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

March 7, 2008

Mr. Eric Becker
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4353

RE: NCR: 02-1429.02:ebecker

Dear Mr. Becker:

Enclosed are the Carlsbad Desalination Project revised Flow, Entrainment and Impingement Minimization Plan (Plan) dated March 6, 2008, as well as Poseidon's detailed responses to your comment letter dated February 19, 2008. Poseidon respectfully requests that the Regional Board review and approve the revised Plan pursuant to Order R9-2006-0065.

If you have any questions please feel free to contact me at (619) 595-7802.

Sincerely,

Peter M. MacLaggan
Senior Vice President

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Poseidon Resources March 7, 2008 Response
San Diego Regional Water Quality Control Board Letter dated February 19, 2008
(NCR: 02-1429.02ebecker

1. The Plan does not yet integrate all the elements of the statutory requirements of California Water Code (CWC) Section 13142. The proposed project only includes "mitigation", while the statute CWC Section 13142.5(b) also requires that dischargers implement best available technology and mitigation measures. The Plan does not appear to include technology measures for the intake structure to reduce impingement and entrainment (I&E).

Response: Water Code Section 13142.5(b) requires industrial facilities using seawater for processing to use the best available site, design, technology, *and* mitigation feasible to minimize impacts to marine life. The Plan has been reorganized so to sequentially analyze the steps that have been take by Poseidon to address each of these provisions:

- Chapter 2 identifies best available site feasible to minimize Project related impacts to marine life;
- Chapter 3 identifies best available design feasible to minimize Project related impacts to marine life;
- Chapter 4 evaluates identifies best available technology feasible to minimize Project related impacts to marine life;
- Chapter 5 quantifies the unavoidable impacts to marine life; and
- Chapter 6 identifies best available mitigation feasible to minimize Project related impacts to marine life

2. The Plan provides an evaluation of impacts based upon one year of data, 2004-05 with record rainfall, but does not explicitly evaluate the on-going impacts from Poseidon's operations.

Response: As described in Chapter 5 of the Plan, the potential entrainment impacts from Poseidon's seawater intake were explicitly assessed using the facility's permitted intake flows of 304 MGD and the potential impingement impacts were assessed assuming these reduced flows and discontinued power plant heat treatment effects.

3. The Carlsbad desalination project's (CDP) listing of impacts appears to omit specific impacts to target invertebrates.

Response: The requested information has been included in Chapter 5 and Attachments 2 and 5 of the revised Plan.

4. The proposed mitigation project does not appear to account for all pertinent impacts resulting from impingement of invertebrates, entrainment of invertebrates, discharges of brine, etc.

Response: Poseidon is using all feasible methods to minimize or reduce its entrainment and impingement impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified in Chapter 5 of the Plan. To minimize unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of this plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving the goals.

As shown in Chapter 6, the proposed mitigation strategy includes the implementation of project a coastal wetlands restoration plan that will be developed pursuant to the state-agency coordinated process; long-term preservation of Agua Hedionda Lagoon; and/or other activities which will benefit the coastal environment in San Diego County. The proposed restoration plan will be enforceable through conditions of approval of the project and the program's success will be monitored through performance standards, monitoring and reporting.

5. The CHREP did not identify and evaluate the possible mitigation projects located within the same watershed, prior to proposing the out of watershed mitigation in San Dieguito Lagoon. The best mitigation for impacting the lagoon would be to replace lost functions by restoring current upland acreage to the historic wetland condition, or by creating new wetlands where there were none historically.

Response: Investigations to date have not identified any mitigation opportunities within Agua Hedionda Lagoon (see Section 6.5) that meet the goals of the program. As a result, the proposed mitigation plan includes a core offsite mitigation program that meets the plan goals and objectives that is being developed in parallel with Poseidon's continued effort to identify feasible mitigation opportunities in Agua Hedionda Lagoon.

Poseidon recognizes the Regional Board would prefer to see mitigation in Agua Hedionda Lagoon if feasible. Accordingly, while Section 6.6 of this plan identifies a core offsite mitigation project, the mitigation plan also presents an implementation action schedule that includes additional coordination activities to either (1) confirm the lack of opportunities, or (2) identify if new mitigation options exist within Agua Hedionda Lagoon.

Poseidon and will be contacting the Department of Fish & Game to more fully assess the potential for restoration opportunities in Agua Hedionda Lagoon. If subsequent Agua Hedionda Lagoon mitigation is determined to be feasible, Poseidon will coordinate with regulatory agencies to implement such mitigation. If Agua Hedionda Lagoon mitigation is confirmed as infeasible, Poseidon will implement the proposed offsite mitigation project.

6. The proposed mitigation ratio of 1:1 isn't fully supported. The Plan should be revised to include an evaluation of other mitigation options that may be available within the watershed. The proposed mitigation ratio appears inadequate in light of several factors generally considered by the Regional Board:

Response: See the response to the previous comment regarding Poseidon's plans to further investigation restoration opportunities in the Agua Hedionda Lagoon watershed. Poseidon recognizes that the degree of mitigation required will be dependent on mitigation ratio requirements of the various regulatory agencies. As a result the proposed Plan (Chapter 6) provides for additional coordination with the regulatory agencies to finalize agency-mandated acreage requirements. Poseidon intends to prepare and submit a restoration project implementation plan to the Executive Director of the Regional Board: for review and approval which will contain the following:

- Goals, objectives, performance criteria and maintenance and monitoring to ensure the success of the proposed Restoration Plan.
- Identification of specific creation, restoration, or enhancement measures that will be used at each site, including grading and planting plans, the timing of the mitigation measures, monitoring that will be implemented to establish baseline conditions and to determine whether the sites are meeting performance criteria.
- Identification of contingency measures that will be implemented should any of the mitigation sites not meet performance criteria.
- As-built plans for each site included in the Restoration Project.
- Annual monitoring reports for no less than five years or until the sites meet performance criteria.
- Legal mechanism(s) proposed to ensure permanent protection of each site – e.g., conservation easements, deed restriction, or other methods.

6. a - The proposed mitigation project is located within a different watershed (the San Dieguito Lagoon) instead of the Agua Hedionda Lagoon. A higher ratio may be appropriate for this project because the referenced mitigation project is out-of-kind (i.e., discharger is not actually replacing the lost resources and functions).

Response: See responses 5 and 6 above.

6.b It is not clear that the proposed one-time mitigation is adequate to compensate for the long-term ongoing impacts to beneficial uses, resources, and functions present in Agua Hedionda Lagoon.

Response: As described in Chapter 6, the primary objective of the restoration plan is to create or restore coastal habitat similar to that of Agua Hedionda Lagoon, which will provide measurable long term environmental benefits adequate to fully mitigate unavoidable impingement and entrainment impacts associated with CDP operations. The restoration plan will rely on well-established methods, techniques and technologies for development and nurturing of coastal habitat of high productivity and long-term sustainability. The restoration plan will target coastal restoration and enhancement activities with clearly defined methodology to measure performance and success.

6.c The mitigation project is for restoration of coastal wetland habitat, rather than the lagoon habitat impacted by the operation of the CDP.

Response: As indicated previously, the intent of the restoration plan is to create habitat comparable to that in Agua Hedionda Lagoon.

7. Poseidon might benefit from convening a joint meeting with the resources agencies (including California Dept Fish and Game, US Fish and Wildlife Service, Army Corps of Engineers, National Marine Fisheries) to discuss the impacts to beneficial uses, resources, and functions by the proposed project, and on the preferred mitigation project so they can discuss agency concerns/comments.

Response: Chapter 6 of the revised Plan includes an action plan and schedule for coordinating with regulatory and resource agencies to finalize locations and acreages selected for the proposed mitigation. Additionally, Poseidon intends to prepare and submit a restoration project implementation plan to the Executive Director of the Regional Board and the Coastal Commission for review and approval which will contain the following:

- Goals, objectives, performance criteria and maintenance and monitoring to ensure the success of the proposed Restoration Plan.
- Identification of specific creation, restoration, or enhancement measures that will be used at each site, including grading and planting plans, the timing of the mitigation measures, monitoring that will be implemented to establish baseline conditions and to determine whether the sites are meeting performance criteria.
- Identification of contingency measures that will be implemented should any of the mitigation sites not meet performance criteria.

- As-built plans for each site included in the Restoration Project.
- Annual monitoring reports for no less than five years or until the sites meet performance criteria.
- Legal mechanism(s) proposed to ensure permanent protection of each site – e.g., conservation easements, deed restriction, or other methods.

Specific Comments on the Plan

8. The assessment should address the seasonal and/or daily variations in impingement impacts.

Response: The results of impingement surveys are summarized in Table 5-1 and the weekly sampling data has been included in Attachment 2 of the revised Plan. These survey data are used in conjunction with intake flows coincident with each that is recorded by the power plant in order to interpolate impingement effects between each of the weekly surveys. These weekly totals are summarized for the annual totals by species including impinged invertebrate species of a size that could be identified in the field. Samples of unknown or unrecognizable impinged species were collected for laboratory verification.

Impingement survey results not only reflect the presence of impingeable fish and invertebrates in the area of the intake screens, but also reflect the variability in their susceptibility to impingement. Many factors, such as debris on the intake screens, turbidity and local currents influence the potential impingement of each species. The majority of these factors have little or no weekly periodicity only a mild seasonality.

9. The assessment needs to include results of an impingement study for target invertebrates. Table 3.2 includes only results for fish during 2004-05.

Response: Attachment 2 contains all impingement data for invertebrates collected during the 2004/2005 impingement study. Review of the this data indicates that bothe the number and the total weight of impinged invertebrates was less than 0.1 kgs/day.

10. The assessment states that: "The total amount of impinged organisms for the individual sampling events is presented in Table 3-2" (p.19). The Plan, however, does not clearly identify individual sampling events. The interpretation of the results is hampered by the absence of a presentation of results for impinged organisms (including invertebrates) with dates, times, and flow rates of sampling events.

Response: Attachment 2 of the Plan includes the requested information.

11. The assessment states that, "The daily biomass of impinged fish during normal operations is 0.96 kgs/day (1.92 lbs/day) for an intake flow of 304 MGD" (p.19). The text discussion should clarify how this figure is determined and how the total conversion discrepancy since 0.96 kgs converts to 2.12 1bs, not 1.92 lbs as indicated in the Plan.

Response: The Plan has been revised to reflect that 0.96 kgs converts to 2.12 1bs, not 1.92 lbs as previously indicated.

The daily biomass of impinged fish, sharks and rays during normal operations of 0.96 kgs/day was calculated by dividing the total annual sample weight of 351,672 grams (see last row of the second column of the Table 5-1 summarizing all impingement data) by the total number of days per year (i.e., 351,672 grams/365 days = 963.48 grams/day = 0.96 kgs/day.

The total annual sample weight of 351,672 grams of all fish was determined based on 24-hr composite samples collected each week during the sampling period of June 2004 of June 2005. The sample accounted for all fish captured at the intake screens over 24-hr period of plant operations during the day of sampling. During each sampling event, the actual amount of the impinged fish contained in the daily sample was counted and weighted as reported in Attachment 2. In addition, the actual power plant flow during the 24-hr sampling period was noted. Than the total sample count and weight for fish of given taxon was calculated as a sum of the individual sample counts of this taxon for all sampling events. Similarly, the total flow for the sampling period was calculated as the sum of the power plant intake flows of each of the sampling events. The unit number and weight of each taxon was calculated by dividing the total number and weight of fish of a given taxon by the power plant intake flow on the day of the sample was collected. Than the unit number and weight for a given taxon was multiplied by the desalination plant intake flow of 304 MGD to calculate the projected number and weight of impinged marine organisms under the stand-alone desalination facility operation. These values are presented in Table 5-1 by taxon.

12. The assessment of impacts from entrainment assessment appears to include larval fish but does not clearly include impacts to fish eggs and invertebrates. It is the understanding of the Regional Board that the 2004-05 study was to include monitoring of (at least) entrained Cancer crab megalops and lobster larvae, but the assessment does not appear to include these data. Also, it is unclear that sampling followed a protocol approved by the Regional Board as stated (p.22).

Response: The study was conducted according to sampling a protocol reviewed and approved by the Regional Board. Prior to approving the study plan, the Board engaged an outside, independent consultant under contract and funded by the EPA, to review and comment on the plan. The Board's consultant suggested a number of changes that were accepted and incorporated in the final Board approved study plan and protocol. The approved protocol, including sampling and sample processing methods and techniques of data analysis and modeling to assess intake effects were followed as described in the final protocol. A copy of the final protocol has been included as Attachment 3 of the Plan. Attachment 5 provides the monthly entrainment survey results of fish and target invertebrate larvae.

13. The Plan does not clearly identify the supporting data or an explanation of underlying assumptions and calculations that were used to estimate proportional mortality values for larval fish as presented (p.23) in the Plan. Therefore, the Regional Board could not objectively evaluate the validity of the estimated proportional entrainment mortality (12.2%) presented in the Plan.

Response: Section 5.3 of the revised Plan provides a detailed explanation of the underlying assumptions, methodology and supporting data used to estimate the entrainment impact of this study.

14. Impacts are based upon the few most commonly entrained (most abundant) species. It is unclear how much more severe impacts may be when populations are small.

Response: In most cases, the more abundant a species of larvae is in an entrainment sample, the closer the intake is to the species' habitat or a center of its spawning population(s). Many of the larval fish species occurring in low numbers in the Poseidon study entrainment samples are ocean species, and conversely larval fish entrained in the highest number were lagoon species.

15. The Regional Board has the following comments regarding the estimated number of lagoon acres impacted, as presented in the plan since:

a. The estimate of the number of lagoon acres used by the three most commonly entrained species is based on a 2000 Coastal Conservancy Inventory (Table 4-2, p.23). It is unclear if this document is accurate or appropriate for the purpose of determining such an important component of the area of habitat production forgone (APF). The reference document (Attachment 4, Table 2), includes the footnote caveat "...This information is not suitable for any regulatory purpose and should not be the basis for any determination relating to impact assessment or mitigation." An accurate delineation of lagoon habitats should be used for this critical component of the APF.

Response: In order to calculate the APF, the number of lagoon habitat acreage occupied by the three most commonly entrained lagoon fish larvae[1] 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 shown in Table 5-5. The actual acreage will be confirmed through a survey of the lagoon habitats that will be conducted during the final design of Poseidon's restoration plan. To the extent that the lagoon habitat acreage established in the survey is higher or lower than that included in the 2000 Inventory, Poseidon's wetlands restoration plan will be proportional adjusted to account for the actual acreage identified in the survey.

b. The estimate of the number of lagoon acres used by the three most commonly entrained species appears to exclude salt marsh and brackish freshwater acreage (p.23). Excluding these intertidal habitats may result in the analysis underestimating this component of the APF.

Response: The areas of Agua Hedionda Lagoon that have potential to be impacted by the CDP operations are those habitats occupied by the three most commonly entrained lagoon fish larvae.[2] These habitats include 49 acres of mudflat/tidal channel and 253 acres of open water. It is not appropriate to include the other lagoon habitats in the APF calculation, such as brackish/freshwater, riparian, salt marsh or upland habitats, that are not occupied by the impacted species.

c. The calculation of the APF (p.23) appears to use values for mortality and lagoon acreage that are not fully supported.

Response: Section 5.3 of the revised Plan includes the calculations in support of the estimate of APF.

d. The text should be revised to include a clear explanation of how the estimated lagoon acreage for commonly entrained species was adjusted to include only impacts associated with operations of CDP, rather than impacts from operation of the Encina Power Station.

Response: Section 5.3 of the revised Plan includes an explanation of how the estimated lagoon acreage for commonly entrained species was adjusted to reflect stand-alone operations of CDP

[1] Ninety-eight percent of the fish larvae that would be entrained by the CDP stand-alone operations are gobies, blennies and hypsopops.
[2] Ninety-eight percent of the fish larvae that would be entrained by the CDP stand-alone operations are gobies, blennies and hypsopops.

16. The evaluation concludes that the small fraction of marine organisms lost to entrainment would have "no effect on the species' ability to sustain their population" and goes on to describe the natural rates of high mortality (p. 24). But the argument that that there are "excess" larvae appears to omit an important consideration. Besides contributing to marine food webs, the naturally high production of larvae serves as a buffer against catastrophic and cumulative impacts to populations. These are important 'ecological services' that must not be taken lightly or given away without adequate mitigation.

Response: Comment noted.

17. The Regional Board prefers that the evaluation of the impact be presented as a rate (loss of x-amount of organisms per year, or impact/year). The proposed mitigation is a fixed amount ($3 to $4 million). It seems unlikely that a fixed amount would adequately compensate for a loss that is a rate over multiple, future years. It appears more likely that a proposed fixed amount really only accounts for mitigation for just one year of operation. The Regional Board may find a fixed amount to be acceptable, provided that:

a. The average annual impact could be reasonably determined and reasonably translated into a dollar amount, and that amount (or correct share) is paid every year of operation - but that is not what is proposed in the Plan or the CHREP.

Response: Attachments 2 and 5 of the revised Plan includes the requested presentation of the impingement and entrainment data, respectively.

To minimize the unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of the Plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving these goals.

As described in Chapter 6 of the revised Plan, the proposed mitigation strategy includes the implementation of project a coastal wetlands restoration plan that will be developed pursuant to a state-agency coordinated process; long-term preservation of Agua Hedionda Lagoon; and/or other activities which will benefit the coastal environment in San Diego County. The proposed restoration plan will be enforceable through conditions of approval of the project and the program's success will be monitored through performance standards, monitoring and reporting. The Regional Board, Coastal Commission and State Lands Commission have ongoing jurisdiction over the proposed Project to insure the adequacy of the proposed restoration plan.

Additionally, ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations.

This approach will insure that the stand-alone CDP operations continue to use the best available site, design, technology and mitigation feasible to minimize Project related impacts to marine life.

b. A fixed amount might also be reasonable if the CDP mitigates its share by increasing lagoon acreage via restoration or creation. Such in-kind mitigation would (if functional) replace the productivity lost to the operation of the CDP, and the impact would be fully mitigated.

Response: See previous response.

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

FLOW, ENTRAINMENT AND IMPINGEMENT MINIMIZATION PLAN

March 6, 2008

CARLSBAD SEAWATER DESALINATION PROJECT

FLOW, ENTRAINMENT AND IMPINGEMENT MINIMIZATION PLAN

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EXECUTIVE SUMMARY

PLAN PURPOSE

The San Diego Regional Water Quality Control Board (Regional Board) adopted Order No. R9-2006-0065 (Permit) for Poseidon Resources Corporation's (Poseidon) Carlsbad Desalination Project (CDP) discharge to the Pacific Ocean via the existing Encina Power Station (EPS) discharge channel. The CDP is planned to operate in conjunction with the EPS by using the EPS cooling water discharge as its source water whenever the power plant is operating.

In the event that the EPS were to cease operations, and Poseidon were to independently operate the seawater intake and outfall for the benefit of the CDP, such independent operation will require additional review pursuant to Water Code Section 13142.5(b). Water Code Section 13142.5(b) requires industrial facilities using seawater for processing to use the best available site, design, technology, *and* mitigation feasible to minimize impacts to marine life.

This Flow, Entrainment and Impingement Minimization Plan (Plan) is developed in fulfillment of the above-stated requirements and contains site-specific activities, procedures, practices and mitigation plans which Poseidon proposes to implement to minimize impacts to marine organisms when the Carlsbad Desalination Project intake requirements exceed the volume of water being discharged by the EPS.

PLAN COMPLIANCE

As shown in Table ES-1, the Plan addresses each of the provisions of Water Code Section 13142.5(b):

- Identifies the best available site feasible to minimize Project related impacts to marine life;
- Identifies the best available design feasible to minimize Project related impacts to marine life;
- Identifies the best available technology feasible to minimize Project related impacts to marine life;
- Quantifies the unavoidable impacts to marine life; and
- Establishes a state-agency coordinated process for identification of the best available mitigation feasible to minimize Project related impacts to marine life.

Table ES-1 Design, Technology and Mitigation Measures to Minimize Impacts to Marine Life		
Category	**Feature**	**Result**
1. Site	Proposed location at Encina Power Station (EPS)	Best available site for the project, no feasible and less environmentally damaging alternative locations.
1. Design	Use of EPS discharge as source water	Sixty-one percent reduction of entrainment and impingement impacts attributable to the CDP
2. Design	Reduction in inlet screen velocity	Reduction of impingement of marine organisms
3. Design	Reduction in fine screen velocity	Reduction of impingement of marine organisms
4. Design	Ambient temperature processing	Eliminate entrainment mortality associated with the elevated seawater temperature
5. Design	Elimination of heat treatment	Eliminate mortality associated with heat treatment.
1. Technology	Installation of VFDs on CDP intake pumps	Reduce the total intake flow for the desalination facility to no more than that needed at any given time, thereby minimizing the entrainment of marine organisms.
2. Technology	Installation of micro-screens	Micro-screens (120 μ) minimize entrainment and impingement impacts to marine organisms by screening the fish larvae and plankton from the seawater.
3. Technology	Installation of low impact prefiltration technology	UF filtrations system minimizes entrainment and impingement impacts to marine organisms by screening the small plankton from the seawater.
4. Technology	Return to the ocean of marine organisms captured by the screens and filters	Minimize entrainment and impingement impacts to marine organisms captured by the screens and filters by returning the organisms to the ocean.
5. Technology	After ten years of operation, State Lands Commission (SLC) to analyze environmental effects of facility and the availability of alternative technologies that may reduce any impacts.	SLC may require Poseidon install additional technology as are reasonable and as are consistent with applicable state and federal laws and regulations. This ensures that the CDP operations at that time are using technologies that the SLC determines may reduce any impacts and are appropriate in light of environmental review.
1. Mitigation	Implementation of project mitigation plan developed pursuant to a state-agency coordinated process described in Chapter 6.	Compensate for unavoidable entrainment and impingement impacts and enhance the coastal environment.
2. Mitigation	Preservation of Agua Hedionda Lagoon though continued maintenance dredging and Lagoon stewardship.	Preserve and protect highly productive marine habitat; maintain and enhance opportunities for public access and recreation; provide sand for beach replenishment and grunion spawning habitat; maintain adequate water quality to support aquaculture, fish hatchery and natural fish habitat; and provide a new high-quality water supply.
3. Mitigation	Fund watershed education programs at the AHL Foundation Discovery Center.	Helps ensure the long-term health and vitality of Agua Hedionda Lagoon and the surrounding watershed.

PROPOSED MITIGATION APPROACH

Poseidon is using all feasible methods to minimize or reduce its entrainment impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified in Chapter 5. To minimize unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of this plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving the goals.

Recognizing that mitigation opportunities in Agua Hedionda Lagoon may be limited, Poseidon proposes a comprehensive but flexible approach for mitigating potential impacts. This approach is based on:

- Conservatively estimating maximum potential impacts
- Identifying goals and objectives of the mitigation program
- Identifying any available mitigation opportunities in Agua Hedionda Lagoon that meet the goals and objectives
- Identifying additional offsite mitigation that meets the mitigation goals
- Developing an action plan and schedule for coordinating with regulatory and resource agencies to finalize locations and acreages selected for the proposed mitigation.

Investigations to date have not identified any mitigation opportunities within Agua Hedionda Lagoon that meet the goals of the program. As a result, the proposed mitigation plan includes a core offsite mitigation program that meets the plan goals and objectives that is being developed in parallel with Poseidon's continued effort to identify feasible mitigation opportunities in Agua Hedionda Lagoon.

Poseidon recognizes the need and priority of implementing mitigation in Agua Hedionda Lagoon if feasible. Poseidon also recognizes that mitigation requirements and regulations of the various review agencies differ, and additional agency coordination is required to insure that needs of all applicable agencies are addressed.

Accordingly, while this plan identifies a core offsite mitigation project, the mitigation plan also presents an implementation action schedule that includes additional coordination activities to either (1) confirm the lack of opportunities, or (2) identify if new mitigation options exist within Agua Hedionda Lagoon.

Poseidon will be contacting the Department of Fish & Game to more fully assess the potential for restoration opportunities in Agua Hedionda Lagoon. If subsequent Agua Hedionda Lagoon mitigation is determined to be feasible, Poseidon will coordinate with regulatory agencies to implement such mitigation.

If Agua Hedionda Lagoon mitigation is confirmed as infeasible, Poseidon will implement the proposed offsite mitigation project.

Table ES-2 summarizes the implementation action schedule for the proposed mitigation plan.

Table ES-2
Mitigation Implementation Approach and Schedule

Element	Actions/Objectives	Schedule
Submittal of draft Minimization Plan to Regional Board	• Public and agency review of revised draft Plan	March 2008
Regional Board consideration of Minimization Plan	• Approval of Plan • Regional Board provides directions on Plan implementation	April 2008
Contacts with California Department of Fish & Game to assess mitigation opportunities in Agua Hedionda Lagoon	• Assess mitigation opportunities for saltwater marsh creation in Agua Hedionda Lagoon via dredging	March 2008
Supplemental contacts with other resource agencies	• Identify (or conform lack of) additional mitigation opportunities in Agua Hedionda Lagoon	April 2008
Convene meeting of resource agencies; Regional Board and Coastal Commission.	• Identify (or confirm lack of) additional mitigation opportunities in Agua Hedionda Lagoon • If applicable, address agency requirements for Agua Hedionda Lagoon mitigation and determine overall implementation feasibility • Address mitigation rations/requirements for core offsite mitigation project in San Dieguito Lagoon	April 2008
Finalize and distribute mitigation program implementation details	• Agency review of implementation details	May 2008
Modify/finalize implementation program details (if applicable)	• Agency review and approval • May involve additional inter-agency coordination meeting	June 2008
Coastal Commission consideration of mitigation project(s)	• Coastal Commission approval of mitigation project	July 2008

REGULATORY ASSURANCE OF PLAN ADEQUACY

There are a number of regulatory assurances in place to confirm the adequacy of the proposed restoration plan. The Regional Board, Coastal Commission and State Lands

Commission have ongoing jurisdiction over the proposed Project to insure the adequacy of the proposed restoration plan.

Additionally, ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations.

This approach will ensure that the stand-alone CDP operations continue to use the best available site, design, technology and mitigation feasible to minimize Project related impacts to marine life.

CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THE PLAN

The San Diego Regional Water Quality Control Board (Regional Board) adopted Order No. R9-2006-0065 (Permit) for Poseidon Resources Corporation's (Poseidon) Carlsbad Desalination Project (CDP) discharge to the Pacific Ocean via the existing Encina Power Station (EPS) discharge channel. The CDP is planned to operate in conjunction with the EPS by using the EPS cooling water discharge as its source water whenever the power plant is operating.

When operating in conjunction with the power plant, the desalination plant feedwater intake would not increase the volume or the velocity of the power station cooling water intake. As a result, the incremental impacts to marine associated with the CDP operating in conjunction with the EPS would not trigger the need for additional technology or mitigation to minimize impacts to marine life.

However, in the event that the EPS were to cease operations, and Poseidon were to independently operate the seawater intake and outfall for the benefit of the CDP, such independent operation will require additional review pursuant to Water Code Section 13142.5(b).[1] Water Code Section 13142.5(b) requires industrial facilities using seawater for processing to use the best available <u>site</u>, <u>design</u>, <u>technology</u>, *and* <u>mitigation</u> feasible to minimize impacts to marine life.

The Regional Water Board recognized that future EPS flows may not follow historical trends and required Poseidon prepare this Flow, Entrainment and Impingement Minimization Plan (Minimization Plan) to 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.[2] The Regional Board review and approval of the Minimization Plan will address any additional review required pursuant to Water Code Section 13142.5(b).[3]

This Flow, Entrainment and Impingement Minimization Plan (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

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[1] Permit at F-49.

[2] Permit at Section VI.2.e provides: "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."

[3] Permit at F-50.

minimize impacts to marine organisms when the Carlsbad Desalination Project (hereafter referred to as CDP or Project) intake requirements exceed the volume of water being discharged by the EPS.

1.2 PLAN ORGANIZATION

The Plan is organized so to sequentially analyze the steps that have been take by Poseidon to address each of the provisions of Water Code Section 13142.5(b):

- Chapter 2 identifies best available <u>site</u> feasible to minimize Project related impacts to marine life;

- Chapter 3 identifies best available <u>design</u> feasible to minimize Project related impacts to marine life;

- Chapter 4 evaluates identifies best available <u>technology</u> feasible to minimize Project related impacts to marine life;

- Chapter 5 quantifies the unavoidable impacts to marine life; and

- Chapter 6 establishes a coordinated state-agency directed process for identification of best available <u>mitigation</u> feasible to minimize Project related impacts to marine life

1.3 PLAN DEVELOPMENT

In anticipation that the EPS might not always satisfy the CDP's source water demands, the Regional Board required Poseidon to submit the Plan within 180 days of the adoption of the Permit. The Permit states:[4]

> The Regional Board recognizes that future EPS flows may not follow historical trends. For this reason, it is warranted to require the Discharger prepare a Flow, Entrainment, and Impingement Minimization Plan. The Flow, Entrainment, and Impingement Minimization Plan shall be submitted 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 discharge by the EPS. The plan shall be subject to the approval of the Regional Water Board and shall be modified as directed by the Regional Water Board.

