (63° F) with a range in monthly means from 12.7° C (55° F) to 21.6° C (71° F). Freezing temperatures are rare. Annual rainfall averages 30.5 cm (12 in.), most of which occurs in winter. The limited range in temperatures coupled with infrequent rainfall leads to a relatively stable system with respect to physical and chemical parameters in the ocean and lagoon. The physical and chemical characteristics of lagoon waters are similar to that of the ocean and only slightly modified as a result of lagoon specific influences (depth, freshwater runoff, oxygen production and consumtion). Lagoon physical parameters are discussed below.

Water Temperature:

Water temperatures in the lagoon exhibit a typical seasonal pattern reflecting the substantial tidal exchange with the Pacific Ocean and the effects of solar warming of the water while in the relatively shallow lagoon system. Temperatures in the Outer Lagoon generally range from 58 ° F during winter to more than 70 ° F during summer. This limited temperature range reflects the relatively stable climatic conditions in Southern California. Temperatures in the Outer Lagoon were typically 1-4 ° C higher than water temperatures in the ocean at the same time (SDG&E 1980). In shallow areas, especially in the Inner Lagoon, water temperatures are often several degrees higher than in the Outer Lagoon as a result of solar heating.

Salinity:

Salinity in the lagoon are generally similar to that of the adjacent ocean as there is a high degree of mixing and relatively little fresh water input for dilution. Salinity exhibit little seasonal pattern and typically range between 30 and 34 ppt. In the Outer Lagoon, Salinity tends to be almost identical to that of the ocean whereas greater differences between the ocean and the Inner Lagoon are more typical. During dry periods, evaporation in the Inner Lagoon can result in slightly elevated Salinity (1 -2 ppt) compared to the ocean whereas during periods of high runoff from Agua Hedionda Creek, Salinity in this segment can be reduced below that of the ocean through dilution with freshwater.

Dissolved Oxygen:

Dissolved oxygen levels within the lagoon are more variable than that of the adjacent ocean waters. Primary production during the day by phytoplankton, eel grass, and macroalgae tends to increase dissolved oxygen levels over that of the incoming ocean waters. On the other hand, respiration by plants (at night), bacteria, and animals, in both the water column and sediments, together with the natural oxidation of organic compounds, tend to reduce dissolved oxygen levels. As a result, dissolved oxygen concentrations within the lagoon can vary considerably depending upon location, both horizontally and vertically, and time of day. In the Outer Lagoon and in the larger channels, tidal mixing tends to produce uniformity, both horizontally and vertically. In areas with more limited tidal mixing, dissolved oxygen levels near the bottom tend to be much lower than at the surface.

Biological Baseline:

Since the present day hydrological unit of Aqua Hedionda Lagoon is only 54 year old and never existed in a natural state with no anthropogenic effects, it is a subjective task to establish a biological baseline for this lagoon. One could establish the baseline condition as the hyper-saline slough which existed prior to the lagoon being built and contained no marine or estuarine value. Another approach for establishing the biological baseline would be to evaluate the conditions at the time that the lagoon was finished and the circulating pumps for the power plant were turned on. At this point, no biological habitats had a chance to foam. There were no eelgrass meadows, no algal mats to provide nursery grounds for fish, and benthic invertebrates had not yet been established. Lastly, the biological baseline could be based at sometime during the power plants operation that despite the continued use of the lagoon water (at consumption rates has high as 860 mgd) the biological community became established. This community has varied throughout the 54 years of the lagoon's existence as a result of periods of high rainfall, severity of Red Tide events, and other natural and anthropogenic effects. Regardless of the timeframe that one chooses to establish the biological baseline, the timeframe that represents the greatest benefits to the marine environment in terms of providing eelgrass meadows, nursery habitat, juvenile rearing habitat, and marine bird foraging habitat is during the power plant existence and the resulting continued maintenance, i.e. dredging, of the lagoon. It should also be noted that the lagoon structure and the habitat that it provides for the marine biological community would fail if dredging were to cease. This point is further explored in section "Lagoon closure and the effects of dredging".

Biological Assessment:

Lagoon Habitats.

The biological communities of Agua Hedionda contain a terrestrial, marsh/inter-tidal and Sub tidal component. The primary terrestrial component is the upland community located at the east end of the inner lagoon. The marsh community contain a both a terrestrial and inter-tidal component and within this lagoon serves as the transition zone between the back reaches of the inner lagoon and the upland community. The inter-tidal community is the zone around the lagoon between the tidal range exhibited within the lagoon. Inter-tidal acreage is approximately 108 acres for the lagoon as a whole. The ratio between inter-tidal and sub-tidal habitats varies as sedimentation increases in the lagoon. Prior to a dredge event in which a well defined inlet sand bar has formed, the tidal ranged is reduced throughout the lagoon which has an effect of reducing the inter-tidal habitat by 33 acres to a total of 75 acres. This is a result of increase tidal lag time cause by the sub-tidal ground friction. The largest biological community is the Sub tidal component and contains rock, sand, mud, and eelgrass habitats. Arial extent of these habitats has remained relatively consistent through the 54 years of the lagoons existence with the exception of the acreage of eelgrass and the sand/mud habitats (MEC, 1994).

