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.*

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SAN DIEGO REGIONAL
WATER QUALITY
CONTROL 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.

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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

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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.

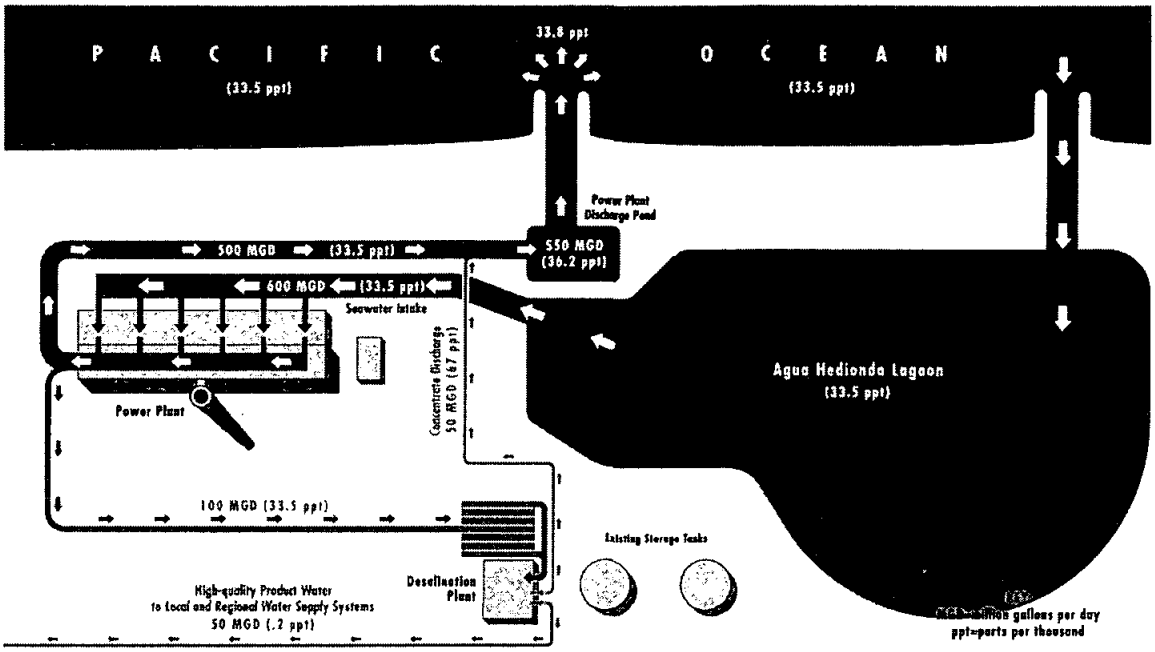

Figure 1-2 –Carlsbad Desalination Plant and Encina Power Station

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
		Estuarine flats
Open Water	253	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)™ (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.

Projects that Would Directly Restore or Enhance Estuarine or Marine Habitat in the Vicinity of Aqua Hedionda Lagoon

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:

Restoration or Enhancement of AHL

- 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.

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.

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.