[4] Permit at F-48.

The Plan has been under development for past 12 months. The original Plan was submitted to the Regional Board on February 12, 2007. Shortly thereafter, the Regional Board posted the Plan and related correspondence on its website for public review and comment. Poseidon revised the Plan in response to comments received from the Regional Board and the public and resubmitted it to the Regional Board on July 2, 2007.

The Regional Board posted the revised Plan and related correspondence on its website for public review and comment. To supplement the Plan, Poseidon also submitted to the Regional Board a Coastal Habitat Restoration and Enhancement Plan (CHREP) that includes a summary projects to accomplish the mitigation element of the Plan. On February 19, 2008, the Regional Board provided Poseidon with written comments from its review of the revised Plan and CHREP. In response to Regional Board comments, Poseidon submitted this revised Plan dated March 4, 2008 to the Regional Board. The revised Plan is subject to the approval of the Regional Board.

CHAPTER 2

SITE

INTRODUCTION

Pursuant to Water Code Section 13142.5(b), this Chapter identifies the best available site feasible to minimize Project related impacts to marine life. This Chapter is broken down into four sections:

- *The first section describes the proposed site and existing power plant facilities.*
- *The second section describes alternative sites that were considered and rejected.*
- *The third section describes why the proposed Project location is the best available site feasible to minimize Project related impacts to marine life.*
- *The fourth section concludes that proposed location for the Project is the best available and there are no feasible and less environmentally damaging alternative locations.*

2.1 PROPOSED SITE

The Carlsbad Desalination Project (CDP) is proposed to be located adjacent to the Encina Power Station (EPS) owned by Cabrillo Power I LLC (Cabrillo). An important consideration for this location is the availability of an existing seawater intake and discharge facilities as well as close proximity to the local regional water distribution systems. The desalination plant would be located on a site currently occupied by a surplus fuel oil storage tank. The tank would be removed, and the desalination plant would be constructed in its place. Integration of the operation of the desalination facility with the existing power plant operation would require two main points of interconnection – seawater intake and concentrate discharge.

The Encina Power Plant withdraws cooling water from the Pacific Ocean via Agua Hedionda Lagoon. After passing through the intake structure (Figure 2-1), trash racks, and traveling screens, the cooling water is pumped through the condensers for the five steam generator units located on site. Depending on the number of generating units in operation, the amount of cooling water circulated through the plant ranges from zero to over 800 MGD.

Figure 2-1 Intake Structure

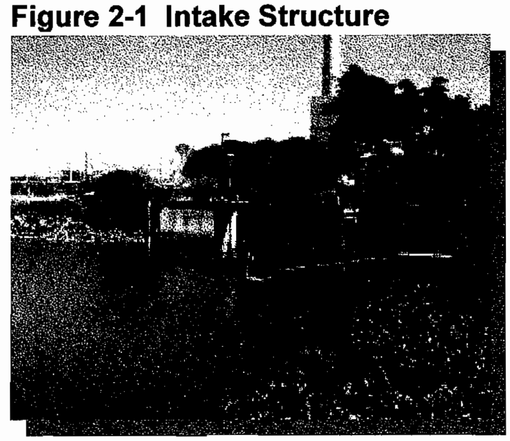


Figure 2-2 Discharge Pond

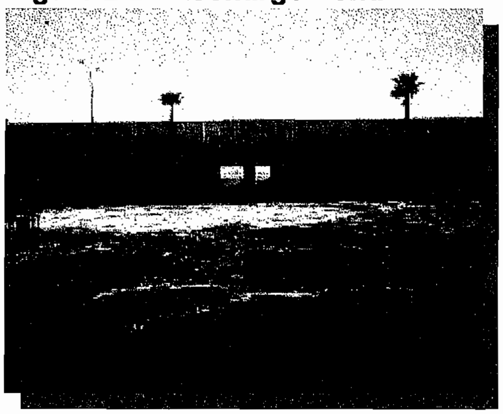
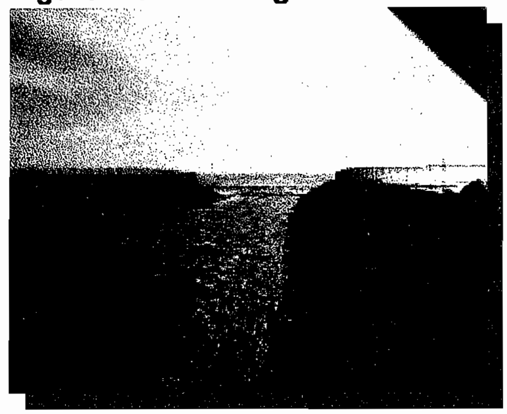


Figure 2-3 Discharge Channel



The primary diversion point for the source of water to the desalination plant would be downstream of the condenser outlet.

The seawater intake would divert seawater from the power plant's cooling water discharge channel to the inlet of the desalination facility. The intake facilities would consist of a diversion structure, pipeline, and a pump station to transport water from the cooling water discharge channel to the inlet of the desalination facility. The pump station would consist of high-volume, low-head vertical turbine pumps.

The EPS discharges seawater to the Pacific Ocean via a discharge pond (Figure 2-2) and channel that extends 500 feet west of Carlsbad Boulevard (Figure 2-3). The concentrated seawater from the desalination process would be mixed with power plant discharge. The discharge facilities would consist of a pipeline (up to 48-inch diameter) from the outlet of the desalination facility back to the existing discharge channel. The discharge point would be located downstream of the diversion point for the intake to prevent re-circulation of the concentrate back to the inlet of the desalination facility.

2.1.1 Existing Power Plant Facilities

The EPS is a once-through 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 north of the generating units.

The mouth of the intake structure is 49 feet wide. Water passes first trough metal coarse screens (trash racks with vertical bars spaced 3-1/2 inches apart) to screen large debris and marine life. The intake forebay tapers into two 12-foot wide intake tunnels. From these tunnels the seawater flow is split among four six-foot wide conveyance tunnels. Tunnels 1 and 2 deliver seawater to intakes for power plant generation Units 1, 2 and 3. Tunnels 3 and 4 carry cooling water to intakes for power plant generation Units 4 and 5, respectively. Vertical traveling screens are located ahead of each of the intakes of pumps.

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 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 2-1 summarizes the capacity of the individual power plant intake pumps.

The EPS 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 has a total capacity of 794.9 MGD (552,000 gpm). The service water pumps have a combined 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.

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 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 gpm.

TABLE 2-1

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).

2.2 ALTERNATIVE SITES

There are only three possible sites in the City of Carlsbad that could accommodate a project of this nature. These are: (1) the Encina Power Station (EPS); (2) Encina Water Pollution Control Facility (EWPCF); and (3) Maerkle Reservoir. Among these, EPS is the only site in reasonable proximity to the seawater intake, the outfall, and key delivery points of the distribution system of the largest user of the desalinated seawater – the City of Carlsbad. This location allows the Project to optimize the cost of delivery of the produced water and minimize the environmental impacts associated with construction and operation of the Project. This particular site also offers the advantage of avoiding the construction of major new intake and discharge facilities, which provides significant environmental and cost benefits.

The Project EIR analyzed the viability of alternative sites for the seawater desalination plant within the boundaries of the EPS and alternative sites within the boundaries of the EWPCF.[1] The Coastal Commission Staff requested an evaluation of other potential locations for the desalination facility and its associated infrastructure. As a result, Poseidon added the Maerkle Reservoir site to the list of alternative sites to be considered. The sites evaluated by the Poseidon and the City of Carlsbad are the only parcels in the entire City of Carlsbad with compatible land use designation and sufficient space

[1] See Final EIR – 03-05 for the Precise Development Plan and Desalination Plant Project SCH #2004041081, City of Carlsbad, p. 4.8-17, June 13, 2006, Section 6.0, Alternatives to the Proposed Action, Subsection 6.2 - Alternative Site Location, pages 6-1 and 6-2.

available to accommodate the desalination facility. The merits of each site are summarized below.

2.2.1 Encina Power Station.

Alternative sites at the EPS were found infeasible because the power plant owner has reserved the remaining portion of the site to—accommodate future power plant modifications, upgrades or construction of new power plant facilities.

2.2.2 Encina Water Pollution Control Facility.

The site located within the boundaries of the EWPCF can only accommodate a desalination plant with a 10 MGD production capacity, due to outfall constraints. A desalination plant of 10 MGD production capacity will be inadequate to satisfy the demand of even one of the users of desalinated water from the Project – the City of Carlsbad, with a demand of up to 25 MGD. This deficiency renders the use of the EWPCF site infeasible. In addition, the use of this site would require construction of a 2-mile long, 72-inch diameter intake pipeline to convey the source seawater from the power plant cooling canal to the EWPCF site, which would have significant cost impacts on the Project and additional environmental and traffic impacts resulting from the construction of such a large pipeline. Installation of a new intake at the EWPCF site is cost-prohibitive.

2.2.3 Maerkle Reservoir.

Maerkle Reservoir is the only other area within the City of Carlsbad that offers compatible land use and is of suitable size to accommodate the Project. The Maerkle Reservoir site is owned by the City of Carlsbad and is located 10.6 miles east of the proposed Project site.

For a number of reasons, this location does not provide a feasible alternative site. First, the public rights-of-way between Maerkle Reservoir and the Pacific Ocean do not have sufficient space to accommodate a 72-inch intake pipeline and a 48-inch concentrate line (Poseidon, 2007). Second, it would be extremely disruptive to the public and the environment to acquire sufficient public and private property outside existing public rights-of-way to construct the pipelines. Third, over 100 MGD of seawater would have to be pumped to an elevation of 531 feet for processing, compared to pumping the seawater to an elevation of 70 feet at the proposed site. Fourth, because the Maerkle site is zoned as "Open Space," a "Public Utility" zoning designation would be incompatible with the Carlsbad General Plan and the proposed Project would be in direct conflict with the adjacent residential retirement community of Ocean Hills. Fifth, such a proposal would be in direct conflict with the City of Carlsbad's objective *"[t]o locate and design a* *desalination plant in a manner that maximizes efficiency for construction and operation and minimizes environmental effects."*

Finally, the additional construction and operating costs associated with piping and pumping the seawater and concentrate over this additional distance would represent a 20 percent increase in the cost of water. Such an increase in cost would render the Project infeasible while providing no measurable benefit to the public or the environment. An additional 10.6 miles of 72-inch seawater supply line would cost approximately $57.1 million. The enlarged pump station to accommodate the additional 461 feet of pump lift required to move the seawater to the alternative site would cost an additional $8.0 million. The additional cost of the 10.6 mile, 48-inch concentrate return line would be $29.6 million. In summary, the alternative Project site at Maerkle Reservoir would result in a $94.7 million (35 percent) increase in the capital budget for the Project (Poseidon, 2006).

Similarly, the alternative Project site at Maerkle Reservoir would result in three significant changes to the Project operating budget arising out of the increase in the amount of energy necessary to pump seawater to an inland location at a higher elevation, which would result in a net increase in operating cost for the Project. First, the cost to pump the seawater from the intake to the alternative plant site would increase $6.7 million per year. Second, the cost to pump the product water from the plant to the intended use area would decrease $3.0 million per year due to the fact that the product water is being pumped from a starting elevation of 511 feet rather than sea level. Finally, the energy recovery opportunity associated with the discharge of the concentrate from 511 feet down to sea level will result in an additional $1.1 million reduction in operating cost. The net increase in operating cost for the alternative Project located at Maerkle Reservoir would be $2.6 million per year (10 percent) (Poseidon, 2006).

The environmental issues associated with the construction of a 10.6-mile, 72-inch intake pipe and a 10.6-mile, 48–inch discharge line, compared to the proposed single 10.6-mile 48-inch product water conveyance pipeline, would be significant. There would be an approximately 225% increase in the volume of material that would need to be excavated. All of this material would need to be trucked offsite for disposal, resulting in over 200% increase in construction-related air quality impacts and traffic impacts over that already accounted for in the Project EIR due to the hauling of pipeline-related excavation material (Poseidon, 2007).

The 72-inch pipeline would likely be constructed in designated open-space or on private property for almost the entire length of the alignment due to the lack of space for additional utilities within existing rights-of-way. Construction-related activities could cause temporary disruption and impacts to an additional 40 feet of private property or public open space along the entire length of the pipeline. Much of this alignment is sensitive habitat such as coastal sage scrub which may prohibit the construction methods that are the basis of the cost estimates provided above. Alternatively, the construction impacts would require mitigation in the form of replacement habitat per the ratios set forth in section 4.3 of the EIR. Tunneling and mitigation costs associated with this alternative could be in the tens of millions of dollars. For these reasons, the alternative Project location at Maerkle Reservoir is financially and environmentally infeasible. In addition, the alternative location is not properly zoned for a desalination facility.

2.3 BEST AVAILABLE SITE

The proposed location for the CDP at the EPS is the best available site for the Project for a number of reasons:

- The site is properly zoned and the proposed use is consistent with other uses in the area.
- The location of the proposed desalination facility adjacent to the existing EPS has a number of environmental and cost advantages that cannot be matched at any other location within the service area to which water will be delivered. These advantages are as follows:
    - Least environmental impacts;
    - Lowest energy consumption;
    - Least disruption to public and private property;
    - Lowest construction cost; and
    - Lowest operating cost.

The proposed site is the only feasible location for the proposed Project in the service area and presents a unique opportunity for minimizing environmental impacts in a cost-effective manner. Locating the desalination facility further inland increases costs, which would indirectly increase the cost of the water to consumers, and increases construction-related disruptions to the public and the environment due to the need to construct a 72-inch and 48-inch pipeline instead of a single 48-inch pipeline, with no clear environmental benefit. Any of the proposed alternatives to co-location would require fundamental changes to the Project, which in turn would require complete redesign and re-engineering, as well as new entitlements from the City of Carlsbad and a new NPDES permit from the Regional Board. Poseidon has already invested eight years developing and obtaining permits for the Project. The potential delays posed by the alternative locations also would preclude the successful completion of the Project within a reasonable time. Therefore, such alternatives are not feasible.

The City of Carlsbad determined that, from a land use planning perspective, the best site for the desalination facility in the entire City of Carlsbad was the parcel in the northwest corner of the power plant property where Fuel Oil Tank No. 3 is currently located.[2] This location was selected specifically to further the City of Carlsbad Redevelopment Plan goals related to facilitating the conversion and relocation of the power plant east of the railroad tracks and enhancement of commercial and recreational opportunities in the area

[2] Final EIR – 03-05 for the Precise Development Plan and Desalination Plant Project SCH #2004041081, City of Carlsbad, p. 4.8-17, June 13, 2006.

west of the railroad tracks currently occupied by the existing power plant. This location leaves the majority of the site open for potential redevelopment at some future date and will create no significant impacts to relocation of the power plant to a site to the east of the railroad tracks or infrastructure needed to serve a power plant at this location.[3]

The Coastal Act provides for special consideration of coastal-dependent industrial facilities. Even if a coastal-dependent project is found to be inconsistent with certain Coastal Act goals, it can be approved upon application of a three part test – (1) that alternative locations are infeasible or more environmentally damaging; (2) that adverse environmental effects are mitigated to the maximum extent feasible; and (3) that to do otherwise (i.e., deny the project) would adversely affect the public welfare.[4]

The Coastal Commission determined that Poseidon's proposed seawater desalination facility would be a coastal-dependent industrial facility, as it would need to be sited on or adjacent to the sea in order to function at all.[5] In applying the three tests above, the Commission found (1) that there are no feasible and less environmentally damaging alternative locations available the Project;[6] (2) that the proposed Project as conditioned mitigates its impacts to the maximum extent feasible;[7] and (3) that facility is a necessary part of the region's water portfolio and denial of the Project would adversely affect the public welfare.[8]

2.4 CONCLUSION

The proposed location for the CDP at the EPS is the best available site for the Project. There are no feasible and less environmentally damaging alternative locations for the Project.

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[3] Id.

[4] See Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 91 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[5] Id.

[6] See Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 92 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[7] Id. at 93.

[8] Id. at 99 and 100.

CHAPTER 3

DESIGN

INTRODUCTION

Pursuant to Water Code Section 13142.5(b), this Chapter identifies the best available design feasible to minimize Project related impacts to marine life. This Chapter is broken down into eight sections:

- *The first section provides a general description of the design features that have been incorporated into the Project to minimize Project related impacts to marine life.*
- *The second section describes the desalination plant intake and discharge facilities and modes of operation.*
- *The third section describes the design feature to use the power plant discharge to the maximum extent feasible to minimize Project related impacts to marine life.*
- *The fourth section describes the design feature to reduce the velocity of seawater through the intake to the maximum extent feasible to minimize the impacts to marine life.*
- *The fifth section describes the design feature to reduce the velocity of seawater through the fine screens to the maximum extent feasible to minimize the impacts to marine life.*
- *The sixth section describes design feature to process ambient temperature seawater to the maximum extent feasible to minimize temperature related impacts to marine life.*
- *The seventh section describes design feature to eliminate heat treatment to the maximum extent feasible to minimize the impacts to marine life.*
- *The eighth section summarizes the design features and the resulting impact they have on minimizing Project related impacts to marine life.*

3.1 DESIGN FEATURES

The Carlsbad seawater desalination project (CDP) incorporates a number of design features that would minimize impingement and entrainment impacts associated with this project. The CDP is designed to use the existing intake and discharge facilities of the Encina Power Generation Station (EPS). When EPS is producing electricity and using 304 MGD or more of seawater for once-through cooling, the proposed desalination plant operation would cause a *de minimis* increase in impingement and entrainment of marine organisms.

Under conditions when the EPS operation is temporarily or permanently discontinued, the desalination plant will continue to use the existing power plant intake and discharge facilities. Under this condition, the impingement and entrainment impacts of the desalination plant operations would be significantly lower than those caused by the EPS operations at the same intake flow, due to a number of differences in the desalination plant and power plant intake design and operations. The key differences are summarized below and described in the following sections:

1. **Use of EPS discharge as source water for CDP.** In 2007 seawater pumping by the EPS would have met 61 percent of the CPD flow requirements, resulting in a 61 percent reduction of entrainment and impingement impacts attributable to the CDP.

2. **Reduction in inlet screen velocity.** The CPD is designed for intake flow of 304 MGD. At this rate of flow, the velocity of the seawater entering the inlet channel is at or below 0.5 feet per second (fps), resulting in impingement losses being reduced to an insignificant level.

3. **Reduction in fine screen velocity.** Under stand-alone operations, the CDP seawater supply would be pumped through an optimum combination of the existing fine screens and condensers serving the power plant so to minimize the velocity and turbulence of the water moving through the system. Lowering velocity and turbulence of the seawater would lessen the physical damage to marine life; resulting in a reduction of impingement and entrainment mortality.

4. **Ambient temperature processing.** One of the factors contributing to entrainment mortality of marine organisms during power plant operations is the increase of the seawater temperature during the once-through cooling process. Under stand-alone operations, the CDP would be designed to use ambient temperature seawater instead of heated seawater, which would eliminate entrainment mortality associated with the elevated seawater temperature.

5. **Elimination of heat treatment.** Periodic heat treatment of the power plant intake and discharge has significant contribution to entrainment and impingement mortality. Under stand-alone operations of the desalination plant, the heat treatment of the intake and discharge would be discontinued and associated entrainment and impingement mortality would be eliminated.

3.2 DESALINATION PLANT INTAKE AND DISCHARGE CONFIGURATION

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 3-1 illustrates the configuration of the desalination plant and EPS intake and discharge facilities. As shown on this figure, under conditions when both the desalination facility and the power plant are operating, seawater collected from Agua Hedionda Lagoon enters the power plant intake facilities, passes through the 3.5-inch inlet screens at the mouth of the intake structure, and subsequently through the vertical travelling screens, and then it is pumped through the plant's condensers. The warm seawater released from the condensers is conveyed to the ocean via discharge canal. The CDP intake structure would be connected to this discharge canal and would divert an average of 104 MGD of the cooling water for production of fresh water.

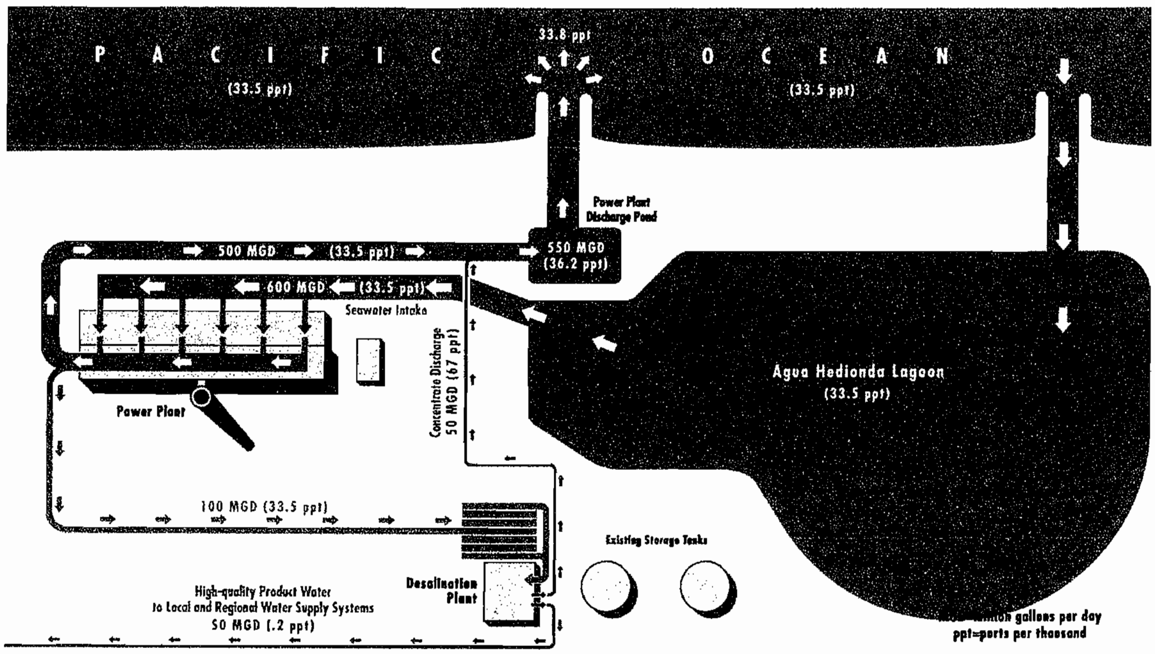


Figure 3-1 –Carlsbad Desalination Plant and Encina Power Station

Approximately 50 MGD of the seawater would be desalinated via reverse osmosis treatment and conveyed for potable use. The remaining 54 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. A minimum of 200 MGD of cooling water would be needed to blend with the 54 MGD of concentrate in order to reduce the desalination plant discharge salinity below the limit of 40/44 ppt (daily/hourly average) established by the Regional Board Order R9-2006-0065 for this project. Therefore, the total volume of cooling water required for normal operation of the desalination plant is 304 MGD.

If the power plant discharge flow is equal to or higher than 304 MGD, then the cooling water discharge volume is adequate to sustain desalination plant operations. Under this condition, since no additional seawater is collected for production of drinking water, the incremental impingement and entrainment impacts of the desalination plant operations is minimal, especially taking under consideration that the power plant operations are assumed to cause 100 percent mortality of the entrained marine organisms.

Under the conditions of temporary or permanent power plant shutdown, or curtailed power generation that results in cooling water discharge below 304 MGD, the existing power plant intake system would need to be operated to collect up to 304 MGD of seawater for the desalination plant. This seawater will pass sequentially through the power plant inlet screens (bar racks), the fine vertical screens, the power plant intake pumps and the power plant condensers before it reaches the desalination plant intake pump station. The features incorporated in the desalination plant design to reduce impingement, entrainment and flow collection under such "stand-alone" operating conditions are discussed below.

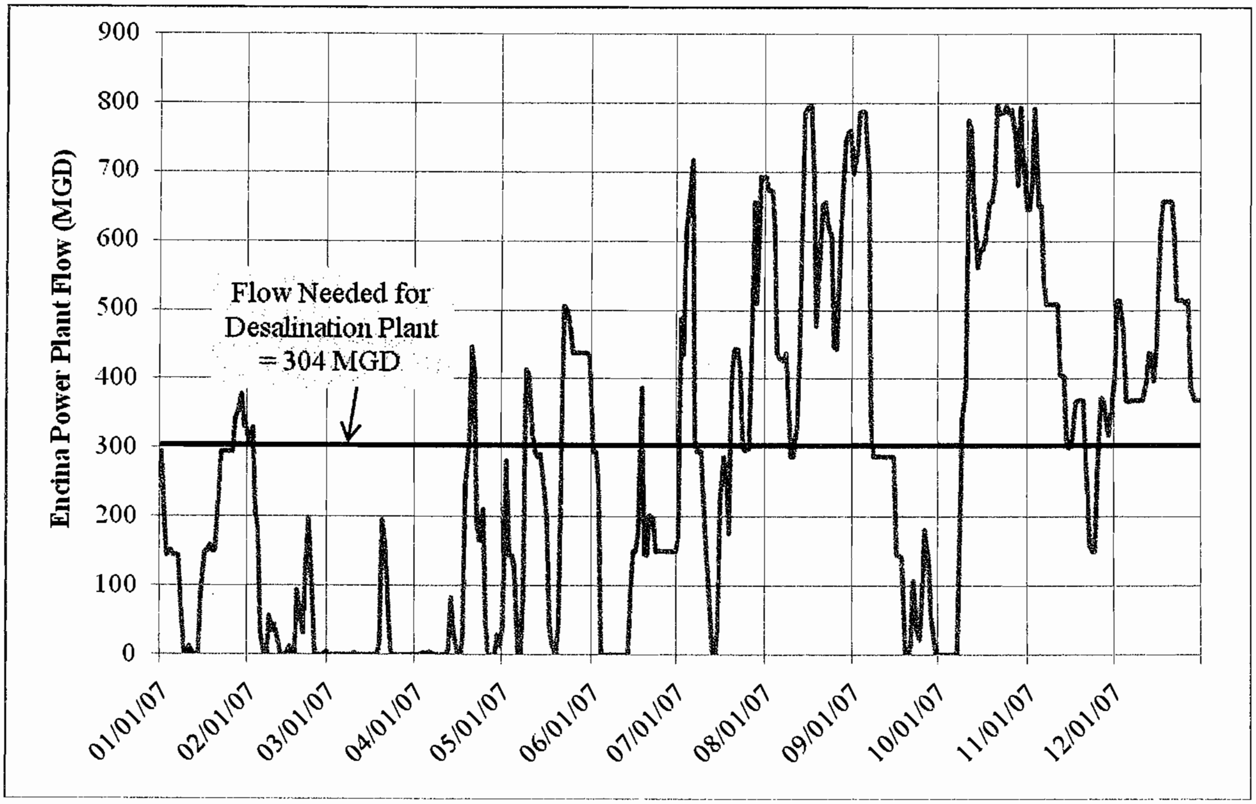
3.3 USE OF EPS DISCHARGE AS SOURCE WATER FOR CDP

The CDP is designed to use the existing intake and discharge facilities of the Encina Power Generation Station (EPS). When EPS is producing electricity and using 304 MGD or more of seawater for once-through cooling, the proposed desalination plant operation would cause a *de minimis* increase in impingement and entrainment of marine organisms.

Under conditions when the EPS operation is temporarily or permanently discontinued, the desalination plant will continue to use the existing power plant intake and discharge facilities. Under this condition, the impingement and entrainment impacts of the desalination plant operations would be significantly lower than those caused by the EPS operations at the same intake flow, due to a number of differences in the desalination plant and power plant intake design and operations.

Figure 3-2 provides a comparison of the 2007 EPS cooling water discharge to the flow needed to support CDP operations. Under 2007 operating conditions, the EPS discharge would provide 61 percent of the CDP annual seawater intake requirements and the CDP would have withdrawn an additional 39 percent of its source water from the EPS intake to make up the deficit in supply available from the EPS discharge. Under these operating conditions, the entrainment and impingement impact that would be attributed to the desalination operations would be limited to only 39 % of that identified in Chapter 5 for the stand-alone desalination facility operations. The CDP's direct use of the EPS discharge, coupled with other design and technology features described in Chapters 3 and 4, would result in a substantial reduction in the CDP entrainment and impingement impacts.

Figure 3-2
2007 EPS Cooling Water Discharge versus CDP Flow Requirements



3.4 REDUCTION IN INLET SCREEN VELOCITY

The CDP was designed for intake flow of 304 MGD (50 percent recovery) to minimize the impingement and entrainment of marine organisms under stand-alone operations. Higher intake flow, although preferable from a point of view of ease of desalination plant operations, would result in elevated potential for impingement and entrainment.