Most of the bottom is covered by a relatively firm sand-silt mixture with silt being predominant in relatively quiescent areas while sand predominates in areas of higher current velocities. Extensive eelgrass (*Zostera marina*) beds can be found throughout the shallower areas of the lagoon while sargassum (*Sargassum muticum*) is common along the shores of the Outer Lagoon nearest the inlet. In the Inner and Middle lagoons, the shoreline consists largely of fine sand with cobble patches whereas the Outer Lagoon is principally lined with rip-rap to prevent erosion.

The major sub-tidal habitats of the lagoon and examples of the types of species residing in those habitats are presented below:

Eelgrass –Currently, at 8.05 acres, the middle lagoon contains the largest area of eelgrass (Table 1). However, in the past the inner lagoon contained the majority of eelgrass habitat. This habitat is an important nursery ground of many offshore fishes and juvenile lobster (*Panulirus interruptus*). Resident fish include Spotted Bay Bass (*Paralabrax clathratus*) Barred Sand Bass (*Paralabrax nebulifer*), Kelp bass (*Paralabrax clathratus*), and several species of Perch and Crocker and also contains a high density of benthic invertebrates.

Rock – 2.06 acres of rocky habitat is found within the lagoon. The majority of this habitat is located in the outer lagoon with smaller amounts found in the inner and middle lagoon around the banks that lead up to interstate 5 and the railroad tracks. The rocky habitat is composed mainly of rip rap areas that were placed along the shoreline were the surrounding terrestrial area slopes toward the lagoon. The majority of this habitat is found in the outer Lagoon and is an important nursery ground of many offshore fishes and juvenile lobster and other benthic invertebrates. Resident fish include Spotted Bay Bass (*Paralabrax clathratus*) Barred Sand Bass (*Paralabrax nebulifer*), Kelp bass (*Paralabrax clathratus*), Garibaldi (*Hypsypops rubicundus*), several species of Perch and Crocker. Invertebrates include the Spiny Lobster (*Panulirus interruptus*), Two Spotted Octopus (*Octopus bimaculatus*) and Purple Sea Urchin (*Strongylocentrotus purpuratus*)

Sand/Mud – The Majority of the Lagoon bottom is comprised of Sand, Sand/Mud, or silt. The distribution of this habitat between the three segments of the lagoon is directly correlated with the size of each segment. The inner lagoonResidents of this habitat include California Halibut (*Paralichthys californicus*), Spotted Bay Bass (*Paralabrax clathratus*) Barred Sand Bass (*Paralabrax nebulifer*), several species of Perch and Crocker.

Table 1. Location and acreage of sub-tidal lagoon habitats

Habitat	Location	Acreage	Date	Lit Source
Eelgrass	Outer	6.32	Dec, 2006	Merkel, 2006
	Middle	8.05	Dec, 2006	Merkel, 2006
	Inner	1.5	Jan, 2007	Verbal Merkel
Rock	Outer	1.28	Jan, 2007	Le Page Per. Data
	Middle	0.62	Jan, 2007	Le Page Per. Data
	Inner	0.16	Jan, 2007	Le Page Per. Data
Sand/Mud	Outer	41.4	Jan, 2007	Le Page Per. Data
	Middle	10.67	Jan, 2007	Le Page Per. Data
	Inner	174.34	Jan, 2007	Le Page Per. Data
Marsh	Outer	0	1993	MEC, 1993
	Middle	0	1993	MEC, 1993
	Inner	17	1993	MEC, 1993
UpLand	Outer	0	1993	MEC, 1993
	Middle	0	1993	MEC, 1993
	Inner	75	1993	MEC, 1993

In addition to its year-round inhabitants, the lagoon serves as important spawning and/or nursery habitat for a variety of marine species that make seasonal migrations into the lagoon. Supplementing these year-round and seasonal inhabitants are species that wander into the lagoon or are transported in by tidal currents. The relatively protected shallow, warmer waters of the lagoon coupled with the variety of species leads to a greater biological productivity than found in adjacent coastal waters.

Benthic Invertebrates. Previous studies have documented at least 182 distinct taxa of benthic macro invertebrates inhabiting Agua Hedionda Lagoon (SDG&E 1980). This list includes both infaunal and epibenthic species, all common to shallow water habitats of Southern California. The distribution and relative abundance of these species within the lagoon is primarily determined by sediment characteristics (Bradshaw et al. 1976).