Impingement losses associated with the collection of seawater at the power plant intake would be reduced when the through-screen velocity at the inlet intake screens (bar racks) is equal to or less than 0.5 fps because this velocity would be low enough to allow some of the marine organisms to swim away from the inlet mount and to avoid potential harm from impingement.

At the design flow of 304 MGD needed for CDP operations, the inlet screen velocity would be less than or equal to 0.5 fps, thereby creating flow conditions that would reduce impingement losses to a less than significant level.

3.5 REDUCE FINE SCREEN VELOCITY

During stand-alone operations, the power plant intake pumps and screens will be operated in modified configuration that minimizes the through-screen velocity and thereby reduces potential impingement of marine organisms that reach these screens.

3.5.1 Description of Power Plant Intake Screen and Pump System

A detailed description of the power plant intake system is provided in Section 2. After the seawater passes through the inlet screens (bar racks) the intake forebay tapers into two 12-foot wide intake tunnels. From these tunnels the seawater enters one 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. Intakes for Unit 4 and 5 are equipped with two and three vertical travelling screens, respectively.

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 period of 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. In 2007, the average annual intake flow was 276 MGD. For comparison, the total intake flow needed for stand-alone operations of the desalination plant is 304 MGD.

3.5.2 Typical Mode of EPS Vertical Screen and Intake Pump Operations

As discussed in the previous section, each of the five power generation units is equipped with two cooling water pumps both of which operate when a given generating unit is producing electricity. All six pumps of power generation units 1, 2 and 3 share two common vertical screens of identical size (3/8-inch) and capacity. The two pumps of unit 4 are serviced by two 3/8-inch screens, and the two pumps of unit 5 are serviced by three 5/8-inch screens located in a common channel upstream of the pumps. With all pumps in operation, the through screen velocity of the vertical screens typically is higher than 0.5 fps, thereby contributing to the impingement of marine organisms that may have reached these screens.

3.5.3 Modified Utilization of the EPS Intake Screens and Pumps During Stand-Alone Operations of the Desalination Plant

Desalination plant operation is independent from the power production process and therefore, the existing EPS intake pumps do not need to be operated coupled with the intake screens of a given unit. This design flexibility of the desalination plant allows a greater number of screens to collect the volume of water needed for the CDP operation. For example, if the power plant needs to generate 287 MW of electricity, typically unit 4 (see Table 2-1) would be used for power generation and both intake pumps and screens associated with this unit would be in service. Under this operational condition, the cooling water flow used would be 307 MGD.

If the desalination plant is operated in stand-alone condition (i.e. no power is generated) then there is greater pump selection flexibility. For example, rather than using two intake pumps of unit 4, the desalination plant would collect similar amount of seawater by running only one pump of unit 4, and one pump of unit 5. However, in this case approximately the same amount of flow would be screened through five screens (the two screens of unit 4 and the three screens of unit 5), thereby reducing the through-screen velocity to at least a half. This significant reduction of the through screen velocity would allow to reduce the impingement of marine life on the vertical screens as well. Such impingement reduction cannot be achieved if the power plant intake pumps are used to deliver cooling water for power generation because when a given power generation unit is used to generate electricity, than both cooling pumps must be in operation simultaneously to provide adequate amount of cooling water for the normal operation of this unit. If the power plant discontinues power generation, than cooling pump operation can be decoupled from the operation of the condensers and this in turns allows to pump the same flow through two over times larger screening area and therefore to reduce the through screen velocity more than two times.

3.6 ELIMINATION OF HEAT-RELATED ENTRAINMENT MORTALITY

The seawater desalination plant will be designed with the flexibility to operate using warm water from the power plant condensers when they are in operation; and cold seawater when the power plant is not generating energy. This design feature will also avoid the need to preheat the intake seawater in the future if and when the power plant once-through cooling operation is discontinued. Elevated seawater temperature may increase the mortality of the entrained marine life. Since under stand-alone conditions the source seawater will not be heated this entrainment mortality factor will be eliminated.

3.7 ELIMINATION OF HEAT TREATMENT RELATED MORTALITY

Under the current mode of operations, the power plant completes heat treatment of the intake facilities every 6 to 8 weeks for 6 to 8 hours per event. Since seawater is re-circulated during the heat treatment event (i.e. no new seawater is collected or discharged), there is 100% mortality of the marine organisms residing in the intake canals unless they are physically removed prior to exposure to elevated temperature. Desalination plant operations would not require heat treatment of the existing intake and discharge facilities and marine organism mortality associated with the heat treatment events will be eliminated. Instead, the power plant intake and discharge system will be cleaned periodically by circulation of plastic scrubbing balls that will be circulated through the system via the existing pumps in a close cycle process. The scrubbing calls will be introduced at the beginning of the cleaning process and captured at the end of the process. The size of the scrubbing balls is usually 0.5 inches and they will move freely within the channels and piping at relatively low velocity (3 to 5 fps).

3.8 SUMMARY OF DESALINATION PLANT DESIGN FEATURES TO MINIMIZE IMPACTS TO MARINE LIFE

The design features are included in the CDP to minimize impacts to marine organisms are summarized in Table 3-1.

TABLE 3-1

DESIGN FEATURES TO MINIMIZE IMPACTS TO MARINE LIFE

Category	Feature	Result
1. Design	Use of EPS discharge as source water for CDP	Sixty-one percent reduction of entrainment and impingement impacts attributable to the CDP
2. Design	Reduction in inlet screen velocity	Reduction of impingement of marine organisms
3. Design	Reduction in fine screen velocity	Reduction of impingement of marine organisms
4. Design	Ambient temperature processing	Eliminate entrainment mortality associated with the elevated seawater temperature
5. Design	Elimination of heat treatment	Entrainment and impingement mortality associated with heat treatment would be eliminated

CHAPTER 4

TECHNOLOGY

INTRODUCTION

Pursuant to Water Code Section 13142.5(b), this Chapter identifies the best available technology feasible to minimize Project related impacts to marine life. This Chapter is broken down into five sections:

- *The first section describes constraints and opportunities associated with inclusion of technology features in the Project to minimize Project related impacts to marine life.*
- *The second section assesses the feasibility of alternative intake technologies to minimize Project related impacts to marine life.*
- *The third section assesses the feasibility of alternative intake screening technologies to minimize Project related impacts to marine life.*
- *The fourth section assesses the feasibility of alternative desalination technologies to minimize Project related impacts to marine life.*
- *The fifth section summarizes the feasibility assessment of technology features and the resulting impact they have on minimizing Project related impacts to marine life.*

4.1 FEASIBILITY CONSIDERATIONS

Poseidon conducted a feasibility assessment of the best available technology for reduction of entrainment and impingement impacts. This assessment resulted in the identification of those technologies that are feasible for implementation under the site-specific conditions of the proposed project. For the purposes of this assessment, we relied upon the definition of feasible set forth in the California Environmental Quality Act (CEQA) Guidelines: *"'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors*" (CEQA Guidelines, § 15364).

Site-specific conditions dictate that a fundamental feasibility constraint associated with potential entrainment and impingement reduction technologies is that the technology must be compatible with both CDP and EPS operations. In its recommended amendment of the EPS intake and outfall lease to authorize use of these facilities by the CDP, the State Lands Commission (SLC) staff recognized entrainment and impingement minimization measures cannot interfere with, or interrupt ongoing power plant operations:[1]

[1] State Lands Commission October 24, 2007 recommended Amendment of Lease PRC 8727.1

12. Without interference with, or interruption of, power plant scheduled operations and at its sole cost and expense, Poseidon Resources, as a separate obligation, shall use the best available design, technology, and mitigation measures at all times during with this Lease is in effect to minimize the intake (impingement and entrainment) and mortality of all forms of marine life associated with the operation of the desalination facility as determined by the San Diego Regional Water Quality Control Board or any other federal, state, or local entity.

When the EPS permanently ceases use of the once-through cooling water system, additional entrainment and impingement technologies may become feasible. While no timeline has been established as to when this might occur, SLC's proposed Lease Amendment requires that in ten years SLC would evaluate the feasibility of the implementation of those additional technologies it determines are appropriate in light of an environmental review it would undertake at that time:[2]

14. Ten years from October 30, 2007, Lessor will undertake an environmental review of the ongoing impacts of the operation of the desalination facility to determine if additional requirements pursuant to Paragraph 12 are required. Lessor will hire a qualified independent environmental consultant at the sole expense of Poseidon Resources with the intent to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. Lessor may require, and Poseidon Resources shall comply with, such additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations and as Lessor determines are appropriate in light of the environmental review.

The CDP design includes the best available technology that has been determined to be feasible for the site specific conditions and size of this project and to minimize impingement and entrainment of marine organisms in the intake seawater. The selection of the desalination plant intake, screening and seawater treatment technologies planned to be used for this project is based on thorough analysis and investigation of a number of alternative seawater intake, screening and treatment technologies.

The following intake alternatives were analyzed:

- Subsurface intake (vertical and horizontal beach wells, slant wells, and infiltration galleries);
- New open ocean intake;
- Modifications to the existing power plant intake system; and
- Installation of variable frequency drives (VFDs) on seawater intake pumps.

Screening technologies compared to identify BTA included:

- Fish net, acoustic and air bubble barriers upstream of the existing intake inlet mouth;

[2] Id.

- New screening technologies to replace the existing inlet screens (bar racks) and fine vertical traveling screens;

Desalination plant treatment technologies for reduced entrainment and improved survival included:

- Installation of micro screens ahead of the pretreatment system;
- Use of membrane pretreatment technology that allows to avoid the use of seawater conditioning chemicals;
- Return to the ocean of marine organisms captured at the desalination plant micro-screens and the pretreatment filters.

The following combination of intake, screening and treatment technologies were found to be feasible impingement, entrainment and flow reduction technology measures for the site-specific conditions of the Carlsbad project:

1. **Installation of VFDs on Desalination Plant Intake Pumps.** The desalination plant intake pump station design will incorporate variable frequency drives to reduce the total intake flow for the desalination facility to no more than that needed at any given time, thereby minimizing the entrainment of marine organisms.

2. **Installation of micro-screens.** Micro-screens (120 μ) minimize entrainment and impingement impacts to marine organisms by screening the fish larvae and plankton from the seawater.

3. **Installation of low impact pretreatment technology.** The desalination facility will rely on low pressure, chemical free membrane pretreatment filtration technology to minimize entrainment and impingement impacts to marine organisms that have passed through the micro screens by filtering the organisms from the seawater via 0.02 μ filters.

4. **Return to the ocean of marine organisms captured by the screens and filters.** Minimize entrainment and impingement impacts to marine organisms captured by the screens and filters by returning them to the ocean.

The assessment of the various technologies considered for impingement, entrainment and flow reduction is presented below.

4.2 ALTERNATIVE DESALINATION PLANT INTAKE TECHNOLOGIES

4.2.1 Desalination Plant Subsurface Intakes

The feasibility of using subsurface intakes (beach wells, slant wells, horizontal wells, and filtration galleries) was evaluated in detail during the EIR and Coastal Commission review phases of this project. A thorough review of the site-specific applicability of subsurface intakes and a comprehensive hydro-geological 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.

Vertical Intake Wells: Vertical intake wells consist of water collection systems that are drilled vertically into a coastal aquifer. A well yield of about 2,100 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 2,100 gpm. Therefore, the maximum production from vertical wells placed under optimum conditions would be about 20,000 gpm (28.8 MGD). Given that the test well was placed 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.

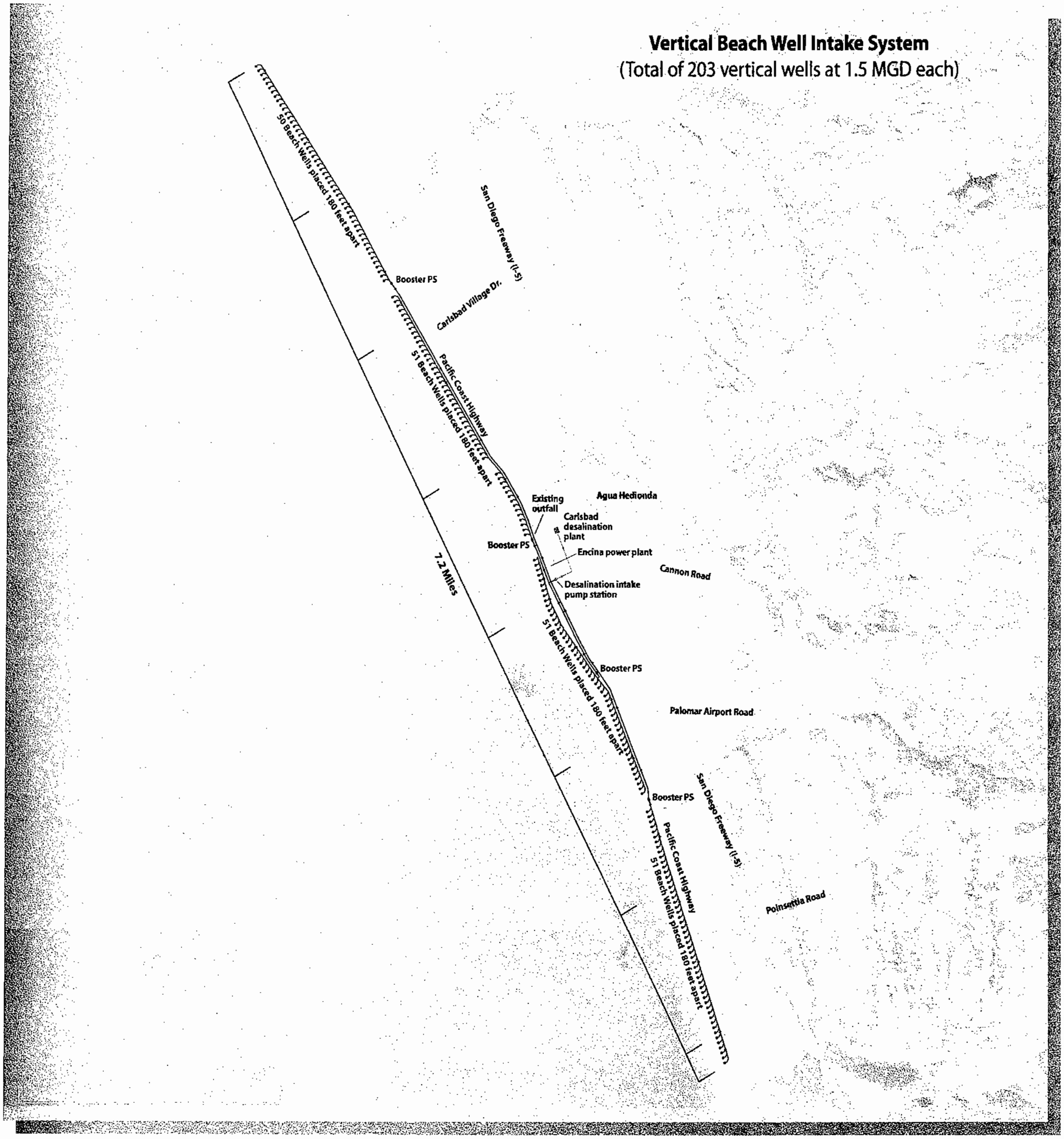
To meet the 304 MGD seawater demand of the project, 253 wells of a 1.5 MGD intake capacity each would have to be constructed. As shown in Figure 4-1, the vertical well intake system would impact 7.2 miles of coastline to collect and transport the water to the proposed desalination facility. As a result, the vertical well intake system is not the environmentally preferred alternative.

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. The implementation of this scenario would require installation of very large number of wells (253) for which beach property is not available. The length of beach that would be occupied by desalination plant intake using vertical wells would be over seven miles and the total cost of the implementation of such intake would be approximately $650 million. See Attachment 1 for a detailed cost estimate. In summary, the vertical well intake alternative is not the environmentally preferred alternative, technically infeasible, and cost prohibitive.

Slant Wells. 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. Collection of 304 MGD of seawater needed for this project would require the use of 76 slant intake wells of capacity of 5 MGD each. The total length of beach occupied by slant wells would be over 4 miles and the construction costs for implementation of this alternative would exceed $410 million. See Attachment 1 for a detailed cost estimate.

The use of slant wells does not offer any advantage in this setting. The well field for which maximum production rates were calculated for vertical wells is located on sand spit located approximately 100 ft from Agua Hedionda and 300 ft from the Pacific Ocean. Those constant

Figure 4-1 - Vertical Beach Well Intake System



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 percent 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 well field to the constant head condition already achieves this, with a little increase in yield resulting from the slant well. Due to the site-specific hydrogeological conditions (low transmissivity of the ocean floor sediments and near shore aquifer) the use of slant wells is also not viable for the Carlsbad seawater desalination project. In summary, the slant well intake alternative is not the environmentally preferred alternative, technically infeasible, and cost prohibitive.

Horizontal Wells. 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 turn pumps it through the plant pretreatment system.

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 (2.5 MGD) per well. This conclusion was also confirmed by the Dana Point Ocean Desalination Project test well that documented a yield of 1,660 gpm (2.4 MGD) 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 (40 MGD), still far below the project demand of 304 MGD. This approach assumes that additional exploration work will prove that elevated TDS concentrations in groundwater in the most permeable strata can be overcome.

Even if ideal conditions for this type of wells are assumed to exist (i.e., each well could collect 5 MGD rather than the 2.5 MGD determined based on actual hydrogeological data), horizontal well intake construction would include the installation of a total of 76 wells. The total length of coastal seashore impacted by this type of well intake would be 4.3 miles. As shown in Figures 4-2 and 4-3, the horizontal intake system would include nine large pump stations located on Tamarac State Beach and would impact 500 acres of shoreline and sensitive nearshore habitat. As a result, the horizontal intake system is not the environmentally preferred alternative. The cost for construction of horizontal well intake system for collection of 304 MGD of seawater needed for the desalination plant operation is estimated at $438 million. See Attachment 1 for a

Figure 4-2 - Horizontal Drain Intake System

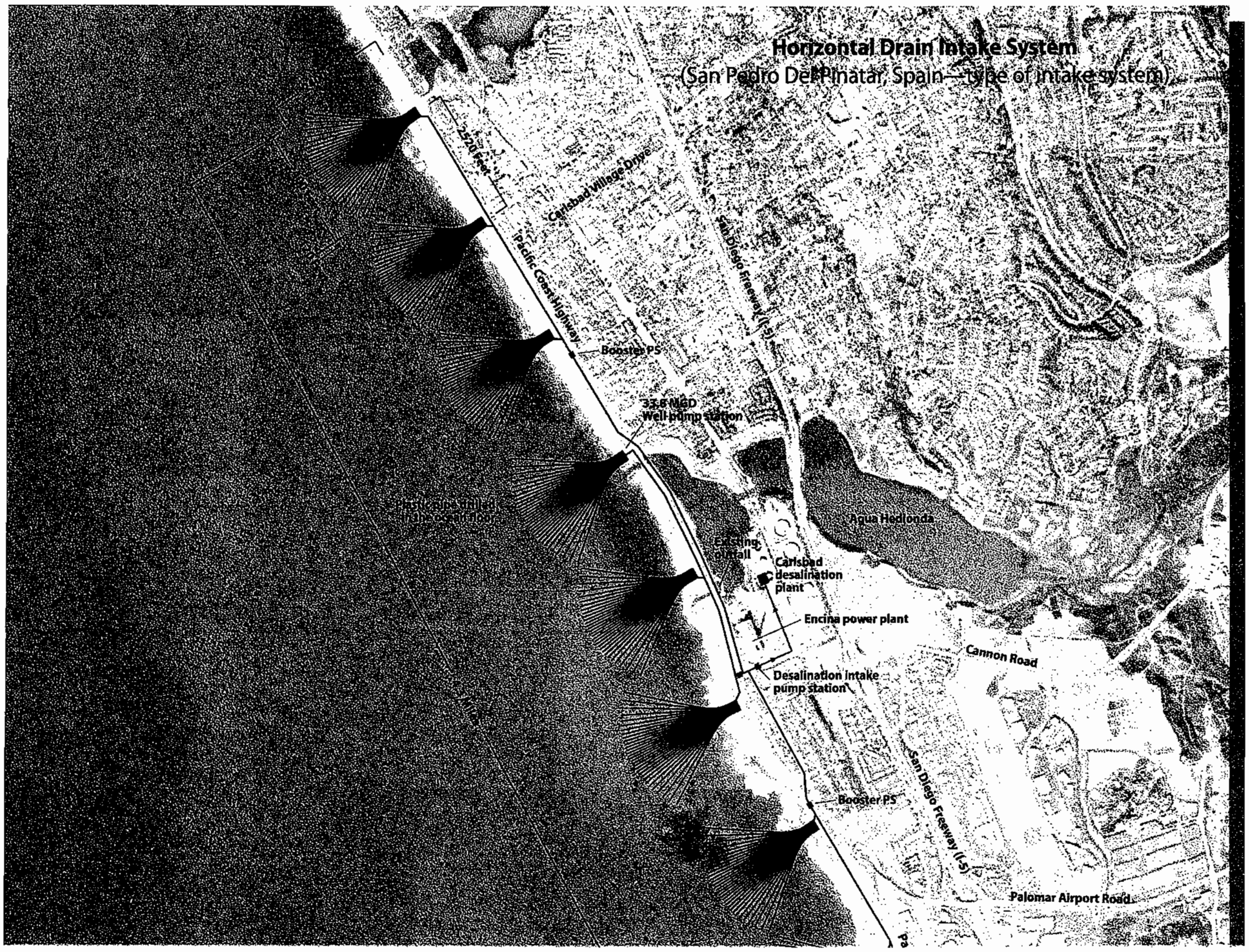
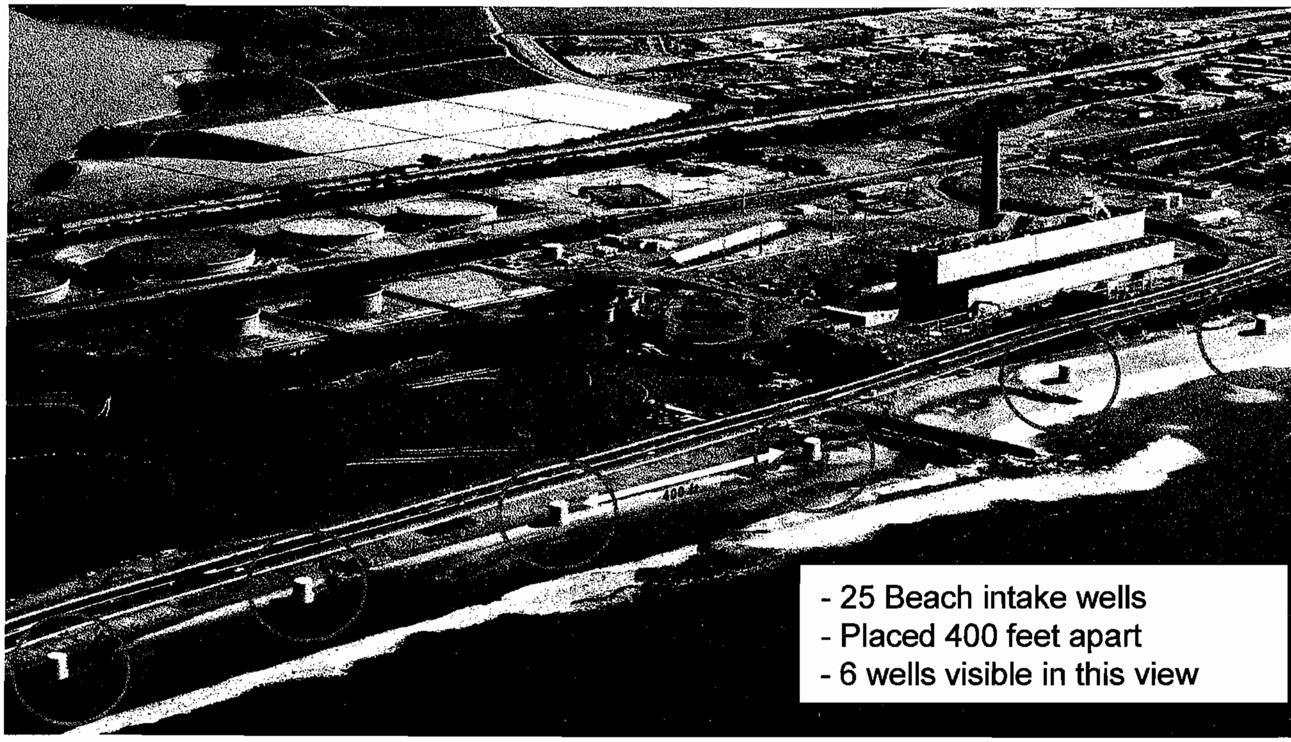


Figure 4-3 – Pump Stations with Horizontal Intakes



detailed cost estimate. In summary, the horizontal intake alternative is not the environmentally preferred alternative, and is technically infeasible, and cost prohibitive.

Subsurface Infiltration Gallery (Fukuoka Type Intake). The subsurface infiltration gallery intake system consists of a submerged slow sand media filtration system located at the bottom of the ocean in the near-shore surf zone, which is connected to a series of intake wells located on the shore. As such, seabed filter beds are sized and configured using the same design criteria as slow sand filters. The design surface loading rate of the filter media is typically between 0.05 to 0.10 gpm/sq ft. Approximately one inch of sand is removed from the surface of the filter bed every 6 to 12 months for a period of three years, after which the removed sand is replaced with new sand to its original depth. As it can be seen on Figures 4-4 and 4-5, the ocean floor has to be excavated to install the intake piping of the wells and pipes are buried at the bottom of the ocean floor.

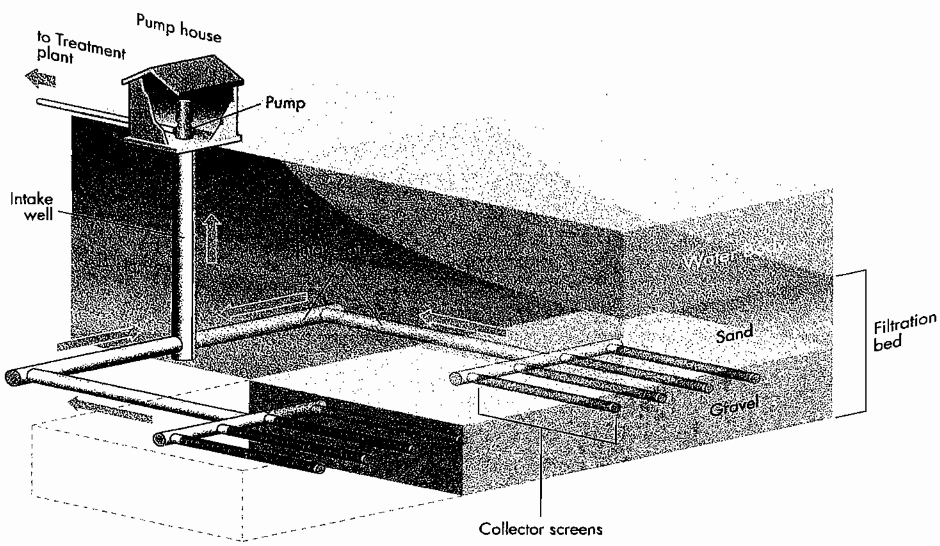


Figure 4-4 – Subsurface Infiltration Gallery (Fukuoka Type Intake)

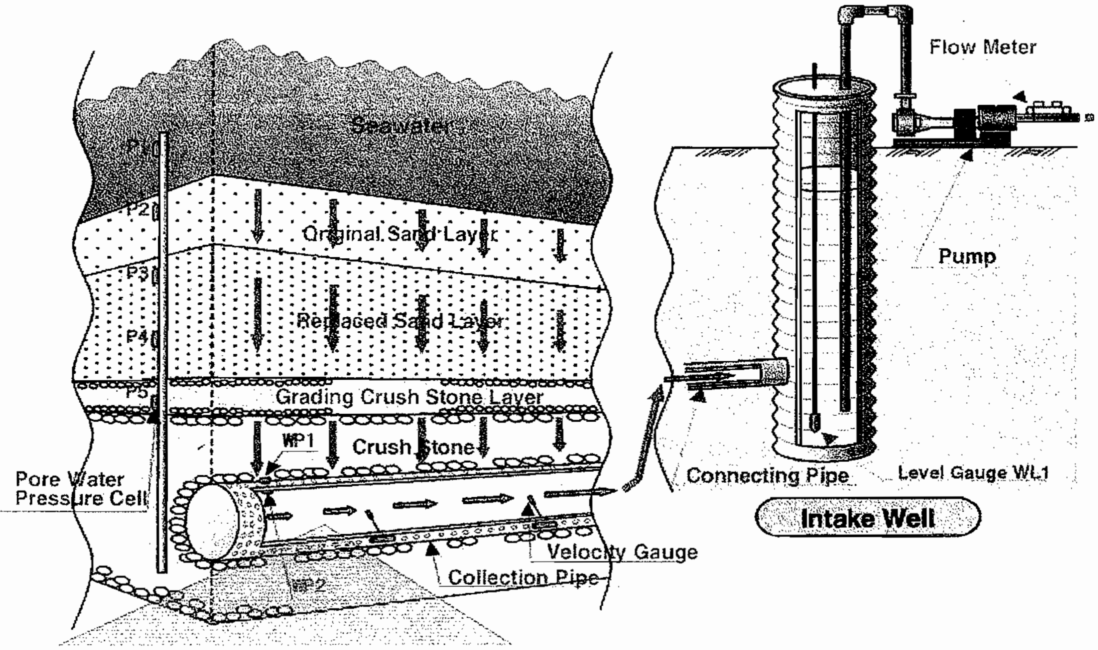


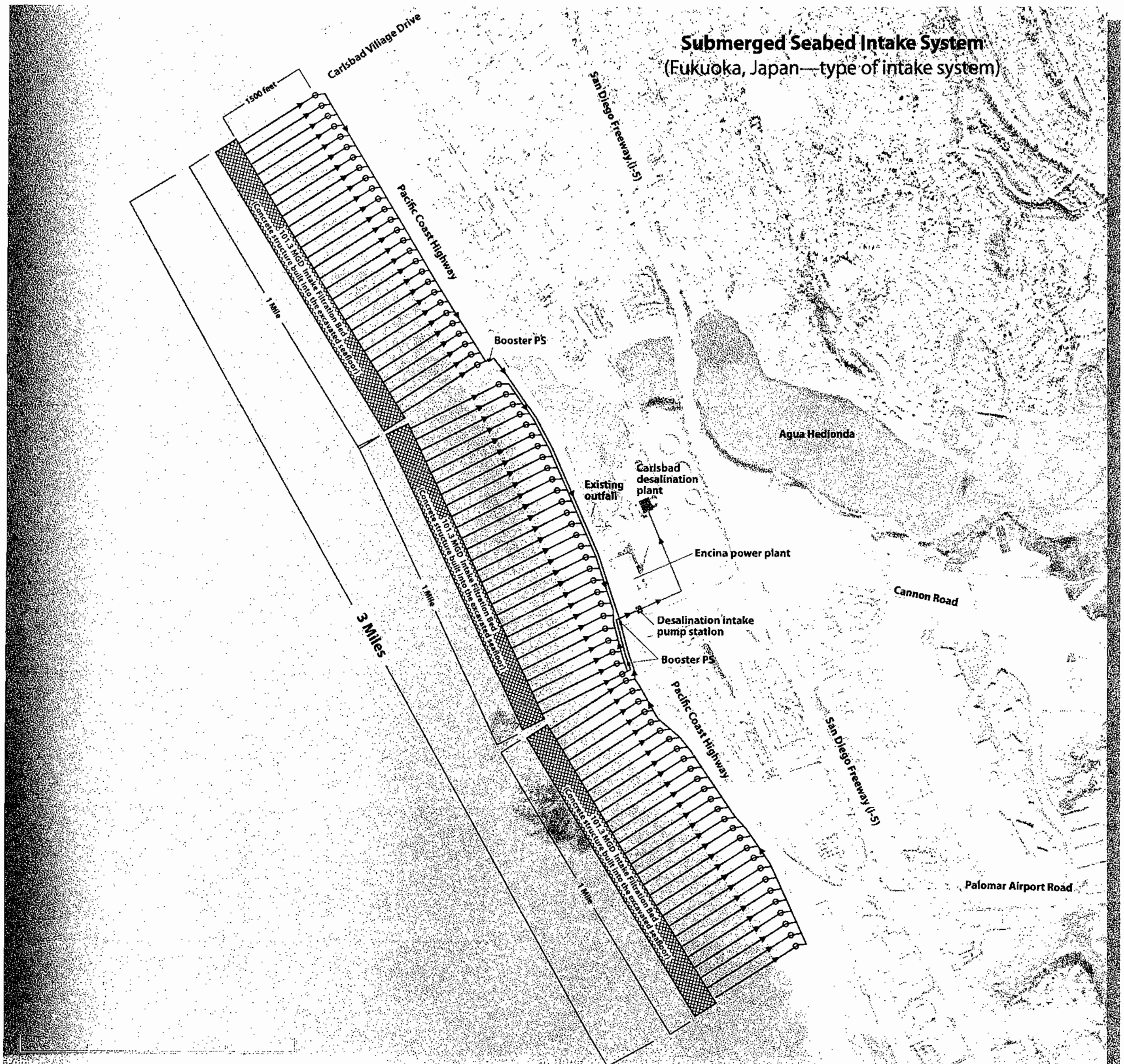
Figure 4-5 – A Cross-Section of Subsurface Infiltration Gallery

For the source water intake feed rate of 304 MGD needed for the Carlsbad seawater desalination project the total area of the ocean floor needed to be excavated to build a seabed intake system of adequate size is 146 acres. As shown in Figure 4-6, a submerged seabed intake system sized to meet the needs of the Carlsbad Desalination Project would impact three linear miles of sensitive nearshore hard bottom kelp forest habitat. The excavation of 146 acre/3-mile long strip of the ocean floor at depth of 15 feet in the surf zone to install a seabed filter system of adequate size to supply the Carlsbad desalination project, will result in a very significant impact on the benthic marine organisms in this location. In addition, the subsurface seabed intake system would have a similar effect on Tamarac State Beach. To collect the seawater from the filter bed and transfer it to the desalination facility, the intake system would require 78 collector pipelines on the ocean floor connected to 78 pump stations that would be installed on the State beach.

The cost for construction of subsurface seabed intake system for collection of 304 MGD of seawater needed for the desalination plant operation is estimated at $647 million. See Attachment 1 for a detailed cost estimate. In summary, the subsurface seabed intake alternative is not the environmentally preferred alternative, technically infeasible, and cost prohibitive.

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) concentration in the water was on the order of 60,000 mg/L, nearly twice that of typical seawater (33,500 mg/L). The test well water also had 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,

Figure 4-6 - Submerged Seabed Intake System



iron and suspended solids concentrations 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 alternative subsurface intakes for this project demonstrate that the alternative intakes that were evaluated are incapable of providing sufficient seawater to support the proposed project. None of the subsurface intake systems considered (vertical wells, slant wells, or horizontal wells) can only deliver a fraction of the 304 MGD of seawater needed for environmentally safe operation of the CDP. The maximum capacity that could be delivered using subsurface intakes is 28,000 gpm (40 MGD), which is substantially below the needed intake flow. Additionally, the quality of the water available from the subsurface intake (salinity twice that of seawater, excessive iron and high suspended solids) would be untreatable. Additionally, the alternative subsurface intake systems were determined not to be the environmentally preferred alternative. Taking into account economic, environmental and technological factors, the alternatives subsurface intakes are not capable of being accomplished in a successful manner within a reasonable period of time; and therefore, have been determined to be infeasible. The Coastal Commission draft findings agree with this conclusion: "find that subsurface intakes appear to be an infeasible alternative."[3]

4.2.2 Construction of New Open Intake for the Desalination Plant

Poseidon also evaluated whether the construction and operation of a new offshore intake to serve the seawater supply needs of the desalination project would be a viable alternative to the use of the existing intake at the Encina Power Generation Station and whether this approach would result in reduced impacts to marine resources.

Specifically, Poseidon studied whether an offshore intake would reduce the frequency of dredging of Agua Hedionda Lagoon under the stand-alone desalination facility operation; and whether a construction of a new intake would reduce environmental impacts as compared to the use of the existing Encina Power Station intake under the stand-alone desalination facility operation. The analysis included the review of the environmental impact report (EIR) for the Agua Hedionda Inlet Jetty Extension Project (Jetty EIR). This EIR identified an offshore intake as an environmentally preferred alternative to the proposed extension of the inlet jetty. Poseidon prepared two studies that demonstrate the construction of a new offshore intake would not reduce the frequency of dredging of Agua Hedionda Lagoon and it is not the environmentally preferred alternative.

The first study addresses whether an offshore intake would reduce the frequency of dredging of Agua Hedionda Lagoon under the stand-alone desalination facility operation.[4] This study concluded that the dredging frequency needed for normal operation of the stand alone desalination facility would be approximately once every three years when adhering to present

[3] See Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 50 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[4] *Comparative Analysis of Intake Flow Rate on Sand Influx Rates at Agua Hedionda Lagoon: Low-Flow vs. No-Flow Alternatives*, Jenkins and Waysl, September 28, 2007

dredging practices. Under the "no power plant and no desalination project" scenario, the minimum dredging volume required to keep Agua Hedionda open to the Pacific Ocean would be about 15 percent less than for the stand-alone desalination facility. This 15 percent reduction however, would not be sufficient to allow the dredge frequency to be extended beyond once every three years due to schedule limitations that prohibit dredging during least tern nesting season. Given the variability in the actual sand transport from year to year and the accuracy of the modeling, there isn't any discernable difference between the estimated dredging frequency and related environmental impacts associated with the operation of stand-alone desalination facility versus the "no power plant, nor desalination project" scenario.

The second study addresses whether an offshore intake would result in fewer environmental impacts than the use of the existing Encina Power Station intake under the stand-alone desalination facility operation.[5] Here the authors evaluate the Jetty EIR and conclude that the draft EIR did not adequately evaluate the environmental impacts associated with constructing an offshore intake. The Jetty EIR did not assess the biological impacts of installing a large diameter pipe 1000 feet offshore, which depending on placement, would potentially destroy existing rocky reef outcroppings occurring offshore. The Jetty EIR did not evaluate the down coast effects of an intake structure on habitat, sand flow, or sedimentation.

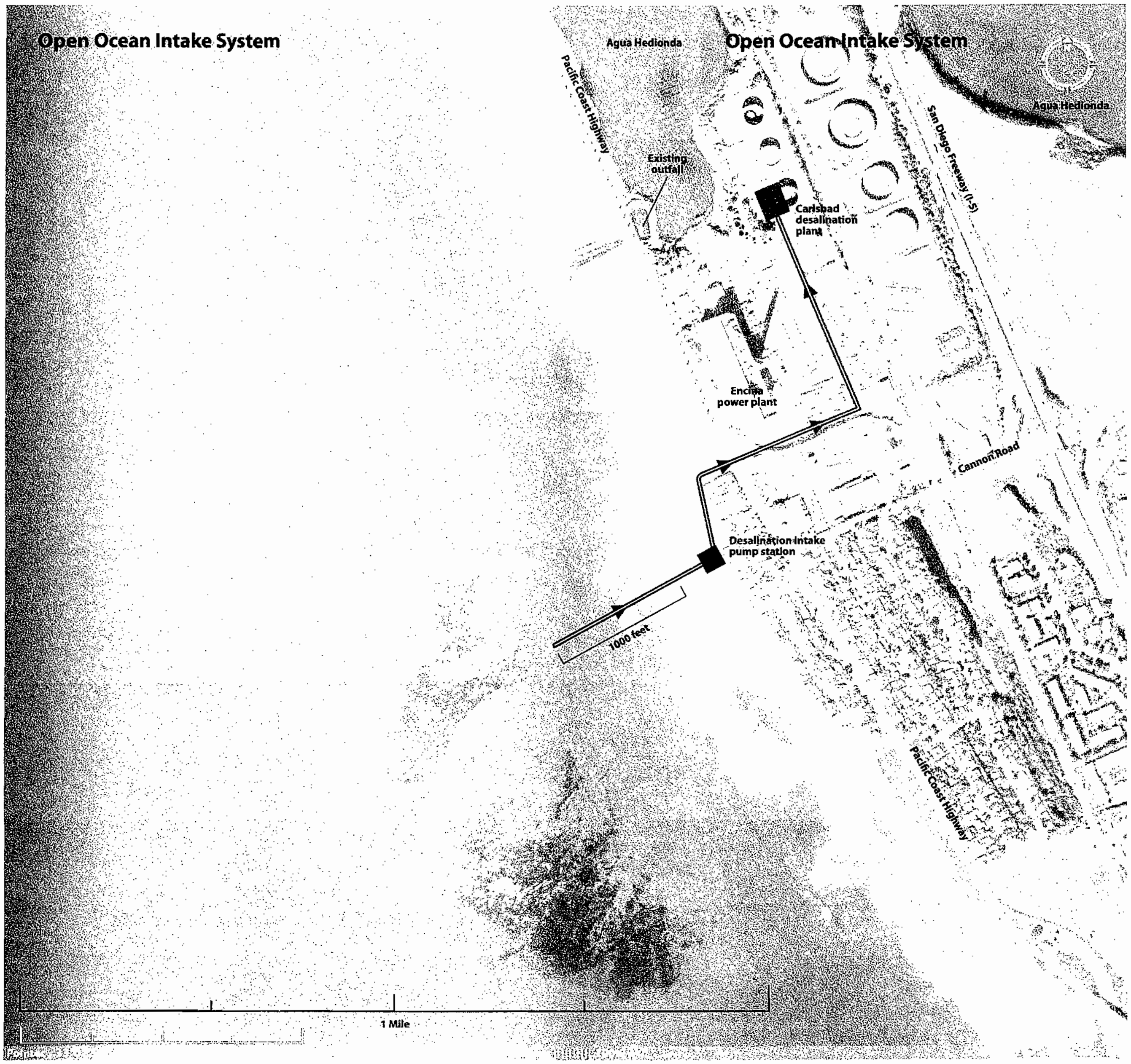
Further, the Jetty EIR did not adequately evaluate entrainment and impingement effects. Based on the environmental analysis of the area for potential location of a new offshore intake, Poseidon is of the opinion that an offshore intake has the potential to affect a greater diversity of adult and juvenile organisms as well as both phyto- and zooplankton species than is currently impacted by the existing intake at the Encina Power Station. The estimated cost of the new offshore intake shown in Figure 4-7 is approximately $150 million (see Attachment 1).

In conclusion, construction of a new open water intake would not result in significant reduction in dredging frequency, would cause permanent construction related impacts to the marine environment and would shift entrainment impacts to a more sensitive area of the marine environment that would affect a greater diversity species. As compared to the environmental impacts caused by the existing EPS intake, the new offshore intake is not the environmentally preferred alternative. Taking into account economic, environmental and technological factors, the alternatives intake is not capable of being accomplished in a successful manner within a reasonable period of time; and therefore, have been determined to be infeasible. The Coastal Commission draft findings agree with conclusion: "determined that alternative intakes that might avoid or minimize environmental impacts are infeasible or would cause greater environmental damage."[6]

[5] *Issues Related to the Use of the Agua Hedionda Inlet Jetty Extension EIR to Recommend An Alternative Seawater Intake for the Carlsbad Desalination Project,* Graham, Le Page and Mayer, October 8, 2007

[6] See Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 63 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

Figure 4-7 – Open Ocean Intake System



4.3 ALTERNATIVE POWER PLANT INTAKE & SCREENING TECHNOLOGIES

A number of alternative intake and screening 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 38 percent of the installed EPS intake pump capacity.

Under the stand-alone desalination plant operations, the existing power plant intake facilities will be operated at reduced flow and fewer pumps will be collecting water through the same existing intake screening facilities. The velocity of the water flowing into the intake would be reduced to 0.5 fps or less. This alone will substantially reduce the impingement impacts associated with the desalination plant operations to a level that the Coastal Commission acknowledged is "a *de minimis* impact."[7]

Technologies listed in Table 4-1 have been evaluated based upon feasibility for implementation at the facility, including 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.

4.3.1 Fish Screens and Fish Handling and Return System

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.

[7] See Id. at 46.

TABLE 4-1

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

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 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.

The capital cost associated with this impingement reduction alternative is estimated at: US$5.7 million. The annual O&M costs for such system are estimated at $200,000 over the costs of operation of the existing intake screening system.

Poseidon considers this alternative to be infeasible for the following reasons:

- The impingement impacts of the proposed Project (0.96 kgs per day of fish species that are highly abundant in the area) have been found by the Coastal Commission, CEQA lead and others to be insignificant.

- Substantial construction costs for a limited benefit;

- The implementation of this alternative will result in increased entrainment because of the significant volume of additional seawater needed to be collected to operate the screen.

4.3.2 New Power Plant Intake and Fine Mesh Screening Structure

Fine mesh traveling screens have been tested and found to retain and collect fish larvae with some success. Application of fine mesh traveling 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. This alternative would replace the existing trash rack structure with a much larger screening structure. Major modifications to the existing tunnel system would be required. Additionally, an appropriate and suitable location to return collected fish, shellfish, and their eggs and larvae would have to be constructed.

The demolition of the existing intake structure; removal of the existing screens; construction of a new intake structure; and installation of new coarse and fine mesh screens equipped with fish collection and return systems; would require a total construction expenditure of $53.3 million. Similar to the previous technology, the implementation of this alternative will also require additional intake flow (4 MGD to 5 MGD) 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 $300,000 per year.

Poseidon considers this alternative infeasible for the following reasons:

- The impingement and entrainment impacts of the proposed Project have been found by the CEQA lead and others to be insignificant.
- Poseidon has committed to restore and enhance at least 37 of marine wetlands habitat that significantly overcompensates for the limited impact of the Project to marine resources.
- Uncertain survival of the captured marine organisms.
- Substantial increase in Project construction costs for a very limited benefit.

4.3.3 Cylindrical Wedge-Wire Screens – Fine Slot Width

Wedge-wire screens are passive intake systems, which operate on the principle of achieving very low approach velocities at the screening media. Wedge-wire screens installed with small slot openings reduce impingement and entrainment and is an EPA approved technology for compliance with the US 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 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.

The EPS, located on the tidal Agua Hedionda Lagoon, would not meet the first two EPA criteria discussed above. First, the intake is not located on a freshwater river. Second, there is not sufficient crosscurrent in the lagoon to sweep organisms and debris away from the screen units; so debris and organisms back-flushed from the screens would immediately re-impinge on the screens following the back-flush cycle. For these reasons, Poseidon considers this alternative infeasible.

4.3.4 Fish Net Barrier

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 operation, while at the same time small enough to keep the marine organisms out of 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 reduce impingement; however, it would not meet reduce the entrainment of eggs and larvae.

The fish net barrier technology is still experimental, with very few successful installations. 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 with kelp and other debris. 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.

4.3.5 Aquatic Filter Barrier

An aquatic filter barrier system, such as the Gunderboom Marine Life Exclusion System (MLES)™, 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.

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. Consequently, this technology is not feasible for implementation at the existing EPS intake and further evaluation is not warranted.

4.3.6 Fine Mesh Dual Flow Screens

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.

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.

4.3.7 Modular Inclined Screens

Modular Inclined Screen (MIS) is a fish protection technology for water intakes developed and tested by the Electric Power Research Institute (EPRI). 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.

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.

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. 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.

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 the desalination plant intake impact.

4.3.8 Angled Screen System – Fine Mesh

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

Using fine screen mesh on the traveling screens minimizes entrainment, but increases potential for impingement of organisms that would have otherwise passed through the 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 impingement and entrainment as compared to the 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.

4.3.9 Behavior Barriers

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

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

4.3.10 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 susceptible juvenile and adult 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, 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. For the reasons previously discussed, this is not a practically feasible consideration for the EPS. Therefore, further evaluation of this technology is not warranted.

4.3.11 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 based on testing completed by EPRI. Therefore, further evaluation of this technology is not warranted.

4.3.12 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 and reviewed the results of research in this field as well. 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. The testing demonstrated no conclusive results and the California Coastal Commission found this device not useful at this station. Therefore, further evaluation of this technology is not warranted.

4.3.13 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.

4.3.14 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.

4.3.15 Installation of Variable Frequency Drives on Existing Power Plant Intake Pumps

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.

As indicated in Table 2-1, the EPS has ten cooling water pumps of total capacity of 794.9 MGD. Currently, all of these pumps are equipped with constant speed motors. Each of the five existing power generation units is coupled with two cooling pumps per unit and both pumps are operated when a given power generator is in service. Because the individual power generation units are designed to operate efficiently only at a steady-state near constant rate of electricity production and therefore, near constant thermal discharge load, reducing cooling flow by VFD in order to diminish entrainment would result in an increased temperature of the thermal discharge which in turn would have a detrimental effect on the marine organisms in the discharge area. The installation of VFDs is also limited by physical site constraints. The VFD units would need to be located near the pump motors in the existing concrete pump pit, which would need to be enlarged in order to accommodate this equipment. The cost associated with such mayor structural modifications along with the cost of the VFDs would exceed $8.5 million. Taking into consideration the limited useful life of the existing power plant, such large expenditures at this time are not prudent.

Under stand-alone operational conditions of the desalination plant, the power plant intake pumps would be operated as described in the precious section (Section 3 – Design). The cooling water pump operations will be decoupled from the condenser operations, which would substantially reduce the seawater velocity through screens. Under these conditions, the intake flow of the desalination plant (and associated entrainment) would be controlled by the VFD system of the desalination plant intake pump station. Installing an additional VDF system on the power plant intake pumps would have a negligible benefit.

In summary, installation of variable frequency drives on existing power plant intake pumps would provide limited benefits to marine life while significantly interfering with ongoing power plant operations. Taking into account economic, environmental and technological factors, this alternative has been determined to be infeasible.

4.3.16 Summary Evaluation of Power Plant Intake and Screening Alternatives

Implementation of the alternatives associated with the modification of the existing power plant intake and screening facilities were found to be infeasible because they would interfere with, or interrupt, power plant scheduled operations. Such significant modifications of the existing intake, and prolonged periods of power plant downtime are difficult to justify given the limited environmental benefit. The extended disruption to power plant operations and significant expenditures associated such modifications would not yield commensurate benefits for the following key reasons:

1. **Impingement.** The impingement impact of the stand-alone operation of the desalination plant has been found to be insignificant by both the City of Carlsbad (Project EIR) and *de minimis* according to the Coastal Commission (Draft CDP Findings) (approximately 2

lbs/day of fish).[8] Therefore, complex and costly intake modifications to reduce this already minimal impingement impact are not prudent. In addition, operational modifications of the existing EPS intake system under stand-alone CDP operation would reduce the fine screen-flow through velocity to further minimize impingement.

2. **Entrainment.** The entrainment impact of the stand-alone CDP operation is mainly driven by the volume of intake flow needed to produce fresh drinking water. In contrast with power plant operations, where water is not essential to produce electricity, in seawater desalination, seawater has to be collected and used to produce fresh water. Therefore, CDP entrainment effects cannot be avoided completely or minimized drastically by modifying the existing power plant intake facilities. Quite the opposite, many of the impingement reduction scenarios (see Sections 4.3.1, 2 &3 and 4.3.6,7&8) could increase the total flow needed for stand-alone desalination plant operations, thereby trading negligible impingement reduction benefits for incremental increase in entrainment.

Taking into account these economic, environmental and technological factors, the power plant intake screening alternatives are not capable of being accomplished in a successful manner within a reasonable period of time; and therefore, have been determined to be infeasible. The Coastal Commission draft findings agree with this conclusion: "The impingement impact of the stand-alone operation of the desalination plant has been found to be *de minimis* and insignificant"[9]; and "the Commission finds that Poseidon's proposal is using all feasible methods to minimize or reduce its entrainment impacts."[10]

When the EPS permanently ceases the use of the once-through cooling water system, additional entrainment and impingement technologies may become feasible. While no timeline has been established as to when this might occur, SLC staff is recommending that in ten years Poseidon would be required to evaluate and implement those additional technologies it determines are appropriate in light of an environmental review it would undertake at that time:[11] The draft State Lands Commission lease would require, ten years after the lease is issued, that the CDP be subject to further environmental review to ensure its operations at that time are using technologies that may reduce any impacts.

4.4 DESALINATION TECHNOLOGIES FOR IMPROVED SURVIVAL OF MARINE LIFE

Seawater desalination treatment processes and technologies differ significantly from these used in once-trough cooling power generation. In power plant installations, all of the entrained organisms pass through a complex system of power generation equipment and piping, and are exposed to thermal stress caused by high-temperature heat exchangers before they exit the power

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[8] See Final Environmental Impact Report EIR 03-05 and Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 40 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[9] See Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 40 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[10] See Id. at 53.

[11] State Lands Commission October 24, 2007 recommended Amendment of Lease PRC 8727.1.

plant with the discharge. Therefore, typically a 100 percent mortality of marine organisms is assumed during the once-through cooling power generation process. State-of-the art reverse osmosis seawater desalination plants, such as the CDP, differ by the following key features:

1. Seawater is not heated in order to produce drinking water, which eliminates the thermal stress of marine organisms entrained in the source water flow;

2. Marine organisms are captured in the first stage of treatment (pretreatment) and therefore, do not pass through most of the desalination plant facilities, which in turn increases their chance of survival. The captured marine organisms are returned to the ocean.

The Carlsbad seawater desalination plant will incorporate a number of technologies that would reduce entrainment and increase the potential to capture marine organisms and to successfully return them to the ocean. These technologies are described below.

4.4.1 Installation of Variable Frequency Drives on Desalination Plant Intake Pumps

The desalination plant intake pump station will be equipped with variable frequency drive system to closely control the volume of the collected seawater. As water demand decreases during certain periods of the day and the year, the variable frequency drive system will automatically reduce the intake pump motor speed thereby decreasing intake pump flow to the minimum level needed for water production.

As in any other water treatment plant, the desalination plant production would vary diurnally and seasonally in response to water demand fluctuations. If variable frequency drive system is not available, the CDP intake pumps would collect a constant flow corresponding to the highest flow requirements of the CDP. The installation of VFD system at the intake pump station would reduce the total intake flow of the desalination plant compared to constant speed-design, which in turns would result in proportional decrease in entrainment associated with desalination plant operations. Pump motor operation at reduced speed during off-peak demand periods also would increase the chance for survival of the marine organisms entrained in the source seawater.

4.4.2 Installation of Micro-screens Ahead of Seawater Pretreatment Facilities

A very fine screen (120 micron/0.12 mm) or also known as micro-screen filtration technology is planned to be installed to filter out most of the marine organisms entrained by the desalination plant intake pumps. The micro-screens are equipped with polypropylene discs, which are diagonally grooved on both sides to a specific micron size. A series of these discs are stacked and compressed on a specially designed spine. The groove on the top of the disks runs opposite to the groove below, creating a filtration element with series of valleys and traps for marine particulates. The stack is enclosed in corrosion and pressure resistant housing. Filtration occurs while water is percolating from the peripheral end to the core of the element (Figure 4-8).

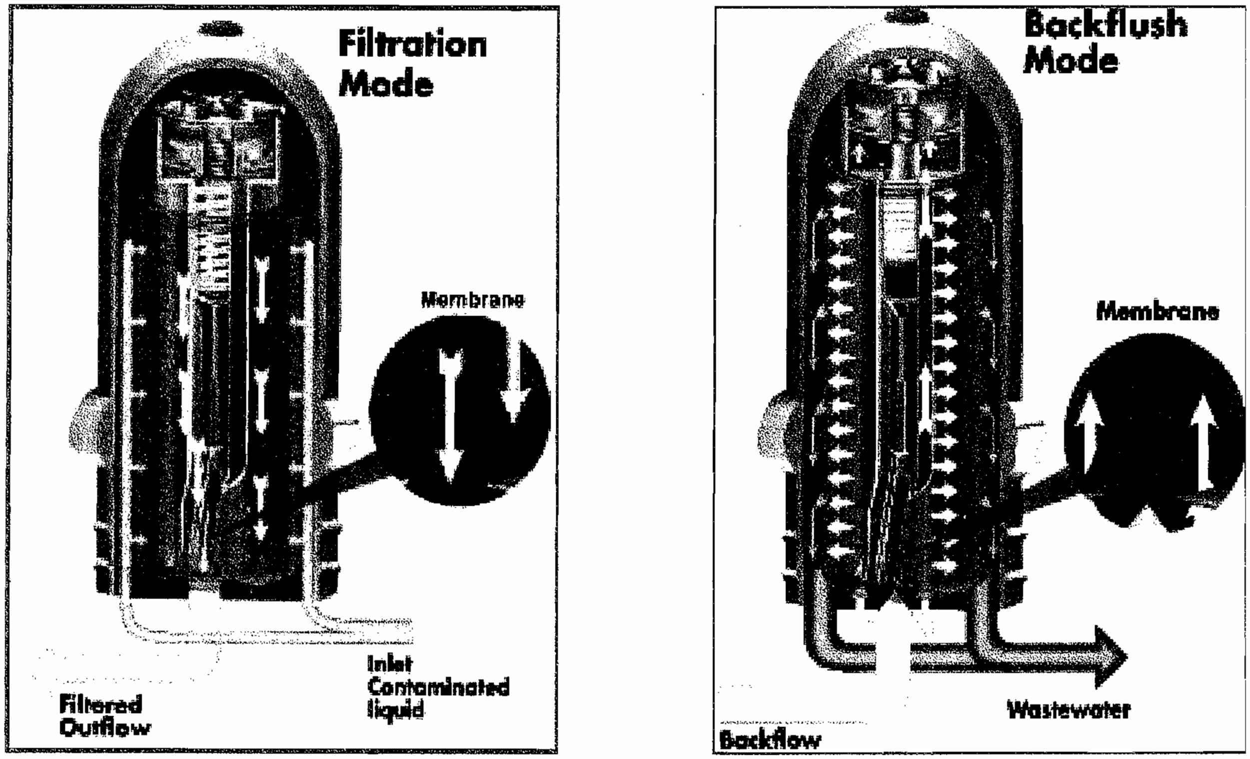

Figure 4-8. Microscreens in filtration and backwash flow modes

Since the intake seawater is already pre-screened by the 3/8 to 5/8- inch power plant intake screens, the seawater directed to the disk filters will contain debris and marine organisms smaller than 3/8-inch (9500 microns) (5/8-inch = 15.8 mm = 15,800 microns). During the filtration mode, seawater debris and marine organisms larger than 15,800 microns but smaller than 120 microns will be retained and accumulated in the cavity between the filter disks and the outer shell of the filters, thereby increasing the head loss through the filters. Once the filter head loss reaches a preset level (typically 5 psi or less) the filters enter backwash mode. All debris and marine organisms retained on the outer side of the filters are then flushed by tangential water jets of filtered seawater flow under 2 to 3 psi of pressure and the flush water is directed to a pipe, which returns the debris and marine organisms retained on the filters back to the ocean.