Phytoplankton. Phytoplankton, consisting primarily of diatoms and dinoflagellates, provide important primary production to the Agua Hedionda Lagoon ecosystem (Bradshaw et al. 1976). Many of the diatoms common in the lagoon are benthic and not truly part of the plankton community. Microzooplankton in the lagoon consists of smaller zooplankton (e.g., rotifers) as well as larval stages of larger macrozooplankton and benthic invertebrates (Bradshaw et al. 1976). The macrozooplankton community within the lagoon is dominated by copepods, especially *Acartia clausii*, *Euterpina acutifrons*, and *Oithona oculata* (Bradshaw et al. 1976). The overall species composition and abundance of this community, according to Bradshaw, was generally similar to that of other shallow coastal habitats of Southern California.

Fish. A total of 104 species of fish have been reported as juveniles or adults from the Agua Hedionda Lagoon (SDG&E, 1980). A total of 68 species were collected by nekton sampling in the lagoon. These catches were dominated by topsmelt, deepbody anchovy and slough anchovy, which together comprised more than 77 percent of the catch. Catch was highest in the Inner Lagoon where a total of 40 species were collected. In this area of the lagoon, the same three dominant species accounted for more than 86 percent of the overall catch. In the Middle Lagoon, overall catch was intermediate with a total of 40 species being collected. Three species, topsmelt, shiner surfperch and California grunion together comprised more than 81 percent of the catch. In the Outer Lagoon, overall catches were lowest with 39 -species being collected. Four species, topsmelt, California grunion, walleye surfperch, and California halibut comprised more than 77 percent of the catch. Prior studies found a total of 88 species of fish were collected in impingement sampling including 36 species of fish not collected in nekton sampling of the lagoon. These additional species were typically marine species rarely encountered in the lagoon (E.A., 1997). Five species of fish, deepbody anchovy, topsmelt, northern anchovy, queenfish, and shiner perch, individually comprised more than 10 percent of the catch and together comprised more than 72 percent of the overall impingement collections. Current impingement data recorded 98 species (Table 2) which compares well with the E.A., 1997 study. In addition to the juvenile and adult fish, a total of 36 species of fish were also collected as eggs and larvae in plankton sampling within the lagoon. All of these species were also collected as juveniles or adults within the lagoon. Overall, egg collections were dominated by anchovies, drums, and sanddabs while larval collections were dominated by silversides, gobies, and anchovies.

Table 2. Fishes, sharks, and rays observed in Agua Hedionda from June 2004 to June 2005.

(unpublished data)

Acanthogobius flavimanus	Yellowfin goby	*Mugil cephalus*	Striped mullet
Albula vulpes	Bonefish	*Mustelus californicus*	Gray smoothhound
Ameiurus natalis	Yellow bullhead	*Myliobatis californica*	Bat ray
Ameiurus nebulosus	Brown bullhead	*Ophichthus zophochir*	Yellow snake eel
Amphistichus argenteus	Barred surfperch	*Oxylebius pictus*	Painted greenling
Anchoa compressa	Deepbody anchovy	*Paraclinus integripinnis*	Reef finspot
Anchoa delicatissima	Slough anchovy	*Paralabrax clathratus*	Kelp bass
Anchoa spp.	Anchovy	*Paralabrax maculatofasciatus*	Spotted sand bass
Anisotremus davidsoni	Sargo	*Paralabrax nebulifer*	Barred sand bass
Atherinops affinis	Topsmelt	*Paralichthys californicus*	California halibut
Atherinopsis californiensis	Jacksmelt	*Peprilus simillimus*	Pacific butterfish
Atractoscion nobilis	White seabass	*Phanerodon furcatus*	White surfperch
Brachyistius frenatus	Kelp surfperch	*Platyrhinoidis triseriata*	Thornback
Cheilopogon pinnatibarbatus	Smallhead flyingfish	Pleuronectiformes unid.	Flatfishes
Cheilotrema saturnum	Black croaker	*Pleuronichthys guttulatus*	Diamond turbot
Chromis punctipinnis	Blacksmith	*Pleuronichthys ritteri*	Spotted turbot
Citharichthys sordidus	Pacific sanddab	*Pleuronichthys verticalis*	Hornyhead turbot
Citharichthys spp.	Sanddabs	*Porichthys myriaster*	Specklefin midshipman
Citharichthys stigmaeus	Speckled sanddab	*Porichthys notatus*	Plainfin midshipman
Cymatogaster aggregata	Shiner surfperch	*Porichthys* spp.	Midshipman
Cynoscion parvipinnis	Shortfin corvina	*Pylodictis olivaris*	Flathead catfish
Dasyatis dipterura	Diamond stingray	*Rhacochilus vacca*	Pile surfperch
Dorosoma petenense	Threadfin shad	*Rhinobatos productus*	Shovelnose guitarfish
Embiotoca jacksoni	Black surfperch	*Roncador stearnsi*	Spotfin croaker
Engraulis mordax	Northern anchovy	*Sarda chiliensis*	Pacific bonito
Fundulus parvipinnis	California killifish	*Sardinops sagax*	Pacific sardine
Genyonemus lineatus	White croaker	Sciaenidae unid.	Croaker
Gibbonsia montereyensis	Crevice kelpfish	*Scomber japonicus*	Pacific mackerel
Gillichthys mirabilis	Longjaw mudsucker	*Scorpaena guttata*	Calif. scorpionfish
Girella nigricans	Opaleye	Scorpaenidae	Scorpionfishes
Gymnura marmorata	Calif. butterfly ray	*Sebastes atrovirens*	Kelp rockfish
Halichoeres semicinctus	Rock wrasse	*Seriola lalandi*	Yellowtail jack
Hermosilla azurea	Zebra perch	*Seriphus politus*	Queenfish
Heterodontus francisci	Horn shark	*Sphyraena argentea*	California barracuda
Heterostichus rostratus	Giant kelpfish	*Strongylura exilis*	California needlefish
Heterostichus spp.	Kelpfish	*Symphurus atricauda*	California tonguefish
Hyperprosopon argenteum	Walleye surfperch	*Syngnathus leptorhynchus*	Bay pipefish
Hyperprosopon spp.	Surfperch	*Syngnathus spp.*	Pipefishes
Hyporhamphus rosae	California halfbeak	*Tilapia* spp.	Tilapias
Hypsoblennius gentilis	Bay blenny	*Torpedo californica*	Pacific electric ray
Hypsoblennius gilberti	Rockpool blenny	*Trachurus symmetricus*	Jack mackerel
Hypsoblennius jenkinsi	Mussel blenny	*Triakis semifasciata*	Leopard shark
Hypsoblennius spp.	Blennies	*Umbrina roncador*	Yellowfin croaker
Hypsypops rubicundus	Garibaldi	*Urolophus halleri*	Round stingray
Lepomis cyanellus	Green sunfish	*Xenistius californiensis*	Salema
Leptocottus armatus	Pacific staghorn sculpin	Zoarcidae	Eelpouts
Leuresthes tenuis	California grunion		
Lyopsetta exilis	Slender sole		