Because of the small size and relatively low differential pressure, these filters are likely to minimize entrainment and impingement mortality of the marine organisms in the source seawater. Since the disk filtration system is equipped with a wash water/organism return pipe, the impinged marine organisms are returned back to the ocean, thereby increasing their chance of survival. Based on US EPA source (US EPA, 2002, Technical Development Document for the Proposed Section 316 (b) Phase II Existing Facilities Rule, EPA 821-R-02003) fine mesh screens show promise for both impingement and entrainment control and "can reduce entrainment by 80 % or more". According to this source, the use of 0.5 mm (500 μ) screen at the Big Bend Power Plant in Tampa Bay area, "the system efficiency in screening fish eggs (primarily drums and bay anchovy) exceeded 95 % with 80 % latent survival for drum and 93 % efficiency for bay anchovy. For larvae (primarily drums, bay anchovies, blennies, and gobies), screening efficiency was 86 % with 65 % latent survival for drum and 66 % for bay anchovy. (Note that latent survival in control samples was also approximately 60 %). According to the same source, a full-scale test by the Tennessee Valley Authority at the John Sevier Plant showed less than half as many larvae entrained with a 0.5-mm (500 μ) screen than 1.0 mm (1,000 μ) and 2.0 mm (2,000 μ) screens combined. These data are indicative of the fact that most likely using finer screens would result in lower entrainment effect. Since the micro-screens proposed for the Carlsbad project have 120 μ openings which are smaller than the smallest fine screens used elsewhere (i.e., 500 μ), the entrainment reduction capability of these micro-screens is expected to be comparable to the fine screens tested at the full scale installations referenced above.

4.4.3 Use of Low Pressure Membrane Pretreatment System

After the source seawater is screened by the 120-μ micro-screens, this water would be conveyed to a membrane pretreatment system in order to remove practically all remaining suspended solids and particulates. The filtered water will then be pumped to the seawater reverse osmosis system for salt separation.

The pretreatment system planned to be used for the Carlsbad seawater desalination project will consist of submerged ultrafiltration (UF) hollow-fiber membranes bundled in cassettes and operated under slight vacuum – typically in a range of 2.5 to 6 psi (see Figure 4-9). The nominal fiber pore size of the UF membranes is 0.02 μ. Practically all marine organisms that were not removed by the 120-μ micro-screens (mostly algae and other phyto- and zooplankton) would be retained by the UF membranes and would periodically be returned back to the ocean during the backwash cycle of these membranes. Membrane backwash would typically be completed with air and water once every 20 to 40 minutes. No chemicals are planned to be applied for seawater conditioning prior to filtration.

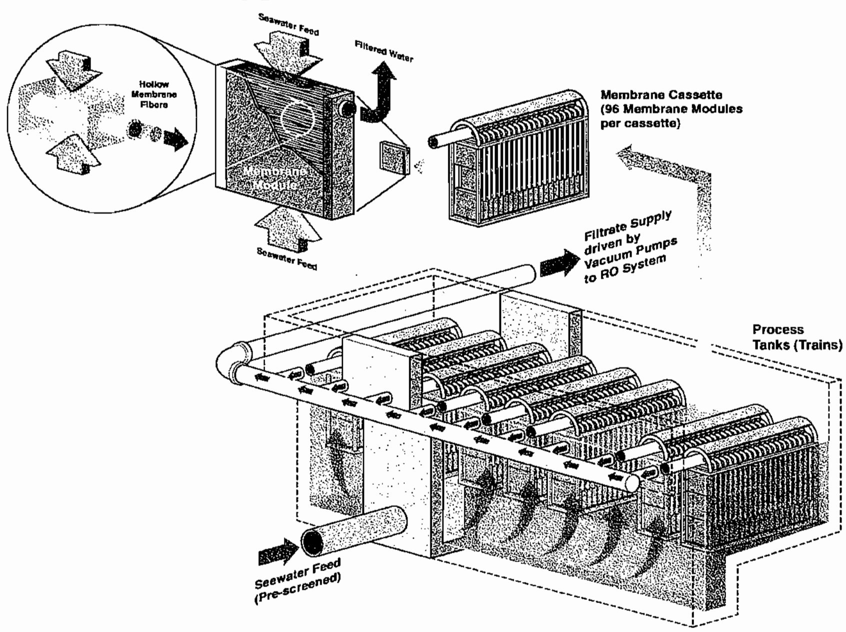

Figure 4-9 – Ultrafiltration Pretreatment System

Evaluation of the same UF pretreatment technology at the Carlsbad seawater desalination pilot plant indicates that the UF system retains all plankton and has potential to be effective entrainment reduction measure. Initial microscopic analysis of the phytoplankton in the UF system backwash completed by M-REP Consulting shows that over 70 % of algal cells maintain their integrity after passing through the micro-screens and the ultrafiltration process (see Figure 4-10).[12]

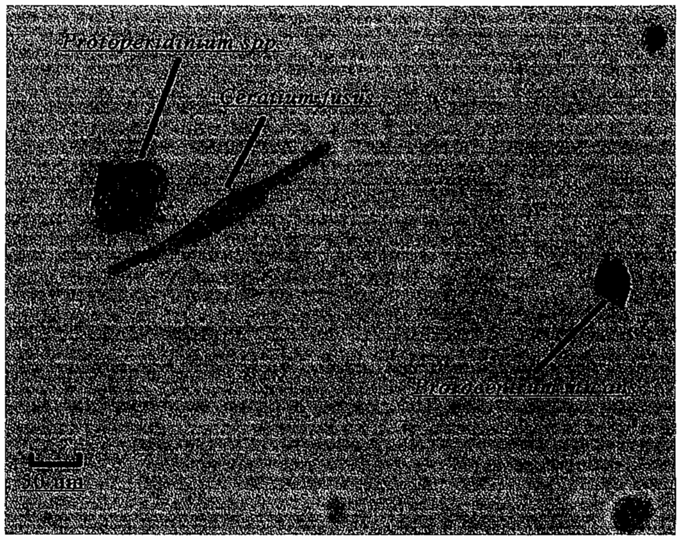

Figure 4-10 – Algae Removed by the UF Pretreatment System

4.5 SUMMARY OF THE FEASIBILITY ASSESSMENT OF TECHNOLOGY FEATURES TO MINIMIZE IMPACTS TO MARINE LIFE

A combination of intake, screening and treatment technologies were found to be feasible for the site-specific conditions of the proposed Project. The technology features are included in the CDP to minimize impacts to marine life are summarized in Table 4-2.

[12] M-Rep Consulting, Update on the preliminary results of the Carlsbad Pilot Algal Study, February 27, 2008.

TABLE 4-2

DESIGN FEATURES TO MINIMIZE IMPACTS TO MARINE LIFE

Category	Feature	Result
1. Technology	Installation of VFDs on CDP intake pumps	Reduce the total intake flow for the desalination facility to no more than that needed at any given time, thereby minimizing the entrainment of marine organisms.
2. Technology	Installation of micro-screens	Micro-screens (120 μ) minimize entrainment and impingement impacts to marine organisms by screening the fish larvae and plankton from the seawater.
3. Technology	Installation of low impact prefitration technology	The desalination facility will rely on low pressure, chemical free membrane pretreatment filtration technology to minimize entrainment and impingement impacts to marine organisms that have passed through the micro-screens by filtering the organisms from the seawater.
4. Technology	Return to the ocean of marine organisms captured by the screens and filters	Substantial reduction in entrainment and impingement impacts to marine organisms captured by the screens and membrane filter by returning the organisms to the ocean. Studies indicate potential for survival of 80 percent or more of the larvae captured by the micro-screens and 70 percent of the algae and other phyto- and zooplankton captured by the membrane filter.
5. Technology	Ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found.	SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations. This ensures that the CDP operations at that time are using technologies that the SLC determines may reduce any impacts and are appropriate in light of environmental review.

In addition, taking into account economic, environmental and technological factors previously discussed, the following technology alternatives intake are not capable of being accomplished in a successful manner within a reasonable period of time; and therefore, have been determined to be infeasible.

- **Installation of subsurface intakes** (beach wells, slant wells, infiltration galleries, etc.) is infeasible for the site-specific conditions of the Carlsbad project because of the limited production capacity, poor water quality of the coastal aquifer, extensive environmental damage associated with the implementation of such intakes and excess cost.

- **Construction of new open ocean intake** in the vicinity of the project site was found more environmentally damaging than the use of the existing intake located in Agua Hedionda Lagoon. This alternative is also cost-prohibitive.

- **Major physical or structural modifications to the existing power plant intake** facilities were found to be infeasible because of the very limited potential of impingement and entrainment benefits they could offer as well as practical constraints with their implementation while the power plant is in operation.

- **Installation of variable frequency drives on existing power plant intake pumps** would provide limited benefits to marine life while significantly interfering with ongoing power plant operations. Taking into account economic, environmental and technological factors, this alternative has been determined to be infeasible.

CHAPTER 5

QUANTIFICATION OF UNAVOIDABLE IMPACTS TO MARINE RESOURCES

INTRODUCTION

This Chapter provides a conservative (upper-end) quantification of the Project related impacts to marine life. This Chapter is broken down into four sections:

- *The first section describes conservative approach to quantification of the Project related impacts to marine life.*
- *The second section provides an assessment of the impingement impact of the desalination facility stand-alone operations.*
- *The third section provides an assessment of the entrainment impact of the desalination facility stand-alone operations.*
- *The fourth section provides a summary of the assessment of impingement and entrainment impacts associated with desalination facility stand-alone operation.*

5.1 CONSERVATIVE APPROACH

As previously described, the CDP is designed to use the existing intake and discharge facilities of the Encina Power Generation Station (EPS). When EPS is producing electricity and using 304 MGD or more of seawater for once-through cooling, the proposed desalination plant operation would cause a *de minimis* increase in impingement and entrainment of marine organisms.

Under conditions when the EPS operation is temporarily or permanently discontinued, the desalination plant will continue to use the existing power plant intake and discharge facilities. Under this mode of operation, the impingement and entrainment impacts of the desalination plant operations would be significantly lower than those caused by the EPS operations at the same intake flow, due to a number of differences in the desalination plant and power plant intake design and operations.

Figure 3-2 provides a comparison of the 2007 EPS cooling water discharge to the flow needed to support CDP operations. Under this operating scenario, the EPS discharge would provide 61 percent of the CDP annual seawater intake requirements and the CDP would pump the remaining source water required to support the desalination plant operations from the EPS intake. The CDP's direct use of the EPS discharge, coupled with the design and technology features described in Chapters 3 and 4, would result in a substantial reduction in the CDP entrainment and impingement impacts.

Nevertheless, Poseidon is proposing a very conservative approach to quantifying the entrainment and impingement impacts that would be used to establish the mitigation requirements for the project that:

1. Does not take any credit for design and technology features that would be incorporated into the CDP to lessen the impacts to marine life;

2. Does not take any credit for the reduction or elimination of the impact to marine life that may occur as a result of the State Lands Commission lease requirements.

3. Does not take any credit for improvements to marine resources that may come about through Poseidon's commitment to assume responsibility for preservation of Agua Hedionda Lagoon after the EPS is decommissioned.

4. Mitigates for the maximum possible impact to marine life associated with the diversion of 304 MGD of seawater from Agua Hedionda Lagoon through the restoration of approximately 37 acres of comparable marine wetlands.

5.2 IMPINGMENT EFFECT OF DESALINATION PLANT STAND-ALONE OPERATIONS

5.2.1 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 considered to be negligible.

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 (Attachment 2). This data was 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 Attachment 3).

5.2.2 Estimate of the Impingement Effect of Desalination Plant Stand-Alone Operations

The abundance and biomass of fishes, sharks, rays and invertebrates impinged on the EPS traveling screens were documented in an extensive study as part of the 316(b) Cooling Water Intake assessment submitted to the San Diego Regional Water Quality Control Board by Cabrillo Power, LLC in early 2008[1].). All impingement sampling data collected during this study are

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[1] Encina Power Station cooling water system entrainment and impingement of marine organisms: Effects on the biological resources of Agua Hedionda Lagoon and the nearshore ocean environment, Tenera Environmental", January 2008.

provided in Attachment 2 of the Minimization Plan. This attachment contains data collected for all individual sampling events, including the dates and times of the sampling events. The average power plant intake flow during the 2004/2005 sampling period was 632.6 MGD. The total annual amount of impinged fish, sharks and rays for intake flow of 304 MGD, representative for stand-alone operation of the desalination plant is presented in Table 5-1. Based on these data, the average he daily biomass of impinged fish, sharks and rays during stand-alone operations of the desalination plant was estimated at 0.96 kg/day (2.11 lbs/day) for an intake flow of 304 MGD.

Table 5-1 presents impingement losses of fishes, sharks and rays 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. Stand-alone operations of the desalination plant will not require the use of heat treatment.

TABLE 5-1

Number and weight of fishes, sharks, and rays impinged during normal operation and heat treatment surveys at EPS from June 2004 to June 2005 prorated for 304 MGD

			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**

The daily biomass of impinged fish, sharks and rays during normal operations of 0.96 kgs/day was calculated by dividing the total annual sample weight of 351,672 grams (see last row of the second column of the Table 5-1 summarizing all impingement data) by the total number of days per year (i.e., 351,672 grams/365 days = 963.48 grams/day = 0.96 kgs/day.

While Table 5-1 presents impingement information for fish, sharks and rays, Attachment 2 also contains all impingement data for invertebrates (crab, octopus, squid, California spiny lobster, etc.) collected during the 2004/2005 impingement study referenced above. Review of this comprehensive impingement data set in Attachment 2 indicates that the both the number and the total weight of the impinged invertebrates was over 10 times smaller than that of fish, sharks and rays (i.e., less than 0.1 kgs/day).

5.2.3 Significance of Impingement Losses

As the CEQA lead agency on the Project EIR, the City of Carlsbad found that the impingement impacts associated with the stand-alone operation of the proposed desalination facility are insignificant and therefore no mitigation is required.[2] In its approval of the Coastal Development permit for the proposed Project, the Coastal Commission found that impingement impacts associated with the stand-alone desalination facility would be "*de minimis* and insignificant."[3] The Coastal Commission conditioned the project to include compensatory mitigation to lessen the effects of unavoidable entrainment and impingement impacts.[4] With the inclusion of this Special Condition 8, the Commission found that the anticipated entrainment and impingement impacts associated with the stand-alone desalination facility would be mitigated to the maximum extent feasible.[5]

5.3 METHODOLOGY FOR ASSESSMENT OF ENTRAINMENT IMPACT

5.3.1 Background Data Used for Preparation of Entrainment Assessment

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 (see Attachment 3). All samples used for the entrainment assessment were collected in front of the EPS intake with a boat-towed plankton net. This is the most up-to-date entrainment assessment available for this facility.

Tenera Environmental 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).

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[2] See Final Environmental Impact Report EIR 03-05

[3] See Coastal Commission Recommended Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 40 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[4] See Coastal Commission Recommended Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, pages 53 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

[5] See Coastal Commission Recommended Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, pages 3 and 4 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

5.3.2 Entrainment Effects Model

The Empirical Transport Model (ETM) used to assess the APF the desalination facility is based on principles used in fishery management. The number of days that the larvae are subject to entrainment, or the number of days the desalination facility is operating, is estimated using the size range of the larvae entrained. This number of operating days is then combined with the entrainment mortality (*PE*) to estimate the total mortality due to entrainment for a study period. These estimates for each study period can then be combined to calculate the average proportional mortality due to entrainment for an entire year.

The *ETM* has been proposed by the U.S. Fish and Wildlife Service to estimate mortality rates resulting from cooling water withdrawals by power plants. The *ETM* model provides an estimate of incremental mortality (a conditional estimate in absence of other mortality imposed on local larval populations by using an empirical measure of proportional entrainment (*PE*) rather than relying solely on demographic calculations. Proportional entrainment (*PE*) (an estimate of the daily mortality) to the source water population from entrainment is expanded to predict regional effects on appropriate adult populations using the *ETM*, as described below.

Empirical transport modeling permits the estimation of conditional mortality due to entrainment while accounting for the temporal variability in distribution and vulnerability of each life stage to power plant withdrawals.

The general equation to estimate *PE* for a day on which entrainment was sampled is:

$$\hat{P}E = \frac{\hat{N}_{Ei}}{\hat{N}_{Si}}$$

Where:

$\hat{N}_{Ei}$ = estimated number of larvae entrained during the day in survey i, calculated as (estimated density of larvae in the water entrained that day) × (design specified daily cooling water intake volume),

$\hat{N}_{Si}$ = estimated number of larvae in the source water that day in survey i (estimated density of larvae in the souce water that day) × (source water volume).

A source water volume is used because: 1) cooling water flow is measured in volume per time, and 2) biological sampling measures larval concentration in terms of numbers per sample volume. Entrained numbers of larvae are estimated using the volume of water withdrawn. A source population is similarly estimated using the source water volume. If one assumes that larval concentrations at the point of entrainment are the same as larval concentrations in the source population volume then it follows that:

$$\hat{P}E = \frac{\hat{V}_{Ei}}{\hat{V}_{Si}},$$

Where :

$\hat{V}_{Ei}$ = design specified daily cooling water intake volume,

$\hat{V}_{Si}$ = estimated source water volume.

The ratio of daily entrainment volume to source volume can thus serve as an estimate of daily mortality. The *PE* value is estimated for each larval duration period over the course of a year by using a source water estimate from an advection model described below.

If larval entrainment mortality is constant throughout the period and a larva is susceptible to entrainment over a larval duration of *d* days, then the proportion of larvae that escape entrainment in period *i* is:

$$(1-\hat{P}E_i)^{\hat{d}}.$$

A larval duration of 23 days from hatching to entrainment was calculated from growth rates using the length representing the upper 99th percentile of the length measurements from larval CIQ gobies collected from entrainment samples during 316(b) study completed by Tenera Environmental. The value for *d* was computed by dividing an estimate of growth rate into the change in length based on this 99th percentile estimate. The minimum size used for computing the larval duration was determined after removing the smallest 1 percent of the values.

It is possible that aging was biased, even though standard lengths of larval fishes (i.e., measurements of minimum, mean, and maximum), and larval growth rates were applied to estimate the ages of the entrained larvae. It was assumed that larvae shorter than the minimum length were just hatched and therefore, aged at zero days. Subsequent ages were estimated using this length. Other reported data for various species suggest that hatching length can be either smaller or larger than the size estimated from the samples, and indicate that the smallest observed larvae represent either natural variation in hatch lengths within the population or shrinkage following preservation. The possibility remains that all larvae from the observed minimum length to the greatest reported hatching length (or to some other size) could have just hatched, leading to overestimation of ages for all larvae.

Sixteen larval duration periods over the course of a year were used to estimate larval mortality (P_M) due to entrainment using the following equation:

$$\hat{P}_M = \frac{1}{16}\sum_{i=1}^{16} 1-(1-\hat{P}E_i)^{\hat{d}}$$

Where:

$\hat{P}E_i$ = estimate of proportional entrainment for the ith period and

$\hat{d}$ = the estimated number of days of larval life.

The estimate of the population-wide probability of entrainment ($\hat{P}E_i$) is the central feature of the *ETM* approach. If a population is stable and stationary, then $\hat{P}_M$ estimates the effects on the fully-recruited adult age classes when uncompensated natural mortality from larva to adult is assumed.

Assumptions associated with the estimation of P_M include the following:

1) Lengths and applied growth rate of larvae accurately estimate larval duration,
2) A source population of larvae is defined by the region from which entrainment is possible,
3) Source water volume adequately describes the population, and
4) The currents used to calculate the source water volume are representative of other years.

The ratio of daily entrainment volume to source volume is used as an estimate of daily mortality. The *ETM* method estimates the source population using an estimate of the source volume of water from which larvae could possibly be entrained. It has been noted that if some members of the target group lie outside the sampling area, the *ETM* will overestimate the population mortality.

Recent work by Largier showed the value of advection and diffusion modeling in the study of larval dispersal, which is central to the *ETM* method. Ideally, three components could be considered in estimating entrainable populations: advection, diffusion, and biological behavior. An *ad hoc* approach, developed by the Technical Working Group during the Diablo Canyon Power Plant (DCPP) 316(b) study, modeled the three components using a single offshore current meter. For the present analysis, lagoon and coastal source water populations were treated separately.

Larval populations in the Agua Hedionda lagoon were computed using the lagoon segment volumes, described below. Nearshore populations were defined using the *ad hoc* approach developed by the DCPP Technical Working Group.

5.3.3 Source Water Volume Used for AHF Calculations

Agua Hedionda Lagoon is comprised of three segments: "outer", "middle", and "inner". The lagoon segments were originally dredged to a mean depth of 2.4 m (8 ft) relative to mean water level (MWL) in 1954. The horizontal areas of the outer, middle, and inner segments at MHW are 267,000 m^2 (66 acres), 110,000 m^2 (27 acres) and 1,200,000 m^2 (295 acres), respectively (Table 5-2). The tidal prism of the outer segment was calculated as 246,696 m^3 (200 acre ft) and for the middle and inner segments as 986,785 m^3 (800 acre ft). The individual volumes of the middle and inner tidal prisms were estimated to be 82,860 m^3 and 903,925 m^3 using weighting by areas. The volumes of the three segments below mean water level were computed as the volume below mean high water minus half the tidal prism (Table 5-2).

TABLE 5-2

VOLUMES OF THE OUTER, MIDDLE, AND INNER SEGMENTS OF THE AGUA HEDIONDA LAGOON

	Design Depth (m re: MWL)	Area (m^2 re: MHW)	Volume (m^3 re: MHW)	Volume (MWL) (m^3 MHW-.5 Prism)
Outer	2.4	267,000	791,356	668,006
Middle	2.4	110,000	326,027	284,597
Inner	2.4	1,200,000	3,556,656	3,104,696
Total		**1,577,000**	**4,674,039**	**4,057,299**

Figure 5-1 shows the sampling blocks used to calculate near shore source water volume. Sampling done in five (the "N" blocks) of the nine blocks was assumed to be representative of alongshore and offshore variation in abundances and therefore the volume from all nine blocks was used in calculating source water abundances. The volumes for these sampling blocks were calculated from bathymetric data for the coastal areas around Carlsbad using ArcGIS software. The total volume in these nine blocks was estimated at 283,303,115 m^3 (Table 5-3).

SDG&E have completed a three-month deployment (June, August, and November 1979) of two Endeco current meter seaward of the outer lagoon entrance. Highest current speeds occurred further offshore, with 10.06 cm/s being the average current speed. The furthest offshore station was over a bottom depth of about 24.4 m (80 ft) at California State plane 355,800 N and 6,625,000 E. The meter was set –3 m below the surface. SCCWRP reported similar current speeds with median offshore currents at Carlsbad of 8.6 cm/s in winter and 7.0–9.5 cm/s in summer from a mid-depth position over a 45 m bottom from 1979–1990.

TABLE 5-3

VOLUMES OF NEAR SHORE SAMPLING BLOCKS USED IN CALCULATING SOURCE WATER ABUNDANCES

Block	Depth (m re: MWL)	Area (m^2 re: MHW)	Volume (m^3 re: MHW)
N1	-5.3	1,195,366	5,959,236
N2	-6.4	1,653,677	9,840,181
N3	-5.6	1,775,546	9,247,259
SW1	-14.8	1,055,516	15,633,525
N4	-18.5	1,359,040	25,081,478
SW2	-17.9	1,711,379	30,499,399
SW3	-27.8	1,312,832	36,386,864
N5	-38.5	1,661,891	63,329,174
SW4	-42.8	2,046,985	87,325,998
Total		**13,772,232**	**283,303,115**

The three months of currents reported in SDG&E in 1980 were rotated to the coastline direction at the Encina Power Station (36 degrees W of N). The average current vector components were 1.702 cm/s downcoast and 0.605 cm/s offshore.

A current meter was placed in the near shore between Stations N4 and N5. The data from the meter was used to characterize currents in the near shore area that would directly affect the dispersal of planktonic organisms that could be entrained by the power plant. The data were used to define the size of the near shore component of the source water by using the current speed and the estimated larval durations of the entrained organisms.

Source water volume and depths of Agua Hedionda Lagoon were very carefully determined based on recent hydrodynamic studies of Agua Hedionda Lagoon.

5.3.4 ETM Modeling for Carlsbad Desalination Project

The effect of the proposed CDF operations on source water populations of larval fishes was evaluated in three steps. First, by computing estimates of the incremental mortality that could result from the desalination facility source seawater withdrawal over a one-day period, second by using the incremental mortality to estimate mortality over the period that the larvae are exposed to water withdrawals, and finally by placing these estimates into context based on empirical data of the number of larvae that survive EPS entrainment and are alive at the point of source seawater water withdrawal by the proposed desalination facility.

The estimate of daily incremental mortality, or proportional entrainment (*PE*), was computed as the ratio of the number of larvae in the water withdrawn by the proposed facility to the number of larvae in the surrounding source water. The estimate of the number of larvae in the water withdrawn is calculated using the average concentration of larvae from samples that were collected inside the EPS cooling water intake system at a point close to the location where the desalination facility would withdraw its water.

The average concentration and variance were calculated for the in-plant surveys conducted on June 10, 2004 and May 19, 2005. The average concentration and variance from these two surveys were then used to calculate estimates of the average in-plant concentration and variance. The average variance from the two surveys was used since it best reflected the level of variation among samples over a 24-hr period. The average concentration was multiplied by desalination facility's maximum feedwater withdrawal volume of 1,150,640 m^3/day (304 MGD) to simulate effects under maximum operating conditions. Similar calculations were used to estimate the source water populations of larvae that would be affected by the proposed CDF operations. Average concentrations of larval fishes from stations in the inner, middle, and outer segments of Aqua Hedionda Lagoon, and stations in the ocean directly offshore from EPS were calculated from the thirteen surveys conducted from June 10, 2004 to May 19, 2005. The average concentrations were multiplied by the volume estimates for each of the water body segments and then combined to estimate the average source water population.

Sources of Variance in ETM

The major sources of variance in *ETM* results have been shown to include variance in estimates of larval entrainment concentrations, source water concentrations, and larval duration, in this order. Variance in estimates of entrainment and source water concentrations of fish larvae is due to spatial differences among stations, day and night diurnal changes, and temporal changes between surveys.

ETM Results

Estimates of desalination intake and source water populations for the fish taxa evaluated are presented in Table 5-4 were based on entrainment and source water data for the sampling period of June 10, 2004 to May 19, 2005. The following documents related to Poseidon's Entrainment Study are enclosed.

- Attachment 2 – Impingement Results, G1 – Traveling Screen and bar Rack Weekly Surveys, G2 – Heat Treatment Surveys

- Attachment 3 – Proposal for Information Collection Clean Water Act Section 316(b), Encina Power Station, Cabrillo Power I LLC, NPDES Permit No. CA0001350, April 1, 2006

- Attachment 4 – Updated Impingement and Entrainment Assessment, Tenera Environmental, May 2007

- Attachment 5 – Carlsbad Desalination Facility – Summary of Fish and Target Shellfish Larvae Collected for Entrainment and Source Water Studies in the Vicinity of Agua Hedionda Lagoon from June 2005 through May 2006.