Medialuna californiensis	Halfmoon	
Menticirrhus undulatus	California corbina	
Micrometrus minimus	Dwarf surfperch	

Birds: Agua Hedionda Lagoon provides habitat for migratory birds as well as resident bird populations (Table 3). Some of the migratory birds use the lagoon as a resting point prior to their nesting area to the south, while others such as the California Least Tern (*Sterna antillarum browni*) use the lagoon as a nesting site (MEC, 1995). Of the 76 species of birds observed within the lagoon area the majority of them are water associated birds (Accounting for 75% of the total number of species.) Within this group of birds, the diversity of shore birds was the highest followed by ducks, geese and coots. Agua Hedionda Lagoon contains bird populations of several special status species, which consist of the California Brown Pelican (*Pelecanus occidentalis californica*), California Least Tern (*Sterna antillarum browni*), Western Snowy Plover (*Charadrius atexandrinus nivosus*), Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*), and the California gnatcatcher (*Polioptila californica*).

Table 3. Birds observed 1994-1995 (MEC, 1997)

American Avocel	Recurvirostra americana	Lesser Scaup	Aythya affinis
American Coot	Fulica americana	Lincoln's Sparrow	Melospiia lincolnii
American Crow	Corvus brachyrltynchos	Loggerhead Shrike	Lanius ludovicianus
American Wigeon	Anas americana	Long-billed Curlew	Numenius americanus
Anna's Hummingbird	Calypte anna	Mallard	Anas platyrhynchos
Barn Swallow	Hirundo ruslica	Marbled Godwit	Limosafcdoa
Belding's Savannah Sparrow	Passerculus sandwichensis beldingi	Marsh Wren	Cistothorus palustris
Black Phoebe	Sayomis nigricans	Mourning Dove	Zenaida macroura
Black Skimmer	Rhynchops niger	Northern Harrier	Circus cyaneus
Black-bellied Plover	Pluvialis squatarola	Northern Pintail	Anas acula
Black-necked Stilt	Himanlopui mexicanus	Northern Rough-winged Swallow	Stelgidopteryx serripennis
Bonaparte's Gull	Larus Philadelphia	Northern Shoveler	Anas clypcata
Bufflehead	Bucephala albeola	Osprey	Pandion haliaelus
California Brown Pelican	Pelecanus occidentalis californica	Pied-billed Grebe	Podilymbus podiceps
California Gull	Larus californicus	Red-breasled Merganser	Mergus senator
California Least Tern	Sterna antillarum browni	Red-necked Phalarope	Phalaropus lobalus
Canvasback	Aylhya valisineria	Red-tailed Hawk	Buteo jamaicensis
Caspian Tern	Sterna caspia	Red- winged Blackbird	Agelaius phoeniceus
Cinnamon Teal	Anas cyanoptera	Redhead	Aylhya americana
Clark's Grebe	Aechmophorus clarkii	Ring-billed Gull	Larus delawarensis
Cliff Swallow	Hirundo pyrrhonola	Ruddy Duck	Oxyura jamaicensis