TABLE 5-4

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**			

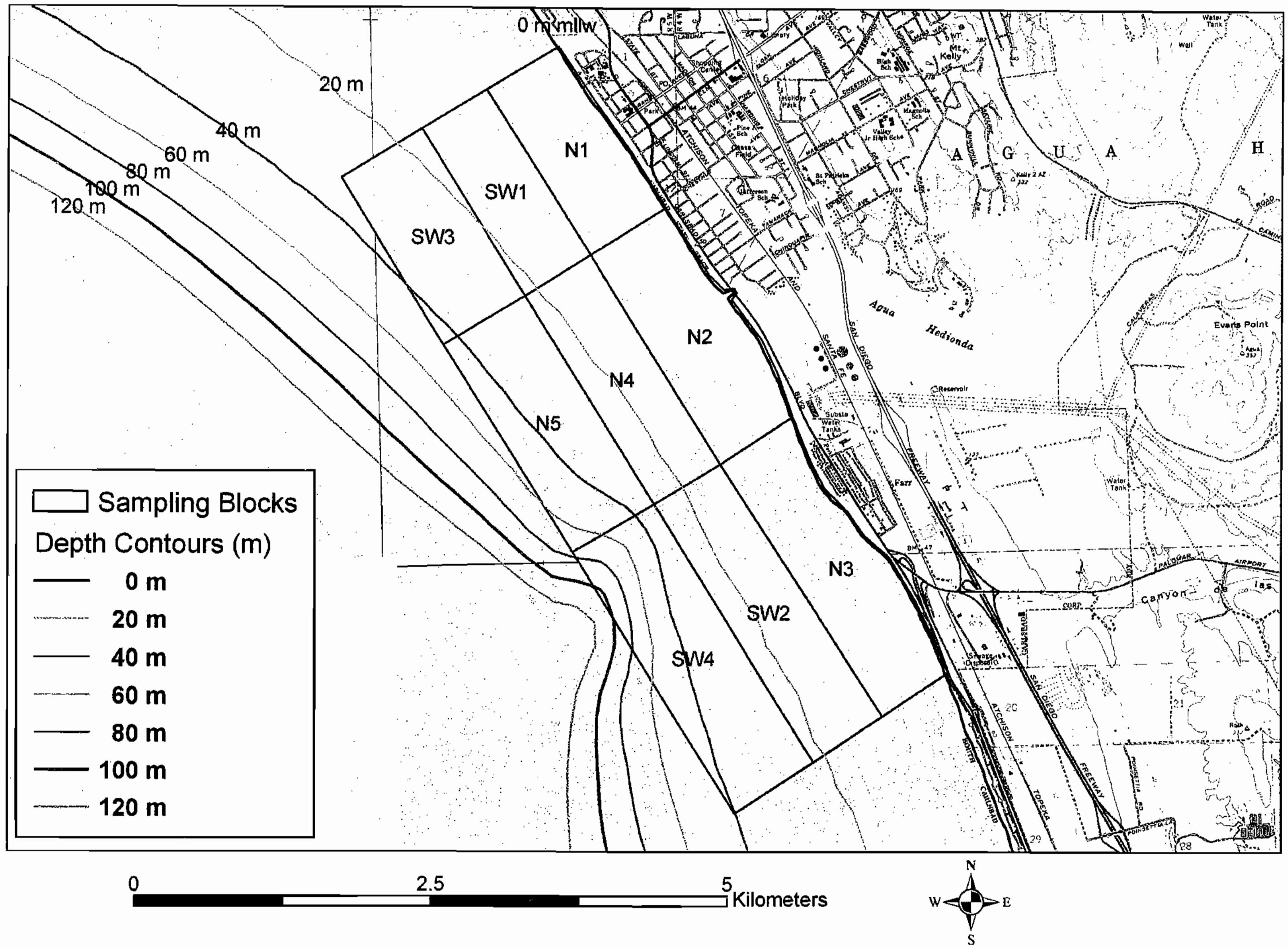

Figure 5-8 Nearshore sampling blocks used to calculate source water volumes

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 AES Huntington Beach Power Generation Plant and 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 very analogous to the proposed Carlsbad Project because both projects are drawing water from the enclosed bays.

5.3.5 Significance of Worst-Case Scenario Entrainment Impacts

As the CEQA lead agency on the Project EIR, the City of Carlsbad found that the entrainment impacts associated with the stand-alone operation of the proposed desalination facility are insignificant and therefore no mitigation is required.[6]

The Coastal Act applies a different standard of review for projects of this nature. The Coastal Act provides that "[m]arine resources shall be maintained, enhanced, and *where feasible* restored."[7] Additionally, the adverse effects of entrainment shall be minimized where feasible.[8] In its approval of the Coastal Development permit for the proposed Project, the Coastal Commission found that Poseidon is "using all feasible methods to minimize or reduce its entrainment impacts" and conditioned the Project to include compensatory mitigation to lessen the effects of unavoidable entrainment and impingement impacts.[9] With the inclusion of this Special Condition 8, the Commission found that the anticipated entrainment and impingement impacts associated with the stand-alone desalination facility would be mitigated to the maximum extent feasible.[10]

5.4 SUMMARY AND CONCLUSIONS

The Coastal Commission found that Poseidon is using all feasible methods to minimize or reduce its impingement and entrainment impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified herein. Nevertheless, as described in Chapter 6, Poseidon has voluntarily committed to restore and enhance sufficient coastal habitat to more than compensate for the Project impacts prior to consideration of benefits to be derived form the minimization measures.

Ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations

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[6] See Final Environmental Impact Report EIR 03-05
[7] Coastal Act Sections 30230.
[8] Coastal Act Sections 30231.
[9] See Coastal Commission draft findings for Poseidon Carlsbad Desalination Project, pages 53 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf
[10] See Coastal Commission draft findings for Poseidon Carlsbad Desalination Project, pages 3 and 4 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations. This approach will ensure that the stand-alone CDP operations continue to use the best technologies to minimize impacts to marine life and are mitigated to the maximum extent feasible.

CHAPTER 6

MITIGATION

INTRODUCTION

Pursuant to Water Code Section 13142.5(b), this Chapter establishes a state-agency coordinated process for identification of the best available mitigation feasible to minimize Project related impacts to marine life..

- *Section 6.1 describes the proposed approach to mitigation.*
- *Section 6.2 describes the assessment of the impacted area.*
- *Section 6.3 provides an assessment of the wetlands restoration needed to compensate for entrainment impacts of the desalination facility stand-alone operations.*
- *Section 6.4 describes the restoration plan development and related benefits.*
- *Section 6.5 describes opportunities for restoration and preservation of Agua Hedionda Lagoon.*
- *Section 6.6 describes opportunities for an offsite restoration program in San Dieguito Lagoon.*
- *Section 6.7 describes the regulatory assurances that are in place to insure the adequacy of the restoration plan.*

6.1 PROPOSED MITIGATION APPROACH

Poseidon is using all feasible methods to minimize or reduce its entrainment impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified in Chapter 5. To minimize unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of this plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving the goals.

Recognizing that mitigation opportunities in Agua Hedionda Lagoon may be limited, Poseidon proposes a comprehensive but flexible approach for mitigating potential impacts. This approach is based on:

- Conservatively estimating maximum potential impacts (see Section 6.2),

- Identifying goals and objectives of the mitigation program (see Section 6.4.1),
- Identifying any available mitigation opportunities in Agua Hedionda Lagoon that meet the goals and objectives (see Section 6.5),
- Identifying additional offsite mitigation that meets the mitigation goals (see Section 6.6).
- Developing an action plan and schedule for coordinating with regulatory and resource agencies to finalize locations and acreages selected for the proposed mitigation.

Investigations to date have not identified any mitigation opportunities within Agua Hedionda Lagoon (see Section 6.5) that meet the goals of the program. As a result, the proposed mitigation plan includes a core offsite mitigation program that meets the plan goals and objectives that is being developed in parallel with Poseidon's continued effort to identify feasible mitigation opportunities in Agua Hedionda Lagoon.

Poseidon recognizes the need and priority of implementing mitigation in Agua Hedionda Lagoon if feasible. Poseidon also recognizes that mitigation requirements and regulations of the various review agencies differ, and additional agency coordination is required to insure that needs of all applicable agencies are addressed.

Accordingly, while this plan identifies a core offsite mitigation project, the mitigation plan also presents an implementation action schedule that includes additional coordination activities to either (1) confirm the lack of opportunities, or (2) identify if new mitigation options exist within Agua Hedionda Lagoon.

Under the proposed plan, if subsequent Agua Hedionda Lagoon mitigation is determined to be feasible, Poseidon will coordinate with regulatory agencies to implement such mitigation.

If Agua Hedionda Lagoon mitigation is confirmed as infeasible, Poseidon will implement the proposed offsite mitigation project. Further, it is recognized that the degree of mitigation required will be dependent on mitigation ratio requirements of the various regulatory agencies. As a result, the proposed plan provides for additional coordination with the regulatory agencies to finalize agency-mandated acreage requirements.

Table 6-1 summarizes the implementation action schedule for the proposed plan.

Table 6-1
Mitigation Implementation Approach and Schedule

Element	Actions/Objectives	Schedule
Submittal of draft Minimization Plan to Regional Board	• Public and agency review of revised draft Plan	March 2008
Regional Board consideration of Minimization Plan	• Approval of Plan • Regional Board provides directions on Plan implementation	April 2008
Contacts with California Department of Fish & Game to assess mitigation opportunities in Agua Hedionda Lagoon	• Assess mitigation opportunities for saltwater marsh creation in Agua Hedionda Lagoon via dredging	March 2008
Supplemental contacts with other resource agencies	• Identify (or conform lack of) additional mitigation opportunities in Agua Hedionda Lagoon	April 2008
Convene meeting of resource agencies; Regional Board and Coastal Commission.	• Identify (or confirm lack of) additional mitigation opportunities in Agua Hedionda Lagoon • If applicable, address agency requirements for Agua Hedionda Lagoon mitigation and determine overall implementation feasibility • Address mitigation rations/requirements for core offsite mitigation project in San Dieguito Lagoon	April 2008
Finalize and distribute mitigation program implementation details	• Agency review of implementation details	May 2008
Modify/finalize implementation program details (if applicable)	• Agency review and approval • May involve additional inter-agency coordination meeting	June 2008
Coastal Commission consideration of mitigation project(s)	• Coastal Commission approval of mitigation project	July 2008

Ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations.

This approach will insure that the stand-alone CDP operations continue to use the best available site, design, technology and mitigation feasible to minimize Project related impacts to marine life.

6.2 CONSERVATIVE ASSESSMENT OF IMPACTED AREA

The assessment of the impacted area due to the desalination facility operation is based on a conservative assumption that the CPD will cause 100 percent mortality to the marine organisms in the seawater diverted from Agua Hedionda Lagoon. This approach to establishing the impact of the desalination plant operation is extremely conservative in that it ignores the design and technology features that have been incorporated in the proposed Project. The following design and technology features are expected to substantially lessen the impacts to marine life.

- **EPS once-through cooling system is expected to continue operating indefinitely.** The magnitude of the entrainment losses identified in Chapter 5 is estimated for continuous operation of the desalination plant on a stand-alone basis notwithstanding the fact that the EPS generating units will be available for service indefinitely. Cal-ISO would ultimately determine when they are no longer needed for grid reliability. In the meantime, seawater pumping by the EPS would likely meet a substantial portion of the CPD flow requirements (e.g., 61 percent in 2007), resulting in a comparable reduction of entrainment and impingement impacts attributable to the CDP.

- **Desalination facility impacts reduced impacts due to modified use of existing facilities.** Potential entrainment mortality that occurs within the existing power plant screens, pumps and condensers upstream of the desalination facility intake would be substantially reduced due to the relatively lower temperature, volume, velocity and turbulence of the desalination operations compared to that of the power plant.

- **Two-thirds of the water is returned to the ocean without further processing.** Only 35 percent of the seawater (104 MGD) actually enters the desalination plant and is subjected to additional processing that would potentially add to the entrainment mortality. The reminder of the seawater (200 MGD) bypasses the desalination facility and is returned to the ocean.

- **Desalination facility incorporates technology to capture marine organisms and return them to the ocean unharmed.** Eighty percent of the marine organisms in the seawater that enters the desalination plant retained by the micro-screens and returned to the ocean. The remaining marine organisms that pass through the micro-screens are subsequently rejected by the pretreatment filters and returned to the ocean. A substantial number of the organisms that are returned to the ocean are expected to survive.

6.3 ESTABLISHING RESTORATION REQUIREMENT

Poseidon is proposing to compensate for the unavoidable impact of stand-alone CDP operation by replacing or restoring comparable marine habitat. The proposed restoration plan is based on the Empirical Transport Model described in Chapter 5 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).

In order to calculate the APF, the number of lagoon habitat acreage occupied by the three most commonly entrained lagoon fish larvae[1] was multiplied by the average Proportional Entrainment Mortality (PM) for the three lagoon species identified in Chapter 5 (12.2 percent). The estimated acres of lagoon habitat for these species are based on a 2000 Coastal Conservancy Inventory of Agua Hedionda Lagoon habitat shown in Table 6-1.[2]

TABLE 6-1

WETLAND PROFILE: AGUA HEDIONDA LAGOON

Approximate Wetland Habitat Acreage

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	
TOTAL	**391**	***(Riparian not included)***

[1] Ninety-eight percent of the fish larvae that would be entrained by the CDP stand-alone operations are gobies, blennies and hypsopops.

[2] The actual acreage will be confirmed through a survey of the lagoon habitats that will be conducted during the final design of Poseidon's Coastal Habitat Restoration and Enhancement Program. To the extent that the lagoon habitat acreage established in the survey is higher or lower than that included in the 2000 Inventory, The wetlands restoration plan would be proportional adjusted to account for the actual acreage identified in the survey.

The areas of Agua Hedionda Lagoon that have potential to be impacted by the CDP operations are those habitats occupied by the three most commonly entrained lagoon fish larvae. These habitats include 49 acres of mudflat/tidal channel and 253 acres of open water. It is not appropriate to include the other lagoon habitats in the APF calculation, such as brackish/freshwater, riparian, salt marsh or upland habitats that are not occupied by the impacted species.

By definition, the APF equals the acres of the lagoon habitat that have the potential to be impacted by the intake operations (302 acres) times the average PM:

$$APF = 302 \ acres \ x \ 0.122 = 36.8 \ acres.$$

Thus, entrainment effect of the stand-alone operation of the desalination plant extends over 12.2 percent, or 36.8 acres of Agua Hedionda Lagoon. The restoration area needed to fully mitigate the stand-alone CDP entrainment losses is 36.8 acres.[3] The restoration requirement is estimated under worst-case conditions when the power plant is no longer operating and the existing pumps are operated solely to deliver 304 MGD of seawater for the operation of the desalination plant.

It is generally accepted that this approach results in an overestimate of the number acres that would be necessary to fully mitigate the CDP entrainment and impingement effects, resulting in a net enhancement of the coastal habitat. This is because the restored habitat provides significant environmental benefits that extend well beyond compensating for the entrainment impacts. For example, the APF calculation does not take into account the enormous ecological value of the restored acreage that will accrue to valuable wetland species completely unaffected by the intake, such as the numerous riparian birds, reptiles, benthic organisms and mammals that will utilize the habitat for foraging, cover and nesting. Nor does the calculation consider the myriad of phytoplankton, zooplankton and invertebrate species that are largely unaffected by the intake operations and benefit directly from the restored wetlands.

Similar to the approach taken throughout this assessment, the APF calculation is also based on a number of very conservative assumptions:

- **Assumes 100 percent mortality of all marine organisms entering the intake.** As indicated previously, this assumption does not take into consideration any of the design and technology features that would be incorporated in the project to avoid impact to marine life. The actual impact to marine life is expected to be substantially lower.

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[3] The methodology used to determine the area impacted by the stand-alone desalination facility operation is based on the recommendation from the Coastal Commission that Poseidon follow the approach used by the California Energy Commission for establishing mitigation requirements for the entrainment effects associated with the operation of the AES Huntington Beach power generation plant.

- **Assumes 100 percent survival of all fish larvae in their natural environment.** In fact, over 90 percent of the fish larvae are lost to predators and do not ever reach adulthood.

- **Assumes species are evenly distributed throughout the entire depth and volume of the water body.** This assumption is very conservative for the site-specific conditions of Agua Hedionda Lagoon because it is well known that some impacted species (i.e., garibaldi) mainly inhabit the rocky area near the entrance to the power plant intake.

- **Assumes the entire habitat from which the entrained fish larvae may have originated is destroyed.** This approach to identifying the restoration requirement for the stand-alone desalination facility assumes that the area of production forgone (APF) is an area of lost habitat for all marine species inhabiting this area. This assumption is extremely conservative because only a small portion of the species inhabiting Agua Hedionda Lagoon would actually enter the power plant intake.

6.4 RESTORATION PLAN DEVELOPMENT

The main objective of the restoration plan is to implement one or more activities which preserve, restore and enhance exiting wetlands, lagoons or other high-productivity near-shore coastal areas located in the vicinity of Agua Hedionda Lagoon and/or elsewhere in San Diego County. Examples of types of activities that may be included in the restoration plan include:

- Wetland Restoration;
- Coastal Lagoon Restoration;
- Restoration of Historic Sediment Elevations to Promote Reestablishment of Eelgrass Beds;
- Marine Fish Hatchery Enhancement;
- Contribution to a Marine Fish Hatchery Stocking Program;
- Artificial Reef Development;
- Kelp Bed Enhancement.

6.4.1 Key Goals and Objectives

The main objective of the restoration plan is to implement one or more activities which preserve, restore and enhance exiting wetlands, lagoons or other high-productivity near-shore coastal areas located in the vicinity of Agua Hedionda Lagoon and/or elsewhere in

San Diego County. The key restoration plan goals are:

- Creation or Restoration of Coastal Habitat. The primary objective of the restoration plan is to create or restore coastal habitat similar to that of Agua Hedionda Lagoon, which will provide measurable long term environmental benefits adequate to mitigate potential impingement and entrainment impacts associated with CDP operations.

- Development of Technically Feasible Project. The restoration plan will rely on well-established methods, techniques and technologies for development and nurturing of coastal habitat of high productivity and long-term sustainability.

- Stakeholder Acceptance for the Selected Project. Implementation of project(s) with a well-defined scope and high priority for the host community and resource agencies and organizations in charge of coastal habitat preservation, restoration development.

- Ability to Measure Performance. The restoration plan will target coastal restoration and enhancement activities with clearly defined methodology to measure performance and success.

6.4.2 Identification of Alternatives

In order to identify suitable coastal habitat enhancement alternatives, on August 31, 2007, Poseidon issued a request for expression of interest (REI) for development and implementation of coastal habitat restoration project associated with the Carlsbad. To date, Poseidon has received eight Statements of Interest for coastal restoration and enhancement projects in response to the REI issued in August 2007. Seven of these proposals include specific coastal enhancement opportunities listed below:

1. San Dieguito Coastal Habitat Restoration;

2. City of Oceanside Loma Alta Lagoon Restoration;

3. Aqua Hedionda Lagoon – Land Acquisition for Expansion of Ecological Reserve;

4. Aqua Hedionda Lagoon – Eradication of Invasive Exotic Plants and Restoration of Native Vegetation;

5. Carlsbad Aquafarm at Agua Hedionda Lagoon – Abalone Stock Enhancement;

6. Buena Vista Lagoon Ecological Reserve – Completion of Restoration/Enhancement Plan Environmental Analysis;

7. Frazee State Beach – Coastal Bluff Habitat Restoration.

A summary of the scope and key benefits of each of the seven coastal habitat enhancement projects was submitted to the Regional Board in October 2007.[4]

6.4.3 Key Restoration Project Benefits

The habitat restoration will not only compensate for the unavoidable entrainment and impingement impacts, but will also enhance the coastal environment. The proposed Restoration Plan will create pelagic and benthic habitat, salt marsh and uplands habitat, thereby extending the benefits from the proposed mitigation measure far beyond the area of actual impact of the desalination plant operations. The proposed restoration project will yield the following key benefits:

- Restore coastal wetlands habitat comparable to that found in and around Agua Hedionda Lagoon; and
- Provides sustainable, comprehensive environmental benefits for water quality, habitat diversity for species abundance and for sensitive and endangered species.

6.4.4 Project Deliverables

Poseidon intends to prepare and submit the following deliverables to the Coastal Commission and the Executive Director of the Regional Board: for review and approval of this restoration plan:

- Restoration Project Implementation Plan which will contain the following:
  - Goals, objectives, performance criteria and maintenance and monitoring to ensure the success of the proposed Restoration Plan.
  - Identification of specific creation, restoration, or enhancement measures that will be used at each site, including grading and planting plans, the timing of the mitigation measures, monitoring that will be implemented to establish baseline conditions and to determine whether the sites are meeting performance criteria.
  - Identification of contingency measures that will be implemented should any of the mitigation sites not meet performance criteria.

[4] Poseidon Resources, *Coastal Habitat Restoration and Enhancement Project*, October 2007.

- As-built plans for each site included in the Restoration Project.
- Annual monitoring reports for no less than five years or until the sites meet performance criteria.
- Legal mechanism(s) proposed to ensure permanent protection of each site – e.g., conservation easements, deed restriction, or other methods.

6.5 OPPORTUNITIES FOR RESTORATION AND PRESERVATION OF AGUA HEDIONDA LAGOON

6.5.1 Agua Hedionda Lagoon Restoration Opportunities

Poseidon has made a considerable effort to identify a restoration project in Agua Hedionda Lagoon. We sent our August 2007 Request for Expressions of Interest to a number of the organizations and individuals that are involved with the Carlsbad Watershed Network (CWN), as well as Carlsbad Aqua Farm, Hubbs Research Institute and the Agua Hedionda Lagoon Foundation. Three proposals were received from Agua Hedionda Lagoon interests:

1. Expansion of Agua Hedionda Lagoon Ecological Reserve

Project Proponent.
The proponent for this project is the Agua Hedionda Lagoon Foundation.

Project Scope
This project includes the acquisition and preservation of land near the Agua Hedionda Lagoon's Ecological Reserve to serve as a coastal habitat for wildlife and migratory birds. The land is located on the north side of Agua Hedionda Lagoon.

Project Benefits and Merits
This project will provide a means for protecting and increasing habitat for migrating birds and endangered species. It also will help insure that nearby archeological sites will remain undisturbed and adjacent Ecological Reserve is maintained as useful wildlife habitat. Foot trails through the Reserve will be proposed to the Department of Fish & Game in exchange for adding land to the Reserve. Enhancing the quality of the Agua Hedionda Lagoon Ecological Reserve will also boost eco-tourism in the area. The project is planned to be completed by the end of year 2010.

2. Agua Hedionda Lagoon – Eradication of Invasive Exotic Plants and Restoration of Native Vegetation

Project Proponent
The proponent for this project is the Agua Hedionda Lagoon Foundation.

Project Scope
The density, biomass and diversity of invasive plant species in the Agua Hedionda Lagoon Watershed are so extensive, that the ability of the natural plant communities to treat nutrients and contaminants from surface runoff into the lagoon has been diminished significantly. The scope of this project is to remove exotic invasive plant species and replace these species with appropriate native plants to restore the protective function of the lagoon watershed vegetation. The project is planned to be completed by December 2009.

Project Benefits and Merits
This project aims to restore the native vegetation in the Agua Hedionda Watershed, which is an essential step towards re-establishing the hydrologic and ecological functions of these riparian and coastal wetland habitats. The project is expected to boost the natural ability of the native riparian and wetland plant habitats to sequester contaminants carried to the lagoon by surface runoff, to reduce flooding and bank erosion, and diminish sediment transport thereby increasing the biological productivity of the Agua Hedionda Lagoon.

3. Agua Hedionda Lagoon – Abalone Stock Enhancement

Project Proponent
The proponent for this project is Carlsbad Aquafarm.

Project Scope
This project will create a stock of 100,000 abalone at the Carlsbad Aquafarm located in the Agua Hedionda Lagoon and use this stock to replenish the population of abalone near the intake to the lagoon and the project discharge area. Carlsbad Aquafarm is currently concentrating its efforts on commercial farming of the Green Abalone and also culturing both Red and Pink Abalone. The farm is well equipped with the facilities and personnel to spawn and raise abalone, as well as experienced divers familiar with abalone biology and ecology to manage and monitor the success of the project. The abalone stock enhancement project can be completed by 2011.

Project Benefits and Merits
Abalone is a key part of the Southern California coastal ecosystem. However, aggressive harvesting of this aquatic resource has resulted in stock depletion and the recent closure of both commercial and recreational fisheries for all abalone species in this region. This project will help replenish and sustain the abalone stock in the area of the Agua Hedionda Lagoon.

6.5.2 Investigation of Additional Restoration Opportunities in Agua Hedionda Lagoon

Investigations to date have not identified any mitigation opportunities within Agua Hedionda Lagoon that meet the goals of the program. As a result, the proposed mitigation plan includes a core offsite mitigation program that meets the plan goals and objectives that is being developed in parallel with Poseidon's continued effort to identify feasible mitigation opportunities in Agua Hedionda Lagoon.

Poseidon recognizes the Regional Board would prefer to see mitigation in Agua Hedionda Lagoon if feasible. Accordingly, while Section 6.6 of this plan identifies a core offsite mitigation project, the mitigation plan also presents an implementation action schedule that includes additional coordination activities to either (1) confirm the lack of opportunities, or (2) identify if new mitigation options exist within Agua Hedionda Lagoon.

Poseidon and will be contacting the Department of Fish & Game to more fully assess the potential for restoration opportunities in Agua Hedionda Lagoon. If Agua Hedionda Lagoon mitigation is determined to be feasible, Poseidon will coordinate with regulatory agencies to implement such mitigation. If Agua Hedionda Lagoon is confirmed to be infeasible, Poseidon will implement the proposed offsite mitigation project (Section 6.6).

6.5.3 Agua Hedionda Lagoon Preservation Opportunities

As shown in Figure 6-3, Agua Hedionda Lagoon currently supports a wide range of beneficial uses, including recreational activities, such as fishing, and water contact recreation. 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 renews the Lagoon's water quality and flush nutrients, sediment and other watershed pollution, particularly from the Lagoon's upper reaches. In addition, the inflow of fresh supplies of ocean 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.

The 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. 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, Poseidon has committed to 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. To help ensure the long-term health and vitality of Agua Hedionda Lagoon and the surrounding watershed, Poseidon is funding watershed education programs at the Agua Hedionda Lagoon Foundation Discovery Center.

6.6 OFFSITE MITIGATION PROGRAM

One proposal was received that meets or exceeds the restoration plan objectives is the proposed San Dieguito Wetland Restoration Plan. The proponent of the project is the San Dieguito River Park Joint Powers Authority (JPA). The JPS's proposal is one part of a larger restoration project that has already been approved by the Coastal Commission, on October 12, 2005.[5] Additionally the San Dieguito Wetland Restoration Plan was the subject of a Final Environmental Impact Report that was prepared and certified by the San Dieguito River Park Joint Powers Authority and U.S. Fish and Wildlife Service.

Pursuant to the requirements of the Coastal Commission,[6] Southern California Edison (SCE) is creating 115 acres of tidal wetlands at San Dieguito and will keep the river mouth open in perpetuity. The San Dieguito Wetlands Restoration Project includes a new deep water lagoon on the west side of I-5, extensive finger channels on the east side of I-5 north of the river, California least tern nesting sites and berms along the river to keep the water in the riverine channel flowing to the sea without dropping sediment or flooding the newly created wetlands under normal conditions.

The proponent for Poseidon's proposed restoration project is San Dieguito River Park Joint Powers Authority (local government agency in partnership with the San Dieguito River Valley Conservancy (501 (c) (3) organization). The JPA is the agency responsible for creating a natural open space park in the San Dieguito River Valley, which will one day extend from the ocean at Del Mar to Volcan Mountain, just north of Julian.

The San Dieguito Lagoon is located approximately 12.5 miles south of Agua Hedionda Lagoon, and has been historically one of the largest lagoons in San Diego County. All property within the proposed restoration project is in public ownership. The JPA is responsible for implementing the San Dieguito River Park Master Plan. Features of the Park Master Plan include trails and interpretive programs, enhancement of the lagoon ecosystem through creation of associated native grassland and coastal sage scrub habitat, expansion of tidal wetlands beyond the SCE project limits, and creation of a series of water quality treatment ponds. The JPA is responsible for maintaining the project area and precluding any uses not consistent with the conservation of wetland habitat.

Poseidon's proposed wetlands restoration project would expand the number of acres of functional wetlands and associated habitat in San Dieguito Lagoon, by supplementing the 115-acre SCE Wetlands Restoration Project. The proposed restoration project will

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[5] CDP # 6-04-88

[6] Id.

create at approximately 37 acres of marine wetlands and seasonal marsh habitat from what is now entirely disturbed land. The current state of the land chosen for this project, results from decades of fill, grading and/or agricultural use, rendering it unsuitable for supporting native species that rely on freshwater/intertidal marsh or upland habitat.

Poseidon's proposed Restoration Project would provide approximately 37 acres of coastal wetland habitat in San Dieguito Lagoon above and beyond what is included in the ongoing SCE Wetland Restoration Project. The majority of the coastal habitat will be marine wetlands located at or below the elevation of the mean high tide for this area. As shown in Figures 1 and 2, the key elements of the project are excavation and grading to create new tidal wetlands (Parcel 1), including sub-tidal, intertidal, transitional, and seasonal salt marsh habitats east of I-5.

The central feature of the proposed restoration project is the conversion of disturbed land to more valuable tidal salt marsh or open water wetland which will become a productive in-kind habitat for species similar to these impacted by impingement and entrainment related to the stand-alone desalination plant operations (i.e., gobies, blennies, etc.). All of the acreage that will be converted to tidal wetland habitat is currently disturbed upland that supports weedy, generally non-native (ruderal) vegetation. After restoration to tidal salt marsh, these habitats will be subject to tidal action throughout the year, which will enable salt marsh plants to be healthier and with higher productivity. These goals will be accomplished by grading the site to substantially create an area that is subject to regular tidal inundation.

The restoration site will be graded to match subtidal and the low tidal salt marshes of the San Dieguito Lagoon Restoration Project being constructed by Southern California Edison. Since the new wetlands will be connected to the existing tidal basin through the existing Dieguito River channel, the tidal exchange will maintain the physical and chemical conditions in the these wetlands such that marine and tidal salt marsh species (such as gobies and blennies) will be able to inhabit, disperse and persist in the wetlands created by the Poseidon's restoration project. Since Southern California Edison has already committed to maintain the mouth of the lagoon open in perpetuity, tidal circulation in the proposed new wetlands will be unrestricted.

Based on the biological survey of the existing tidal wetlands of the San Dieguito Lagoon completed as a part of the Southern California Edison Restoration Project,[7] these wetlands are of the same type of habitat that would be impacted by desalination plant operations (i.e., gobies, blennies, anchovy, topsmelt, white croaker, etc.). Therefore, the implementation of the proposed restoration project will create in-kind replacement habitat, which has 1:1 restoration value. The 1:1 restoration ratio of the proposed project is consistent with the methodology used by the California Energy Commission for establishing mitigation requirements for the entrainment effects associated with the operation of the AES Huntington Beach and Morro Bay power generation plants.

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[7] SCE, *San Dieguito Wetlands Restoration Project, Final Restoration Plan*, November 2005

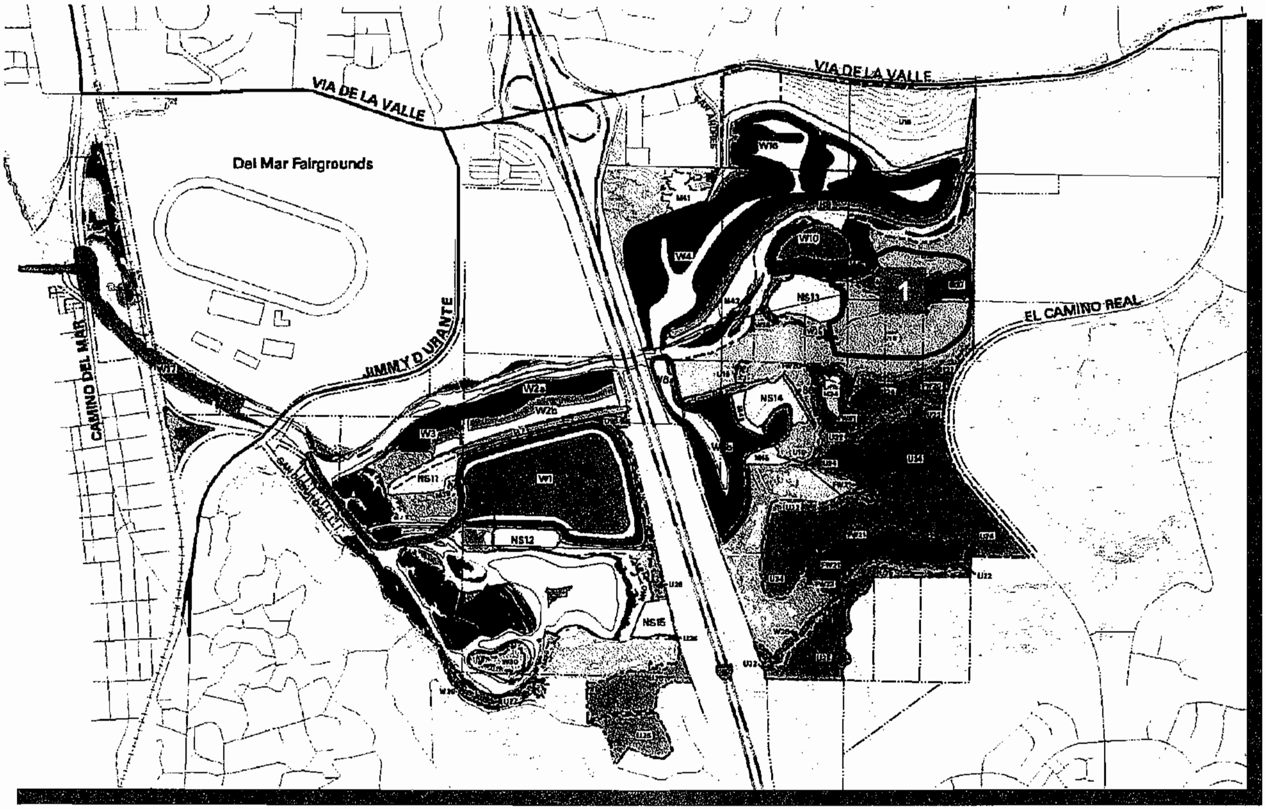

Figure 6-1 – San Dieguito Wetlands Restoration Project

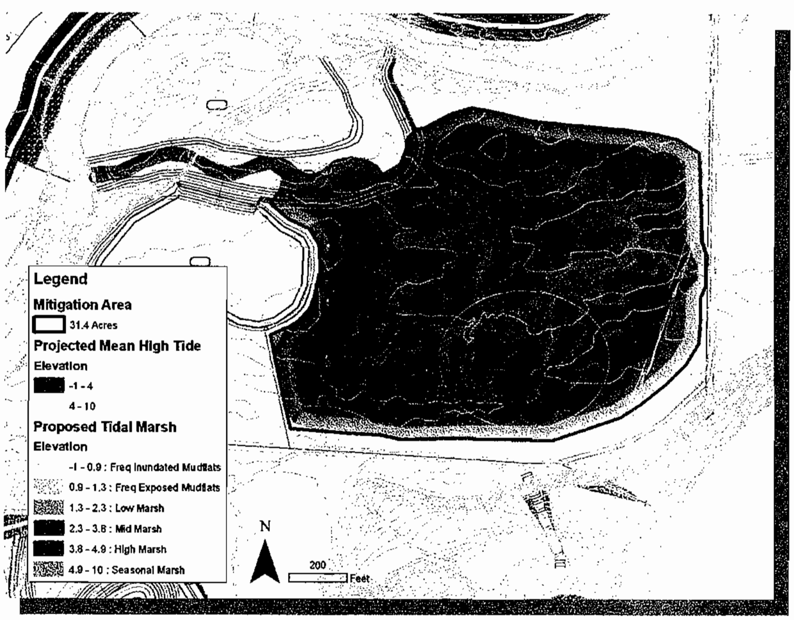

Figure 6-2 – Proposed Restoration Site

The Coastal Commission found this location to be acceptable for mitigation of the entrainment and impingement impacts of the San Onofre Nuclear Generating Station which is 45 miles away from San Dieguito Lagoon and is impacting open water fish species that don't necessarily reside in a lagoon environment. The proposed desalination facility is much closer to the proposed mitigation site (12 miles) and Poseidon is proposing to replace tidally exchanged coastal lagoon habitat with in-kind habitat.

6.7 REGULATORY ASSURANCE OF RESTORATION PLAN ADEQUACY

There are a number of regulatory assurances in place to confirm the adequacy of the proposed restoration plan. The Regional Board, Coastal Commission and State Lands Commission have ongoing jurisdiction over the proposed Project to insure the adequacy of the proposed restoration plan.

6.7.1 Regional Board

The Regional Board is insuring that Poseidon will provide adequate mitigation consistent with Water Code Section 13142.5(b) through the imposition of Special Condition 12 in the draft Lease Amendment for the proposed project:[8]

> *b. California Water Code Section 13142.5(b) Applicability. Water Code Section 13142.5(b) requires industrial facilities using seawater for processing to use the best available site, design, technology, and mitigation feasible to minimize impacts to marine life. The CDP is planned to operate in conjunction with the EPS by using the EPS cooling water discharge as its source water. When operating in conjunction with the power plant, the desalination plant feedwater intake would not increase the volume or the velocity of the power station cooling water intake nor would it increase the number of organisms impinged by the Encina Power Station cooling water intake structure. Recent studies have shown that nearly 98 percent of the larvae entrained by the EPS are dead at the point of the desalination plant intake. As a result, a de minimis number of organisms remain viable which potentially would be lost due to the incremental entrainment effect of the CDP operation. Due to the fact that the most frequently entrained species are very abundant in the area of the EPS intake, Agua Hedionda Lagoon and the Southern California Bight, species of direct recreational and commercial value would constitute less than 1 percent of all the organisms entrained by the EPS. As a result, the incremental entrainment effects of the CDP operation in conjunction with the EPS would not trigger the need for additional technology or mitigation to minimize impacts to marine life. However, in the event that the EPS were to cease operations, and the discharger were to independently operate the seawater intake and outfall for the*

[8] Regional Board Order R9-2006-0065 at F-49.

benefit of the CDP, such independent operation will require additional review pursuant to Water Code Section 13142.5(b). The Regional Water Board review and approval of the Flow Minimization, Entrainment and Impingement Minimization Plan will address any additional review required pursuant to Water Code Section 13142.5(b).

With the October 2006 approval Order R9-2006-0065, the Regional Board has ongoing jurisdiction over the Project to insure Poseidon is using the best available design, technology, and mitigation measures at all times consistent with Water Code Section 13142.5(b).

6.7.2 State Lands Commission

The State Lands Commission is insuring that Poseidon will provide adequate mitigation consistent with Public Resources Code 6370, et seq. through the imposition of Special Condition 12 in the draft Lease Amendment for the proposed project:[9]

> *12. Poseidon Resources shall use the best available design, technology, and mitigation measures at all times during which this Lease is in effect to minimize the intake (impingement and entrainment) and mortality of all forms of marine life associated with the operation of the desalination facility as determined by the San Diego Regional Water Quality Control Board or any other federal, state, or local entity.*

With the approval of the approval the draft lease for the Project, the State Lands Commission reserves the right to terminate the lease if Poseidon is not using the best available design, technology, and mitigation measures at all times as determined by the San Diego Regional Water Quality Control Board or any other federal, state, or local entity.

6.7.3 Coastal Commission

The Coastal Commission is insuring that Poseidon will provide adequate mitigation consistent with applicable Coastal Act provisions through the imposition of Special Condition 8:[10]

> ***1) Marine Life Mitigation Plan:*** *PRIOR TO ISSUANCE OF THE PERMIT, the Permittee shall submit to and obtain from the Commission approval of*

[9] State Lands Commission draft Amendment of Lease PRC 8727.1.

[10] See Coastal Commission Recommended Revised Findings Coastal Development Permit for Poseidon Carlsbad Desalination Project, page 91 of 108; http://documents.coastal.ca.gov/reports/2008/3/W25a-3-2008.pdf

a Marine Life Mitigation Plan in the form of an amendment to this permit that includes the following:

a) Documentation of the project's expected impacts to marine life due to entrainment and impingement caused by the facility's intake of water from Agua Hedionda Lagoon. This requirement can be satisfied by submitting a full copy of the Permittee's Entrainment Study conducted in 2004-2005 for this project.

b) To the maximum extent feasible, the mitigation shall take the form of creation, enhancement, or restoration of aquatic and wetland habitat

c) Goals, objectives and performance criteria for each of the proposed mitigation sites. It shall identify specific creation, restoration, or enhancement measures that will be used at each site, including grading and planting plans, the timing of the mitigation measures, monitoring that will be implemented to establish baseline conditions and to determine whether the sites are meeting performance critieria. The Plan shall also identify contingency measures that will be implemented should any of the mitigation sites not meet performance criteria.

d) "As-built" plans for each site and annual monitoring reports for no less than five years or until the sites meet performance criteria.

e) Legal mechanism(s) proposed to ensure permanent protection of each site – e.g., conservation easements, deed restriction, or other methods.

With the approval of the Coastal Development permit for the proposed project conditioned as described above the Coastal Commission is insuring that Poseidon will provide the mitigation needed to address Project related impacts in a manner consistent with applicable Coastal Act provisions.

6.8 SUMMARY AND CONCLUSIONS

Poseidon is using all feasible methods to minimize or reduce its entrainment impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified in Chapter 5. To minimize unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of this plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving the goals.

As shown in Table 6-2, the proposed mitigation strategy includes the implementation of project a coastal wetlands restoration plan that will be developed pursuant to the state-agency coordinated process; long-term preservation of Agua Hedionda Lagoon; and/or other activities which will benefit the coastal environment in San Diego County. The restoration plan will be enforceable through conditions of approval of the project and the program's success will be monitored through performance standards, monitoring and reporting.

Additionally, ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations.

This approach will insure that the stand-alone CDP operations continue to use the best available site, design, technology and mitigation feasible to minimize Project related impacts to marine life.

Table 6-2
Mitigation

Category	Feature	Result
1. Mitigation	Implementation of project mitigation plan developed pursuant to a state-agency coordinated process described in Chapter 6.	Compensate for the unavoidable entrainment and impingement impacts and enhance the coastal environment.
2. Mitigation	Preservation of Agua Hedionda Lagoon though continued maintenance dredging and Lagoon stewardship.	Preserve and protect 388 acres of highly productive marine habitat; maintain and enhance opportunities for public access and recreation; provide sand for beach replenishment and grunion spawning habitat; maintain adequate water quality to support aquaculture, fish hatchery and natural fish habitat; and provide San Diego County with a new high-quality drinking water supply.
3. Mitigation	Funding watershed education programs at the Agua Hedionda Lagoon Foundation Discovery Center	Helps ensure the long-term health and vitality of Agua Hedionda Lagoon and the surrounding watershed

CHAPTER 7

CONCLUSION

7.1 PLAN PURPOSE

The San Diego Regional Water Quality Control Board (Regional Board) adopted Order No. R9-2006-0065 (Permit) for Poseidon Resources Corporation's (Poseidon) Carlsbad Desalination Project (CDP) discharge to the Pacific Ocean via the existing Encina Power Station (EPS) discharge channel. The CDP is planned to operate in conjunction with the EPS by using the EPS cooling water discharge as its source water whenever the power plant is operating.

In the event that the EPS were to cease operations, and Poseidon were to independently operate the seawater intake and outfall for the benefit of the CDP, such independent operation will require additional review pursuant to Water Code Section 13142.5(b). Water Code Section 13142.5(b) requires industrial facilities using seawater for processing to use the best available site, design, technology, *and* mitigation feasible to minimize impacts to marine life.

This Flow, Entrainment and Impingement Minimization Plan (Plan) is developed in fulfillment of the above-stated requirements and contains site-specific activities, procedures, practices and mitigation plans which Poseidon proposes to implement to minimize impacts to marine organisms when the Carlsbad Desalination Project intake requirements exceed the volume of water being discharged by the EPS.

7.2 PLAN COMPLIANCE

As shown in Table 7-1, the Plan addresses each of the provisions of Water Code Section 13142.5(b):

- Identifies the best available site feasible to minimize Project related impacts to marine life;
- Identifies the best available design feasible to minimize Project related impacts to marine life;
- Identifies the best available technology feasible to minimize Project related impacts to marine life;
- Quantifies the unavoidable impacts to marine life; and
- Establishes a state-agency coordinated process for identification of the best available mitigation feasible to minimize Project related impacts to marine life.

Table 7-1 Design, Technology and Mitigation Measures to Minimize Impacts to Marine Life		
Category	**Feature**	**Result**
1. Site	Proposed location at Encina Power Station (EPS)	Best available site for the project, no feasible and less environmentally damaging alternative locations.
1. Design	Use of EPS discharge as source water	Sixty-one percent reduction of entrainment and impingement impacts attributable to the CDP
2. Design	Reduction in inlet screen velocity	Reduction of impingement of marine organisms
3. Design	Reduction in fine screen velocity	Reduction of impingement of marine organisms
4. Design	Ambient temperature processing	Eliminate entrainment mortality associated with the elevated seawater temperature
5. Design	Elimination of heat treatment	Eliminate mortality associated with heat treatment.
1. Technology	Installation of VFDs on CDP intake pumps	Reduce the total intake flow for the desalination facility to no more than that needed at any given time, thereby minimizing the entrainment of marine organisms.
2. Technology	Installation of micro-screens	Micro-screens (120 μ) minimize entrainment and impingement impacts to marine organisms by screening the fish larvae and plankton from the seawater.
3. Technology	Installation of low impact prefitration technology	UF filtrations system minimizes entrainment and impingement impacts to marine organisms by screening the small plankton from the seawater.
4. Technology	Return to the ocean of marine organisms captured by the screens and filters	Minimize entrainment and impingement impacts to marine organisms captured by the screens and filters by returning the organisms to the ocean.
5. Technology	After ten years of operation, State Lands Commission (SLC) to analyze environmental effects of facility and the availability of alternative technologies that may reduce any impacts.	SLC may require Poseidon install additional technology as are reasonable and as are consistent with applicable state and federal laws and regulations. This ensures that the CDP operations at that time are using technologies that the SLC determines may reduce any impacts and are appropriate in light of environmental review.
1. Mitigation	Implementation of project mitigation plan developed pursuant to a state-agency coordinated process described in Chapter 6.	Compensate for unavoidable entrainment and impingement impacts and enhance the coastal environment.
2. Mitigation	Preservation of Agua Hedionda Lagoon though continued maintenance dredging and Lagoon stewardship.	Preserve and protect highly productive marine habitat; maintain and enhance opportunities for public access and recreation; provide sand for beach replenishment and grunion spawning habitat; maintain adequate water quality to support aquaculture, fish hatchery and natural fish habitat; and provide a new high-quality water supply.
3. Mitigation	Fund watershed education programs at the AHL Foundation Discovery Center.	Helps ensure the long-term health and vitality of Agua Hedionda Lagoon and the surrounding watershed.

7.3 PROPOSED MITIGATION APPROACH

Poseidon is using all feasible methods to minimize or reduce its entrainment impacts. These methods are likely to reduce the Project related impacts to marine life well below the levels identified in Chapter 5. To minimize unavoidable Project related impacts to marine life, Poseidon has voluntarily committed to a state-agency coordinated process to identify the best available mitigation feasible. The objective of the mitigation portion of this plan is to identify mitigation needs, set forth mitigation goals, and present a plan and approach for achieving the goals.

Recognizing that mitigation opportunities in Agua Hedionda Lagoon may be limited, Poseidon proposes a comprehensive but flexible approach for mitigating potential impacts. This approach is based on:

- Conservatively estimating maximum potential impacts
- Identifying goals and objectives of the mitigation program
- Identifying any available mitigation opportunities in Agua Hedionda Lagoon that meet the goals and objectives
- Identifying additional offsite mitigation that meets the mitigation goals
- Developing an action plan and schedule for coordinating with regulatory and resource agencies to finalize locations and acreages selected for the proposed mitigation.

Investigations to date have not identified any mitigation opportunities within Agua Hedionda Lagoon that meet the goals of the program. As a result, the proposed mitigation plan includes a core offsite mitigation program that meets the plan goals and objectives that is being developed in parallel with Poseidon's continued effort to identify feasible mitigation opportunities in Agua Hedionda Lagoon.

Poseidon recognizes the need and priority of implementing mitigation in Agua Hedionda Lagoon if feasible. Poseidon also recognizes that mitigation requirements and regulations of the various review agencies differ, and additional agency coordination is required to insure that needs of all applicable agencies are addressed.

Accordingly, while this plan identifies a core offsite mitigation project, the mitigation plan also presents an implementation action schedule that includes additional coordination activities to either (1) confirm the lack of opportunities, or (2) identify if new mitigation options exist within Agua Hedionda Lagoon.

Poseidon will be contacting the Department of Fish & Game to more fully assess the potential for restoration opportunities in Agua Hedionda Lagoon. If subsequent Agua Hedionda Lagoon mitigation is determined to be feasible, Poseidon will coordinate with regulatory agencies to implement such mitigation.

If Agua Hedionda Lagoon mitigation is confirmed as infeasible, Poseidon will implement the proposed offsite mitigation project.

Table 7-2 summarizes the implementation action schedule for the proposed mitigation plan.

Table 7-2
Mitigation Implementation Approach and Schedule

Element	Actions/Objectives	Schedule
Submittal of draft Minimization Plan to Regional Board	• Public and agency review of revised draft Plan	March 2008
Regional Board consideration of Minimization Plan	• Approval of Plan • Regional Board provides directions on Plan implementation	April 2008
Contacts with California Department of Fish & Game to assess mitigation opportunities in Agua Hedionda Lagoon	• Assess mitigation opportunities for saltwater marsh creation in Agua Hedionda Lagoon via dredging	March 2008
Supplemental contacts with other resource agencies	• Identify (or conform lack of) additional mitigation opportunities in Agua Hedionda Lagoon	April 2008
Convene meeting of resource agencies; Regional Board and Coastal Commission.	• Identify (or confirm lack of) additional mitigation opportunities in Agua Hedionda Lagoon • If applicable, address agency requirements for Agua Hedionda Lagoon mitigation and determine overall implementation feasibility • Address mitigation rations/requirements for core offsite mitigation project in San Dieguito Lagoon	April 2008
Finalize and distribute mitigation program implementation details	• Agency review of implementation details	May 2008
Modify/finalize implementation program details (if applicable)	• Agency review and approval • May involve additional inter-agency coordination meeting	June 2008
Coastal Commission consideration of mitigation project(s)	• Coastal Commission approval of mitigation project	July 2008

7.4 REGULATORY ASSURANCE OF PLAN ADEQUACY

There are a number of regulatory assurances in place to confirm the adequacy of the proposed restoration plan. The Regional Board, Coastal Commission and State Lands Commission have ongoing jurisdiction over the proposed Project to insure the adequacy of the proposed restoration plan.

Additionally, ten years after the lease is issued, that the CDP will be subject to further environmental review by the State Lands Commission (SLC) to analyze all environmental effects of facility operations and alternative technologies that may reduce any impacts found. SLC may require additional requirements as are reasonable and as are consistent with applicable state and federal laws and regulations.

This approach will ensure that the stand-alone CDP operations continue to use the best available site, design, technology and mitigation feasible to minimize Project related impacts to marine life.

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- Final Environmental Impact Report
- Verification of All Other Permits or Approvals Applied for by Public Agencies
- City of Carlsbad Resolution No. 2006-156-EIR 03-05
- City of Carlsbad Resolution No. 420-RP 05-12
- City of Carlsbad Ordinance No. NS-805-SP 144 (H)
- City of Carlsbad Ordinance No. NS-806-PDP 00-02
- Planning Commission Resolution No. 6093 – SUP 05-04
- Planning Commission Resolution No. 6092 – CDP 04-41
- Planning Commission Resolution No. 6090 – DA 05-01 / Development Agreement Finding of Fact
- CEQA Mitigation Monitoring and Reporting Program for the FEIR
- Planning Commission Resolution No. 6094 – HMPP 05-08
- Planning Commission Resolution No. 6088 – PDP 00-02
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ATTACHMENT 1

COST ESTIMATE OF SUBSURFACE INTAKE ALTERNATIVES

304 MDG Intake Cost Estimates - October 2007

VERTICAL BEACH WELLS

Total Capacity =		304	MGD
Individual Intake Well Capacity =		1.5	MGD
Duty Number of Intake Wells Needed =		203	
Additional Standby Intakes Needed @ 25 % =		51	
Total Intake Wells Needed =		253	
Minimum Distance Between Wells (Best Case)=		150	ft
Length of Beach Occupied by Wells =		7.2	miles
Land Needed to Install Wells & Support Facilities		8.6	acres
Cost of Installation of Individual Well =	$	1,200,000	per well
Total Costs of Well Installation =	$	304,000,000	
Cost of Seawater Conveyance Pipelines @US$500/ft =	$	18,925,000	
Cost of Intake Booster Pump Stations - =	$	30,400,000	
Cost of Electrical Power Supply for Well Pumps =	$	50,160,000	
Total Construction (Direct) Costs =	**$**	**403,485,000**	
Indirect Costs			
Acquisition of Land to Install Wells & Support Struct. =	$	4,304,408	
Engineering, Design and Procurement @ 25 % =	$	100,871,250	
Environmental Mitigation Costs @ 15 % =	$	60,522,750	
Contingency @ 20 % =	$	80,697,000	
TOTAL INDIRECT COSTS	**$**	**246,395,407.71**	
TOTAL PROJECT EPC COSTS =	**$**	**649,880,408**	

SLANT WELLS - Similar to Dana Point Desal Plant

Total Capacity =		304	MGD
Individual Intake Well Capacity =		5	MGD
Duty Number of Intake Wells Needed =		61	
Additional Standby Intakes Needed @ 25 % =		15	
Total Intake Wells Needed =		76	
Minimum Distance Between Wells (Best Case)=		300	ft
Length of Beach Occupied by Wells =		4.3	miles
Land Needed to Install Wells & Support Facilities		17.4	acres
Cost of Installation of Individual Well =	$	2,400,000	per well
Total Costs of Well Installation =	$	182,400,000	
Cost of Seawater Conveyance Pipelines @US$500/ft =	$	11,250,000	
Cost of Intake Booster Pump Stations - =	$	30,400,000	
Cost of Electrical Power Supply for Well Pumps =	$	31,920,000	
Total Construction (Direct) Costs =	**$**	**255,970,000**	
Indirect Costs			
Acquisition of Land to Install Wells & Support Struct. =	$	8,723,600	
Engineering, Design and Procurement @ 25 % =	$	63,992,500	
Environmental Mitigation Costs @ 15 % =	$	38,395,500	
Contingency @ 20 % =	$	51,194,000	
TOTAL INDIRECT COSTS	**$**	**162,305,600**	
TOTAL PROJECT EPC COSTS =	**$**	**418,275,600**	

HORIZONTAL RANNEY WELLS

Total Capacity =		304	MGD
Individual Intake Well Capacity =		5	MGD
Duty Number of Intake Wells Needed =		61	
Additional Standby Intakes Needed @ 25 % =		15	
Total Intake Wells Needed =		76	
Minimum Distance Between Wells (Best Case)=		400	ft
Length of Beach Occupied by Wells =		5.7	miles
Land Needed to Install Wells & Support Facilities		17.4	acres
Cost of Installation of Individual Well =	$	2,500,000	per well
Total Costs of Well Installation =	$	190,000,000	
Cost of Seawater Conveyance Pipelines @US$500/ft =	$	15,000,000	
Cost of Intake Booster Pump Stations - =	$	30,400,000	
Cost of Electrical Power Supply for Well Pumps =	$	33,060,000	
Total Construction (Direct) Costs =	**$**	**268,460,000**	
Indirect Costs			
Acquisition of Land to Install Wells & Support Struct. =		$ 8,723,600	
Engineering, Design and Procurement @ 25 % =	$	67,115,000	
Environmental Mitigation Costs @ 15 % =	$	40,269,000	
Contingency @ 20 % =	$	53,692,000	
TOTAL INDIRECT COSTS	**$**	**169,799,600**	
TOTAL PROJECT EPC COSTS =	**$**	**438,259,600**	

SUBSURFACE INFILTRATION GALLERY (FUKUOKA TYPE INTAKE)

Total Capacity =		304	MGD
Capacity of Individual Intake Galleries =		101.3	MGD
Duty Intake Galleries Needed =		3	
Additional Standby Intakes Needed @ 0 % =		0	
Total Intake Galleries Needed =		3	
Length x Width x Depth Each Gallery =		5280x400x15	ft
Total Length of Intake System =		3.0	miles
Land Needed to Install Wells & Support Facilities		17.9	acres
Cost of Installation of Individual Gallery =	$	120,000,000	per 100 MGD gallery
Total Costs of Gallery Installation =	$	360,000,000	
Cost of Seawater Conv. Pipelines @US$500/ft =	$	7,922,606	
Cost of Intake Booster Pump Stations - =	$	12,160,000	
Cost of Electrical Power Supply for Well Pumps =	$	18,608,000	
Total Construction (Direct) Costs =	**$**	**398,690,606**	
Indirect Costs			
Acquisition of Land to Install Intake & Support Struct. =	$	8,956,114	
Engineering, Design and Procurement @ 25 % =	$	99,672,652	
Environmental Mitigation Costs @ 15 % =	$	59,803,591	
Contingency @ 20 % =	$	79,738,121	
TOTAL INDIRECT COSTS	**$**	**248,170,478**	
TOTAL PROJECT EPC COSTS =	**$**	**646,861,084**	

NEW OPEN INTAKE - 1,000 FT INTAKE LINE W/ LOW-VELOCITY INTAKE STRUCTURE

Total Capacity =		304 MGD
Length of Intake Pipe =		1000 ft
Land Needed to Install Wells & Support Facilities		2.3 acres
Cost of Installation of Intake Pipe @ US$45,000/ft =	$	45,000,000
Cost of Construction of Ocean Intake Structure =	$	10,500,000
Cost of New Intake Screens =	$	8,000,000
Cost of New Intake Pump Station =	$	24,320,000
Cost of Power Supply for New Pump Station =	$	5,223,000
Total Construction (Direct) Costs =	**$**	**93,043,000**
Indirect Costs		
Acquisition of Land to Install Intake & Support Struct. =	$	1,147,842
Engineering, Design and Procurement @ 25 % =	$	23,260,750
Environmental Mitigation @ 15 % =	$	13,956,450
Contingency @ 20 % =	$	18,608,600
TOTAL INDIRECT COSTS	**$**	**56,973,642.06**
TOTAL PROJECT EPC COSTS =	**$**	**150,016,642**