Common Raven	Corvus corax	Sanderling	Calidris alba
Common Snipe	Gallinago gallinago	Sandpiper, unidentified	Calidris spp.
Common Yellowthroal	Geolhlypis irichas	Savannah Sparrow	Passerculus sandwichensis
Cooper's Hawk	Accipiter cooperii	Scaup spp.	Athya spp.
Double-crested Cormorant	Phalacrocorax auritus	Semipalmated Plover	Charadrius semipaimatus
Dowitcher spp.	Limnodromus spp.	Short-billed Dowitcher	Umnodromus griseus
Dunlin	Calidris alpina	Snowy Egret	Egretta thula
Eared Grebe	Podiceps nigricollis	Song Sparrow	Melospim melodia
Forster's Tem	Sterna forsteri	Turkey Vulture	Cathartes aura
Gadwall	Anas strepera	Western Grebe	Aechmophorus occidentalis
Great Blue Heron	Ardea herodias	Western Gull	Larus occidentalis
Great Egret	Casmerodius albus	Western Mendowlark	Slumella neglecfa
Greater Yellowlegs	Tringa melanoleuca	Western Sandpiper	Calidris mauri
Green-winged Teal	Anas crecca	Western Snowy Plover	Charadrius atexandrinus nivosus
Homed Grebe	Podiceps auritus	Whinibrel	Numenius phaeopus
House Finch	Carpodacus mexicanus	Willet	Catoplrophorus semipaimatus
Killdeer	Charadrius vociferus		
Least Sandpiper	Calidris mintititla		

Eelgrass-*Zostera marina.* Eelgrass is a flowering marine plant Agua Hedionda at depths between 0.0 feet Mean Lower Low Water (MLLW) and -10 feet (MLLW). Eelgrass is considered a sensitive marine resource in southern California because eelgrass meadows provide cover and habitat for many types of marine organisms.

Eelgrass canopy (consisting of shoots and leaves approximately two to three feet long) attract many marine invertebrates and fishes and the added vegetation and the vertical relief it provides enhances the abundance and the diversity of the marine life compared to areas where the sediments are barren. The vegetation also serves a nursery function for many juvenile fishes, including species of commercial and/or sportsfish value (California halibut and barred sand bass). A diverse community of bottom-dwelling invertebrates (i.e., clams, crabs, and worms) live within the soft sediments that cover the root and rhizome mass system.

Eelgrass meadows are also critical foraging centers for seabirds (such as the endangered California least tem) that seek out baitfish (i.e., juvenile topsmelt) attracted to the eelgrass cover. Lastly, eelgrass is an important contributor to the detrital (decaying organic) food web of bays as the decaying plant material is consumed by many benthic invertebrates (such as polychaete worms) and reduced to primary nutrients by bacteria.

A review of the literature pertaining to eelgrass coverage shows that the greatest coverage of eelgrass was recorded during a survey completed in 1976 which reported 70 acres of eelgrass (Bradshaw et. al. 1976). Currently it is estimated that only 15.42 acres are present. Personal observations and conversations with Merkel and Assoc. have lead to a conclusion that despite a recent eelgrass mitigation transplant of over 14 acres in the inter lagoon alone, the heavy rains of 2005 and the severe red tide event during the following summer killed off large portions of eelgrass within the lagoon.

Lagoon closure and the effects of dredging

The following paragraph is a partial summary of the attached document entitled "Coastal processes effects of reduced intake flows at Agua Hedionda Lagoon" (Jenkins, 2007).

Agua Hedionda Lagoon is located within the Oceanside Littoral Cell. Within this cell, sand move from the north to south and eventually lost out of the cell at the extreme southern edge as a result of two submarine canyons that transport the sand to deep ocean basins. Sand is also lost from the cell by tidal action into and out of the lagoon which will trap sand into the lagoon regardless of the flow rate at the intake structure. The trapped sand has several impacts on both the lagoon and the littoral cell. These impacts include among others the depleting of sand beaches that are located south of the lagoon and the creation of sand bars within the lagoon. These sand bars if not removed by maintenance dredging will reduce tidal exchange rates and lagoon water resident time which deplete nutrients and oxygen levels within the lagoon. The sand bars over time will grow to a point were inlet closure can occur resulting in a chocking off the lagoon and the destruction of the marine habitat. The rate at which this occurs is dependent on many factors including natural factors such as winter storms and El Nino events and also anthropogenic factors such as beach replenishment projects to the north of the lagoon and the rate of water uptake in the outer lagoon for cooling water purposes. The rate at which sand influx occurs has been monitored continually. During normal plant operations, which requires the use of an average daily volume of water at a rate of 528.69 mgd the lagoon entrains 184,724 cubic yards of sand per year. This volume of sand increases the risk of lagoon closure by 11% per year. Within 4.5 years after maintenance dredging the risk is high enough to assume that closure is more probable then not (Table 4). A reduced flow scenario capable of supporting the proposed desalination project on stand alone bases would decrease the sand influx to 106,218 cubic yards per year, thus increasing the time of likely lagoon closure to 7.9 years. Under a no water intake scenario the risk of lagoon closure is more likely then not after 8.2 years

Table 4. Relationship between power plant flow rate, sand influx, and threat of lagoon closure.

Lagoon State	Avg. Volume of Water needed (mgd)	Rate of Sand Influx per year (yds^3)	Time of likely Lagoon Closure (years)	Dredge Cycle (years)
Power Plant Normal Op.	529	184,724	4.5	2-3
Stand alone Desalination	304	106,218	7.9	4-5
No flow	0	90,000	8.2	4-5

Under normal power plant operations the maintenance dredging interval has been fairly consistent at every two to three years for several reasons. The two most important are: 1) Sand removal must take place prior to a point where there is still enough leeway in time so that a sudden lagoon closure is not probable; 2) Sand removal must take place at a point prior to the lagoon hydrology being compromised. For a reduced flow (stand alone desalination plant) and a "No Flow" scenario necessary dredge intervals would be the same and should be done every four to five years. As such, there would be no difference in the potential impacts to the lagoon and beach habitats under a reduced flow or no flow scenario.

Other alternatives to prolong dredging activities were evaluated by Cabrillo Power in the year 2001. During the course of this investigation, it was decided that sand infilling could be reduced if the north end of the entrance jetty was extended 200 feet seaward. The analysis indicated that the extension of the jetty would decrease the rate of infilling, but the lagoon would still need a maintenance dredging program. The application for permits to extend the jetty was ultimately withdrawn since the lead agency, State Lands Commission identified concerns about the potential for sand bypassing the lagoon and covering adjacent hard bottom habitat including the sensitive surfgrass habitat and decided that an intake pipe offshore was a better alternative to provide cooling water for the power plant. Cabrillo Power found this alternative was not acceptable due to likely significant impacts to hard bottom habitats that are offshore and because it would not solve the problem of sand infilling into the lagoon. Furthermore, concerns about additional sands entering into the littoral zone north of the jetty as a result of beach nourishment projects did not materialize. In light of these hurdles it was determined that impacts associated with both the extension of the lagoon jetty and the offshore intake were unacceptable and neither approach would create a situation were dredging would no longer be needed.

Value of Maintenance Dredging:

The benefits of dredging to maintain the hydrological unit of Agua Hedionda include preserving the habitats necessary to maintain the current biological community, providing and maintaining aquaculture endeavors, recreational activities, and providing the necessary volume to maintain the tidal prism to provide the power plant water for cooling purposes. Thus being in conformity with the California Ocean Plan which identifies beneficial uses of the ocean waters of the State as to be as follows: Industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation, commercial and sport fishing; mariculture; preservation and enhancement of designated Areas of Special Biological Significance; rare and endangered species; marine habitat; fish spawning and shellfish harvesting. Continued maintenance dredging will insure that these beneficial uses will not be lost and will protected and be consisted with policies of Chapter 3 of the Coastal Act 30220, 30230, 30231, and 30233. These benefits far outweigh the alternative of no dredging and losing 388 acres of highly productive marine habitat as a result of beach infilling and the closing off of the lagoon inlet. It is this mind set that the Coastal Commission has used in approving current and past dredge permits. As stated in the California Costal Commission's staff report and approval notice for the recently approved dredge permit for Cabrillo Power (Application # 6-06-61) the proposed dredging is "consistent with past Commission actions for maintenance dredging and beach deposition". The resolution on this application was that an approval was granted on the grounds that it is in conformity with policies of Chapter 3 of the Coastal Act. It should be noted that the failure to dredge the lagoon would be contrary to this coastal act. It would violate Section 30230 by failing to maintain and enhance marine resources; it violate Section 30231 by failing to protect the biological productivity and the quality of coastal waters, wetlands and estuaries; and Section 30233 and 30220 by limiting the ability of water oriented recreational activities and aquaculture endeavors. This approved permit and the protocol submitted with the dredge application is nearly identical to prior application and has been shown to adequately deal with the maintenance dredging required to maintain the hydrology of the lagoon. Therefore, any future dredging that would be required under a reduced flow scenario for a stand alone desalination plant would remain the same. This dredge protocol provides for the protection of sensitive marine resources, in particular eel grass beds.

Users of Agua Hedionda Lagoon

The Agua Hedionda Lagoon (AHL) was initially dredged in 1952 resulting in numerous opportunities for public access and recreation in and around the lagoon. Since then, several enterprises have been built along the lagoon shores to take advantage of the ecosystem created by the cooling water flow and dredging operations. The lagoon supports both profit and non-profit enterprises. Private businesses along the AHL include the Carlsbad Aquafarm and California Watersports. Non-profit groups include the Hubbs-SeaWorld Research Institute (HSWRI), which runs a state-of-the-art fish hatchery along the lagoon shores. In addition, the YMCA and the Agua Hedionda Lagoon Foundation (AHLF) support recreational and educational activities at the lagoon. These enterprises consider the AHL a unique and invaluable resource, which they have become dependant for their operations.

FOR PROFIT ENTERPRISES

Carlsbad Aquafarm

The Carlsbad Aquafarm leases 6 acres of the outer AHL and uses the environment created by Encina Power Station (EPS) to grow mussels, oysters and scallops. Annual harvest averages one million pound of shellfish a year. The business started in 1990 and has expanded to include land-based aquaculture for seaweed, abalone and seahorses. The aquafarm supplies restaurants in Los Angeles, Orange, and San Diego counties and has customers in both the east coast and mid-western United States. In addition, the business has developed an international customer base, providing shellfish and algae for research.

Along with providing a commercial and academic benefit to the community their endeavors also lessen the pressure on the natural stocks and the habitats that they live in.

The aquaculture farm is dependant upon the current environmental conditions of the Agua Hedionda Lagoon. The cooling water flow allow the aquafarm necessary conditions to grow high quality shellfish. The water quality is very important for the growth of the shellfish and for ensuring they are acceptable for human consumption. If dredging of the lagoon was to decrease or ultimately cease, the conditions the aquafarm needs to grow its products would quickly deteriorate and the farm would no longer be able to grow shellfish and the business would have to close.

The Agua Hedionda Lagoon ecosystem is a unique ecosystem for aquaculture farming. It is considered the only location in southern California where the Carlsbad Aquafarm can grow mussels, oysters, and scallops. All other locations do not have the proper designation by the Department of Health Services to allow for such an endeavor.

California Watersports

California Watersports is located at the Snug Harbor Marina, in the inner lagoon of the AHL.

The watersports facility is dependant upon the current conditions of the AHL. The tidal flushing allows for clean water, which attracts people to the lagoon. They also require significant water depth to allow for the operation of the water craft. If dredging of the lagoon was stopped, this business and all lagoon related recreation would cease.

NON-PROFIT ENTERPRISES

Hubbs-SeaWorld Research Institute

The Hubbs-SeaWorld Research Institute built the Leon Raymond Hubbard, Jr. Marine Fish Hatchery along the shoreline of the outer AHL in 1995. It is the only commercial-scale marine finfish hatchery in the west coast of the United States. This facility is part of the Ocean Resources Enhancement and Hatchery Program, focusing on the rearing white seabass (*Atractoscion nobilis*) for introduction into the wild. The facility can produce up to 350,000 juvenile white seabass annually. Annual fish released per year varies, in 2004 over 270,000 fish were released and in 2005, about 100,000 fish were released. In addition to white seabass, hatchery staff also researches the rearing of other species such as California sheepshead (*Semicossyphus pulcher*) and California yellowtail (*Seriola dorsalis*).

The intake of the hatchery is located in the AHL and requires high quality ocean water supported by maintenance dreding of the lagoon. If dredging of the lagoon were to stop, the intake would have to be relocated, which is not feasible for the non-profit organization.

The AHL was an ideal location for the HSWRI to build this state of the art hatchery. The fish produced by the hatchery are highly valuable to the fishing community. White seabass populations were in significant decline due to overfishing and habitat destruction. The Leon Raymond Hubbard, Jr. Marine Fish Hatchery is the only facility rearing this species. To date, the facility has released over 1,000,000 white seabass into the wild and catch rates by fishermen are increasing, suggesting that the population may be on the rise. Each fish is valued about $10 in terms of food and human labor costs (Rodgers, 2006). If the hatchery has the capability to release 350,000 fish each year, this equates to a potential value of $3,500,000 for the hatchery operations at the AHL.

YMCA

The YMCA leases land on the middle lagoon area of the AHL where they hold a summer camp for children ages 6-12 years old. Recreational activities conducted at the camp include swimming and boating. The camp runs for about 6 weeks with about 60 kids/ week. They also offer their facilities for other recreational uses in the summer.

YMCA personnel monitor the water quality of the AHL where the camp is located. Since the area is used for swimming, the water quality standards must be closely monitored. At present, the cooling water intake and tidal flushing help maintain a safe water quality level for swimming. If the cooling water intake from EPS and dredging activities were to stop, water quality levels would likely drop below acceptable standards for swimming.

The YMCA chose to hold the camp along the shores of the AHL because of the area's appeal to the public. The lagoon offers a safe calm environment, ideal for a children's swim camp. A value for recreational swimming cannot easily be assigned. The camp can accommodate up to 360 children per summer session and offers their facilities for other uses. There are no other locations in the Carlsbad area that offer uncrowded safe conditions where children are able to swim like to AHL. Thus, the area is considered invaluable in terms of offering a unique location for children's recreation.

Agua Hedionda Lagoon Foundation

The Agua Hedionda Lagoon Foundation (AHLF) is a non-profit organization founded in 1990 located along the outer lagoon shores. The foundation was established "to conserve, restore, and enhance environmental features of the AHL and its watershed."[1] Currently the foundation has 250 members.

---

[1] http://www.aguahedionda.org/AHLFhomepage3.htm

The AHLF has several goals to promote environmental awareness and recreation at the lagoon. Currently they offer a couple of miles of hiking trails but would like to extend the trails to cover the circumference of the lagoon. In addition, they would like to develop pilot school programs educating children about lagoon ecology and indigenous cultures. They would like to install webcams along the lagoon shores so that people from all over the world can learn about the lagoon. The foundation recently completed a Discovery Center on the lagoon shore to provide a center of wetland-related environmental education for the community.

The value of the lagoon as a site for recreation and environmental education depends considerably on the water quality of the lagoon. The lagoon attracts hundreds of species of birds, mammals, fish, invertebrates, and plants (AHLF 2005). These animals in turn, attract people who will use of the area for hiking, fishing, birding, and for teaching their children about the environment and indigenous cultures. If the water quality of the lagoon were to decrease, wildlife populations could decrease and fewer people would be attracted to the area for recreation and education.

The AHLF considers the AHL as the only wetland south of Morro Bay where people can actually touch and get in the water. The foundation believes that the area holds a strong potential as a site of recreation and environmental education to not only Carlsbad, but to the world. A monetary value cannot easily be placed on the recreational and educational activities sponsored by the AHLF. However the uniqueness of the lagoon and the area available for recreational potential (approximately 400 acres) makes it a highly valuable resource in southern California.

Conclusions:

Agua Hedionda Lagoon is a man made hydrological unit that is 54 years old. Prior to the dredging of this lagoon it was a hyper-saline slough that had no marine component a thus provide little if any benefits to the surrounding nearshore environment. Within the 54 years of its existence and despite the fact that the Encina Power Plant uses up to 680 mgd for their cooling water needs the lagoon has and continues to perform as a marine, estuarine, and wetland biological unit. It provides nursery grounds and habitat for several fish, invertebrates, and avian species including some of which that are listed as sensitive species.

The local community also benefits from this lagoon. The various uses of the lagoon (commercial, research, recreational) make the area an important resource. A monetary value of over $8,500,000 could potentially be generated from the enterprises discussed above. Recreational activities cannot easily be assigned a direct monetary value. However, in place of a monetary value, issues such as the size and quality of the area, accessibility to the public, and the uniqueness may be considered (Letson and Milan, 2002). The city of Carlsbad maintains strong control over boat use of the AHL, as users are required to obtain permits for both active and passive vessels used on the lagoon. Currently the city issues about 400 permits per year, with a 50-50% proportion between active and passive permits. As stated above, the AHLF has over 200 members. In addition, recreational fishing is a popular pastime along the outer lagoon shore. The site is considered heavily used by the California Department of Fish and Game. CA DFG data on fishing pressure for the Carlsbad area shows that the AHL attracted 79% of the recreational fishing effort compared to other observed locations (Oceanside Jetty to Batiquitos Lagoon, 18%; Encinitas to Leucadia, 3%) from 2004-2005 (N=542); Michelle Horeczko, California Department of Fish and Game, pers. comm.). The AHL has strong appeal for recreation given the number of permits issued and the number of recreational anglers that use the lagoon.

The lagoon offers a large area for both aquatic and land based recreation and could be considered as high quality given the amount of wildlife that is found there as well as the number of people that use the area. Each enterprise along the lagoon views the area as unique; they would not be able to run their businesses or facilities elsewhere. If the exchange with ocean water were to decrease or stop, a one-of-a-kind environment would be lost in southern California. The businesses that have become dependant upon the lagoon would be forced to shut down, opportunities for public access and recreation would be lost and nearly 400 acres of highly productive marine habitat would be destroyed.

Lit Cited:

2006, Merkel & Associates, Inc. Pre-dredge eelgrass survey in support of the Encina Power Station, Agua Hedionda 2007 dredging project at Agua Hedionda Lagoon (Outer Lagoon), Carlsbad, CA.

1993, MEC San Dieguito Lagoon restoration project regional coastal lagoon resources summary: Draft technical memorandum. Submitted to Southern California Edison Company.

2007, Le Page Personal Data. Satellite overlay on TOPO Maps