ATTACHMENT 2

IMPINGEMENT RESULTS

G1 – TRAVELING SCREEN AND BAR RACK WEEKLY SURVEYS

G2 – HEAT TREATMENT SURVEYS

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA001 — **Survey Date: June 24 - 25, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	186	40-84	1.3-15.3	729.7
Engraulis mordax	northern anchovy	46	37-90	0.4-10.5	69.2
Heterostichus rostratus	giant kelpfish	8	81-113	4.1-8.2	47.9
Heterostichus spp.	kelpfish	7	81-118	4.0-12.2	47.8
Anchoa compressa	deepbody anchovy	6	31-107	0.1-11.6	13.7
Engraulidae	anchovies	4	-	1.6	1.6
Atherinops affinis	topsmelt	3	54-115	0.9-18.8	25.5
Porichthys myriaster	specklefin midshipman	3	300-378	210	210.0
unidentified fish	unid. fish	3	34	0.5-2.0	4.4
Hyporhamphus rosae	California halfbeak	2	111-125	10.9-11.7	22.6
Paralabrax spp.	sand bass	2	33-55	0.7-2.0	2.7
Anchoa delicatissima	slough anchovy	1	-	3.0	2.8
Atherinopsidae	silverside	1	46	1.0	1.0
Hypsoblennius spp.	blennies	1	252	267	267.0
Pleuronichthys verticalis	hornyhead turbot	1	291	227	226.5
Sphyraena argentea	California barracuda	1	136	0.8	0.8
Syngnathus leptorhynchus	bay pipefish	1	290	9.7	9.7
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	9	253-410	143-521	1,984.7
Urolophus halleri	round stingray	2	285-337	244-444	688.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	7	15-34	2.0-18.0	66.1
	Total:	**294**			

Survey: EPSIA002 — **Survey Date: June 30 - July 1, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	242	40-115	1.6-31.0	957.0
Roncador stearnsi	spotfin croaker	51	33-205	0.6-106	260.4
Engraulis mordax	northern anchovy	36	35-103	0.2-14.0	57.6
Heterostichus rostratus	giant kelpfish	33	74-128	3.4-16.0	209.8
Atherinops affinis	topsmelt	29	34-115	0.5-15.2	117.3
Strongylura exilis	California needlefish	5	95-142	0.6-2.0	6.1
Hypsopsetta guttulata	diamond turbot	3	104-140	27.7-79.4	173.4
Porichthys myriaster	specklefin midshipman	3	250-305	160-312	633.0
Anchoa delicatissima	slough anchovy	2	65	1.1-3.1	4.2
Paralichthys californicus	California halibut	2	55-95	2.9-11.5	14.4
Sphyraena argentea	California barracuda	2	78-85	2.0-3.6	5.6
Anchoa compressa	deepbody anchovy	1	43	2.2	2.2
Paralabrax nebulifer	barred sand bass	1	230	312	312.0
Seriphus politus	queenfish	1	102	15.7	15.7
unidentified fish	unid. fish	1	-	0.1	0.1
unidentified fish, damaged	unid. damaged fish	1	-	0.4	0.4
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	5	224-505	112-600	1,505.6
Myliobatis californica	bat ray	1	295	392.0	391.5
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	5	19-47	5.7-47.6	96.3
Octopus spp.	octopus	1	-	10.1	10.1
	Total:	**425**			

Encina Power Station Impingement Abundance: : Traveling Screen and Bar Rack Survey Data

Survey: EPSIA003 **Survey Date: July 07 - 08, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	83	45-66	2.5-7.0	363.0
Roncador stearnsi	spotfin croaker	31	35-52	0.7-2.0	40.1
Heterostichus rostratus	giant kelpfish	29	75-123	3.2-14.9	181.2
Anchoa compressa	deepbody anchovy	17	35-99	0.9-10.5	64.1
Strongylura exilis	California needlefish	13	75-135	0.3-9.5	64.4
Engraulis mordax	northern anchovy	9	42-46	0.5-1.3	6.5
Atherinops affinis	topsmelt	4	60-110	2.2-28.8	43.4
Anchoa delicatissima	slough anchovy	3	-	1.3	1.3
Paralichthys californicus	California halibut	3	43-63	1.5-3.8	7.3
Engraulidae	anchovies	2	-	1.2	1.2
Porichthys myriaster	specklefin midshipman	2	249-270	200-250	450.0
Anchoa spp.	anchovy	1	65	2.5	2.5
Cheilotrema saturnum	black croaker	1	48	1.8	1.8
Gibbonsia montereyensis	crevice kelpfish	1	88	8.3	8.3
Hypsopsetta guttulata	diamond turbot	1	285	400	400.0
Sardinops sagax	Pacific sardine	1	35	0.4	0.4
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	7	225-293	165-375	1,715.1
Myliobatis californica	bat ray	1	245	240	239.5
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	6	26-34.5	6.2-12.1	54.0
	Total:	**215**			

Survey: EPSIA004 **Survey Date: July 14 - 15, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Engraulis mordax	northern anchovy	228	34-109	0.4-11.0	186.9
Cymatogaster aggregata	shiner surfperch	191	45-228	2.3-326	1,327.3
Atherinops affinis	topsmelt	126	45-139	0.8-26.9	472.1
Heterostichus rostratus	giant kelpfish	119	57-137	1.5-19.6	834.0
Roncador stearnsi	spotfin croaker	38	37-226	0.8-149	306.5
Anchoa delicatissima	slough anchovy	28	33-42	0.2-1.5	24.4
Seriphus politus	queenfish	25	35-60	0.7-3.3	41.7
Strongylura exilis	California needlefish	17	84-375	0.6-45.4	91.8
Sardinops sagax	Pacific sardine	15	35-59	0.4-2.3	15.4
Anchoa compressa	deepbody anchovy	10	60-116	2.5-22.5	76.1
Porichthys myriaster	specklefin midshipman	7	164-354	53.3-369.3	1,692.9
Paralichthys californicus	California halibut	5	41-99	1.3-10.6	32.5
Syngnathus spp.	pipefishes	4	103-179	0.8-4.2	11.6
Hypsopsetta guttulata	diamond turbot	1	145	79.1	79.1
Scomber japonicus	Pacific mackerel	1	63	2.2	2.2
Symphurus atricauda	California tonguefish	1	90	7.3	7.3
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	20	268-421	179-600	5,135.9
Urolophus halleri	round stingray	1	85	29.7	29.7
Myliobatis californica	bat ray	5	248-317	236.7-531.3	2,010.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	3	21-33	5.8-16.1	32.7
Octopus spp.	octopus	1	-	239.4	239.4
	Total:	**846**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA005 | **Survey Date: July 21 - 22, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	70	51-71	3.5-10.0	459.0
Sardinops sagax	Pacific sardine	64	40-68	0.5-4.0	90.5
Engraulis mordax	northern anchovy	35	41-106	0.5-9.6	35.1
Seriphus politus	queenfish	20	36-499	0.9-97.6	160.4
Heterostichus rostratus	giant kelpfish	13	81-116	3.6-12.5	93.9
Atherinops affinis	topsmelt	9	54-129	0.8-20.1	56.6
Roncador stearnsi	spotfin croaker	9	46-76	2.4-7.7	35.2
Porichthys myriaster	specklefin midshipman	6	233-378	132-600	1,766.6
Anchoa delicatissima	slough anchovy	5	45	0.6	4.5
Cheilotrema saturnum	black croaker	5	43-52	1.3-2.3	9.3
Syngnathus spp.	pipefishes	4	137-207	0.8-3.8	8.0
Anchoa compressa	deepbody anchovy	3	80-116	5.9-19.9	32.7
Atractoscion nobilis	white seabass	2	79-83	7.6-11.4	19.0
Hypsopsetta guttulata	diamond turbot	2	141-163	73-124	196.7
unidentified fish	unid. fish	2	50-58	1.4-1.6	3.0
Paralichthys californicus	California halibut	1	54	2.2	2.2
Scomber japonicus	Pacific mackerel	1	89	7.8	7.8
Strongylura exilis	California needlefish	1	377	39.3	39.3
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	11	273-618	191-1212	4,244.2
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	3	21-42	2.2-14.8	21.1
	Total:	**266**			

Survey: EPSIA006 | **Survey Date: July 28 - 29, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	95	41-240	1.1-156	530.0
Cymatogaster aggregata	shiner surfperch	53	52-109	2.2-25.5	341.2
Heterostichus rostratus	giant kelpfish	23	45-116	1.9-12.9	130.0
Engraulis mordax	northern anchovy	22	41-93	0.4-7.8	28.0
Atherinops affinis	topsmelt	17	55-107	1.2-11.9	86.1
Strongylura exilis	California needlefish	11	76-372	0.4-55.7	90.4
Porichthys myriaster	specklefin midshipman	8	285-380	226-410	2,608.8
Anchoa delicatissima	slough anchovy	4	65-84	3.4-6.5	17.9
Sardinops sagax	Pacific sardine	3	55-72	1.5-5.1	9.4
Anchoa spp.	anchovy	2	-	7.4	7.4
Paralichthys californicus	California halibut	2	87-114	8.6-16.3	24.9
Anchoa compressa	deepbody anchovy	1	66	2.9	2.9
Cheilotrema saturnum	black croaker	1	50	2.9	2.9
Sphyraena argentea	California barracuda	1	45	0.3	0.3
Syngnathus spp.	pipefishes	1	175	1.1	1.1
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	8	265-368	160-410	1,898.7
Urolophus halleri	round stingray	2	160-170	217-278	495.0
Myliobatis californica	bat ray	1	254	204.3	204.3
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	2	25-42	8.4-24.1	32.5
	Total:	**257**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA007 **Survey Date: August 04 - 05, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	19	43-80	1.4-6.3	63.0
Atherinops affinis	topsmelt	13	57-100	0.9-9.8	38.0
Cymatogaster aggregata	shiner surfperch	11	55-99	2.9-21.1	77.4
Heterostichus rostratus	giant kelpfish	3	83-115	5.1-11.4	26.6
Porichthys myriaster	specklefin midshipman	3	294-309	242-331	872.5
Hypsopsetta guttulata	diamond turbot	2	139-270	69.5-282.5	352.0
Strongylura exilis	California needlefish	2	62-131	0.1-1.1	1.2
Anchoa compressa	deepbody anchovy	1	104	15.9	15.9
Anchoa delicatissima	slough anchovy	1	92	9.4	9.4
Engraulis mordax	northern anchovy	1	70	4.0	4.0
Sardinops sagax	Pacific sardine	1	57	1.4	1.4
Sciaenidae unid.	croaker	1	25	0.1	0.1
Syngnathus spp.	pipefishes	1	186	1.4	1.4
unidentified fish	unid. fish	1	315	700	700.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	7	252-296	133-213	1,250.8
Myliobatis californica	bat ray	3	240-250	175.4-183.9	537.3
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	1	25	6.3	6.3
Loxorhynchus crispatus	moss crab	1	7.3	1.1	1.1
	Total:	**72**			

Survey: EPSIA008 **Survey Date: August 11 - 12, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	375	37-156	0.5-40.8	1,068.2
Cymatogaster aggregata	shiner surfperch	97	56-109	5.1-29.4	895.0
Anchoa compressa	deepbody anchovy	43	64-169	3.1-19.9	426.7
Seriphus politus	queenfish	28	35-167	1.0-62.1	239.2
Heterostichus rostratus	giant kelpfish	24	73-137	2.9-21.6	175.2
Sardinops sagax	Pacific sardine	17	59-92	2.5-9.3	65.8
Syngnathus spp.	pipefishes	16	145-210	0.5-2.8	23.3
Engraulis mordax	northern anchovy	12	54-95	1.7-7.7	37.6
Strongylura exilis	California needlefish	12	78-297	0.8-20.2	59.6
Porichthys myriaster	specklefin midshipman	9	53-309	1.9-306.2	1,556.9
Leuresthes tenuis	California grunion	8	52-71	1.4-2.9	17.9
Anchoa delicatissima	slough anchovy	2	75-101	4.6-11.1	15.7
Cheilotrema saturnum	black croaker	2	62-119	3.7-20.7	24.4
Hypsopsetta guttulata	diamond turbot	2	91-202	8.4-190	198.1
Anisotremus davidsonii	sargo	1	243	341.2	341.2
Hyperprosopon argenteum	walleye surfperch	1	153	96.9	96.9
Paralabrax spp.	sand bass	1	32	0.9	0.9
Pleuronichthys verticalis	hornyhead turbot	1	152	97.3	97.3
Roncador stearnsi	spotfin croaker	1	164	57.1	57.1
Sciaenidae unid.	croaker	1	38	2.7	2.7
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	8	259-341	150-297	1,595.1
Urolophus halleri	round stingray	8	124-242	133-600	2,290.9
Myliobatis californica	bat ray	9	230-315	111.6-404.8	2,602.8
Platyrhinoidis triseriata	thornback	1	53	10.2	10.2
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	3	25.3-36	8.0-21.1	38.7
Loxorhynchus crispatus	moss crab	1	11	0.8	0.8
Hemigrapsus oregonensis	yellow shore crab	2	18-20	0.9-2.8	3.7
Pelia tumida	dwarf teardrop crab	1	13	1.9	1.9
	Total:	**686**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA009 **Survey Date: August 18 - 19, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	18	56-124	1.7-15.8	81.2
Heterostichus rostratus	giant kelpfish	14	66-158	3.4-33.2	122.2
Strongylura exilis	California needlefish	13	87-170	0.4-3.7	28.3
Sardinops sagax	Pacific sardine	10	65-85	3.0-9.4	90.6
Cymatogaster aggregata	shiner surfperch	5	57-75	5.0-11.3	41.6
Seriphus politus	queenfish	5	57-70	3.5-5.5	22.9
Anchoa delicatissima	slough anchovy	2	70-71	3.6-4.4	8.0
Hermosilla azurea	zebra perch	2	53-260	4.8-600	604.8
Paralichthys californicus	California halibut	2	81-103	6.9-16.0	22.9
Porichthys myriaster	specklefin midshipman	2	75-268	5.5-200	205.5
unidentified fish	unid. fish	2	37-44	2.1-2.6	4.7
Hypsoblennius gentilis	bay blenny	1	95	14.7	14.7
Hypsopsetta guttulata	diamond turbot	1	136	57.9	57.9
Leuresthes tenuis	California grunion	1	146	19.9	19.9
Syngnathus spp.	pipefishes	1	184	2.5	2.5
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	2	270-288	162-190	352.2
Urolophus halleri	round stingray	2	133-230	95-123	218.0
Myliobatis californica	bat ray	1	340	550	550.0
Ophichthus zophochir	yellow snake eel	1	420	51.8	51.8
Platyrhinoidis triseriata	thornback	1	630	1,500	1,500.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	2	22-30	6.1-15.6	21.7
Pyromaia tuberculata	tuberculate pea crab	1	15	3.2	3.2
Octopus spp.	octopus	-	-	-	-
	Total:	**89**			

Survey: EPSIA010 **Survey Date: August 25 - 26, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	24	39-115	0.7-16.1	110.5
Seriphus politus	queenfish	13	46-121	1.5-20.2	80.6
Atherinops affinis	topsmelt	9	64-133	2.1-17.0	68.0
Heterostichus rostratus	giant kelpfish	9	74-125	3.1-15.8	60.8
Sardinops sagax	Pacific sardine	8	-	8.0	36.8
Cymatogaster aggregata	shiner surfperch	7	64-80	6.3-11.3	60.7
Leuresthes tenuis	California grunion	6	59-81	1.6-3.4	13.4
Engraulis mordax	northern anchovy	3	54-56	1-1.8	4.4
Porichthys myriaster	specklefin midshipman	3	275-314	180-350	725.8
Hermosilla azurea	zebra perch	2	35-70	1.1-8.1	9.2
Hypsopsetta guttulata	diamond turbot	2	188-216	39.1-254	293.4
Strongylura exilis	California needlefish	2	105-508	1.2-290	291.2
Paralabrax nebulifer	barred sand bass	1	57	2.6	2.6
Roncador stearnsi	spotfin croaker	1	280	500	500.0
unidentified fish	unid. fish	1	-	20.1	20.1
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	3	260-300	145-220	546.2
Urolophus halleri	round stingray	3	125-147	89.4-148	353.4
Myliobatis californica	bat ray	2	208-240	148-185	332.4
Rhinobatos productus	shovelnose guitarfish	1	410	300	300.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	4	18.5-39	0.8-24.3	25.1
Lophopanopeus spp.	black-clawed crabs	1	14	1.3	1.3
	Total:	**105**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA011 **Survey Date: September 01 - 02, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Heterostichus rostratus	giant kelpfish	10	80-97	3.8-10.1	60.6
Anchoa delicatissima	slough anchovy	4	60-73	2.1-4.0	10.4
Leuresthes tenuis	California grunion	4	65-112	2.2-13.5	25.7
Seriphus politus	queenfish	3	55-63	2.3-5.9	11.9
Cymatogaster aggregata	shiner surfperch	2	68-70	8.2-8.9	17.1
Paralichthys californicus	California halibut	2	59-118	3.1-25.8	28.9
Anchoa compressa	deepbody anchovy	1	79	7.4	7.4
Paralabrax spp.	sand bass	1	39	1.1	1.1
Porichthys myriaster	specklefin midshipman	1	400	550	550.0
Sardinops sagax	Pacific sardine	1	75	3.6	3.6
Strongylura exilis	California needlefish	1	-	1.8	1.8
Syngnathus spp.	pipefishes	1	152	0.6	0.6
unidentified fish, damaged	unid. damaged fish	1	-	137.4	137.4
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	1	327	233.3	233.3
Myliobatis californica	bat ray	1	340	400	400.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	1	25	4.0	4.0
Taliepus nuttallii	globose kelp crab	1	11	0.7	0.7
	Total:	**36**			

Survey: EPSIA012 **Survey Date: September 08 - 09, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	93	42-94	0.2-12.3	301.0
Leuresthes tenuis	California grunion	43	54-73	1.0-5.0	94.7
Seriphus politus	queenfish	29	32-155	0.6-53.0	218.0
Heterostichus rostratus	giant kelpfish	24	60-122	2.1-16.2	172.7
Engraulis mordax	northern anchovy	15	52-71	1.2-4.1	29.5
Cymatogaster aggregata	shiner surfperch	7	53-95	4.9-25.0	79.0
Porichthys notatus	plainfin midshipman	5	53-400	1.6-420	723.6
Sphyraena argentea	California barracuda	5	48-73	0.6-3.3	10.2
Xenistius califoriensis	salema	4	31-55	0.7-2.3	4.9
Paralabrax nebulifer	barred sand bass	3	46-124	2.0-28.4	43.5
Sardinops sagax	Pacific sardine	3	68-75	3.5-4.1	11.2
Cheilotrema saturnum	black croaker	2	35-55	1.2-4.3	5.5
Phanerodon furcatus	white surfperch	2	85-93	19.7-20.0	39.7
Porichthys myriaster	specklefin midshipman	2	54-360	1.8-410	411.8
Atherinops affinis	topsmelt	1	103	9.9	9.9
Hypsopsetta guttulata	diamond turbot	1	231	380	380.0
Paralichthys californicus	California halibut	1	105	19.0	19.0
Pleuronectiformes unid.	flatfishes	1	-	54.7	54.7
Roncador stearnsi	spotfin croaker	1	250	380	380.0
Strongylura exilis	California needlefish	1	138	2.0	2.0
Syngnathus spp.	pipefishes	1	133	0.9	0.9
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	4	254-599	137-265	708.2
Myliobatis californica	bat ray	1	-	110	110.0
Urolophus halleri	round stingray	1	-	200	200.0
INVERTEBRATES					
Hemigrapsus oregonensis	yellow shore crab	1	18	2.5	2.5
	Total:	**251**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA013
Sample Count: 19

Survey Date: September 15 - 16, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	24	55-100	5.1-29.6	216.5
Leuresthes tenuis	California grunion	15	48-124	0.9-15.8	72.3
Anchoa delicatissima	slough anchovy	10	40-70	0.5-3.5	22.4
Anchoa compressa	deepbody anchovy	9	58-86	2.0-5.7	30.9
Heterostichus rostratus	giant kelpfish	8	82-124	3.4-15.8	59.2
Sphyraena argentea	California barracuda	4	81-90	2.8-3.6	13.3
Trachurus symmetricus	jack mackerel	4	36-40	0.6-0.9	3.0
Atherinops affinis	topsmelt	3	79-101	3.9-9.8	19.5
Strongylura exilis	California needlefish	3	184-410	4.0-64.8	89.5
Porichthys myriaster	specklefin midshipman	2	57-229	1.8-247	248.8
Sardinops sagax	Pacific sardine	2	67-73	3.1-3.2	6.3
Seriphus politus	queenfish	2	71-73	4.0-5.2	9.2
Xenistius califoriensis	salema	2	37-40	0.8-1.2	2.0
Brachyistius frenatus	kelp surfperch	1	95	28.9	28.9
Cheilotrema saturnum	black croaker	1	43	0.6	0.6
Engraulis mordax	northern anchovy	1	72	2.6	2.6
Paralichthys californicus	California halibut	1	60	3.1	3.1
Umbrina roncador	yellowfin croaker	1	37	1.0	1.0
unidentified fish, damaged	unid. damaged fish	1	-	20.3	20.3
SHARKS/RAYS					
Myliobatis californica	bat ray	2	299-422	201-298	499.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	5	30-58	2.5-17.5	33.2
Pachygrapsus crassipes	striped shore crab	2	18-35	0.5-24.8	25.3
Pugettia spp.	kelp crabs	1	22	4.1	4.1
	Total:	**104**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA014
Sample Count: 19

Survey Date: September 22 - 23, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	52	22-94	0.8-9.3	119.4
Seriphus politus	queenfish	34	22-82	0.1-8.4	102.1
Leuresthes tenuis	California grunion	20	49-115	1.0-17.1	89.4
Cymatogaster aggregata	shiner surfperch	17	56-90	5.6-18.3	162.5
Anchoa delicatissima	slough anchovy	5	50-76	1.8-4.0	12.3
Sardinops sagax	Pacific sardine	4	62-80	2.8-10.6	20.3
Anisotremus davidsonii	sargo	3	42-72	1.9-10.6	16.9
Heterostichus rostratus	giant kelpfish	3	90-98	5.2-7.3	17.7
Roncador stearnsi	spotfin croaker	3	90-93	9.6-17.7	42.3
Xenistius califoriensis	salema	3	30-41	0.6-1.9	4.2
Atractoscion nobilis	white seabass	2	36-75	0.5-3.4	3.9
Cheilopogon pinnatibarbatus	spotted flyingfish	2	310-313	291-310	601.1
Cheilotrema saturnum	black croaker	2	62-87	5.9-14.4	20.3
Engraulis mordax	northern anchovy	2	57-58	1.1-1.5	2.6
Paralabrax nebulifer	barred sand bass	2	43-50	1.5-3.0	4.5
Sphyraena argentea	California barracuda	2	72-111	2.3-8.3	10.6
Strongylura exilis	California needlefish	2	118-225	1.7-12.5	14.2
Umbrina roncador	yellowfin croaker	2	50-55	2.5-3.6	6.1
Atherinopsis californiensis	jacksmelt	1	125	22.1	22.1
Menticirrhus undulatus	California corbina	1	108	18.9	18.9
Oxylebius pictus	painted greenling	1	66	4.8	4.8
Porichthys myriaster	specklefin midshipman	1	163	41.2	41.2
Syngnathus spp.	pipefishes	1	505	50.0	50.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	1	340	330	330.0
Myliobatis californica	bat ray	1	297	375	375.0
INVERTEBRATES					
Loligo opalescens	market squid	3	75-129	7.4-10.8	26.2
Callinectes spp.	crab	1	26	13.8	13.8
Pachygrapsus crassipes	striped shore crab	1	28	10.1	10.1
Pyromaia tuberculata	tuberculate pea crab	1	12	-	-
	Total:	**173**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA015 **Survey Date: September 29 - 30, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	28	35-78	0.5-7.0	77.4
Leuresthes tenuis	California grunion	16	57-150	1.5-36.0	136.0
Engraulis mordax	northern anchovy	11	33-116	0.2-14.0	24.7
Anchoa compressa	deepbody anchovy	10	45-81	0.5-5.0	22.0
Hyperprosopon argenteum	walleye surfperch	10	49-85	2.0-15.0	80.5
Xenistius califoriensis	salema	10	35-63	0.5-4.0	19.5
Anchoa delicatissima	slough anchovy	5	56-77	1.0-5.0	14.0
Anisotremus davidsonii	sargo	4	38-58	1.0-5.0	9.5
Heterostichus rostratus	giant kelpfish	4	95-121	4.0-22.0	45.0
Sphyraena argentea	California barracuda	4	88-115	4.0-10.0	24.0
Strongylura exilis	California needlefish	4	139-325	0.7-42.0	54.7
Atherinops affinis	topsmelt	2	64-78	3.0-6.0	9.0
Embiotoca jacksoni	black surfperch	2	164-175	170-200	370.0
Paralichthys californicus	California halibut	2	120-133	20.0-35.0	55.0
Sardinops sagax	Pacific sardine	2	71-75	2.0-3.5	5.5
Atherinopsis californiensis	jacksmelt	1	181	47.0	47.0
Atractoscion nobilis	white seabass	1	145	45.0	45.0
Genyonemus lineatus	white croaker	1	100	2.1	2.1
Paralabrax maculatofasciatus	spotted sand bass	1	81	10.5	10.5
Peprilus simillimus	Pacific butterfish	1	130	50.0	50.0
Roncador stearnsi	spotfin croaker	1	115	20.0	20.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	1	292	190	190.0
Urolophus halleri	round stingray	1	272	270	270.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	7	18-33	2.5-9.0	36.2
Cancer antennarius	brown rock crab	2	11-25	0.2-1.7	1.9
Lophopanopeus frontalis	molarless crestleg crab	2	11-13	0.4	0.8
Cancer productus	red rock crab	1	26	3.4	3.4
Loligo opalescens	market squid	1	70	7.0	7.0
Panulirus interruptus	California spiny lobster	1	-	66.0	66.0
Pyromaia tuberculata	tuberculate pea crab	1	9	0.6	0.6
	Total:	**137**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA016 **Survey Date: October 06 - 07, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	57	48-130	0.5-20.8	289.5
Seriphus politus	queenfish	47	35-98	1.0-14.8	222.3
Anchoa compressa	deepbody anchovy	35	45-95	1.0-10.7	141.8
Cymatogaster aggregata	shiner surfperch	19	57-82	5.0-13.7	175.2
Engraulis mordax	northern anchovy	17	50-103	1.2-8.9	30.5
Xenistius califoriensis	salema	17	27-58	0.5-4.0	22.6
Anchoa delicatissima	slough anchovy	5	53-85	1.0-6.0	14.0
Sphyraena argentea	California barracuda	4	96-435	3.0-110	139.9
Porichthys myriaster	specklefin midshipman	3	87-390	7.2-460	822.2
Heterostichus rostratus	giant kelpfish	2	72-275	1.0-195	196.0
Paralichthys californicus	California halibut	2	128-133	39.0-40.0	79.0
Strongylura exilis	California needlefish	2	73-82	0.3	0.7
Leuresthes tenuis	California grunion	1	68	2.0	2.0
Paralabrax maculatofasciatus	spotted sand bass	1	29	1.5	1.5
Sardinops sagax	Pacific sardine	1	66	3.0	3.0
SHARKS/RAYS					
Urolophus halleri	round stingray	3	60-154	13.6-195	368.6
Myliobatis californica	bat ray	2	294	400	400.0
INVERTEBRATES					
Loligo opalescens	market squid	11	47-66	4.0-10.0	70.6
Portunus xantusii	Xantus' swimming crab	10	10-50	0.5-9.0	38.9
Taliepus nuttallii	globose kelp crab	2	5-6	0.5	1.0
Cancer spp.	cancer crabs	1	24	2.6	2.6
Pachygrapsus crassipes	striped shore crab	1	12	2.5	2.5
Pachygrapsus spp.	shore crab	1	15	0.9	0.9
Pugettia producta	northern kelp crab	1	8	-	-
Pyromaia tuberculata	tuberculate pea crab	1	6	-	-
	Total:	**246**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA017 | **Survey Date: October 13 - 14, 2004**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	5	55-65	1.2-3.0	2.0
Atractoscion nobilis	white seabass	2	252	140-144	1.2
Engraulis mordax	northern anchovy	2	48-51	1.2	2.4
Seriphus politus	queenfish	2	43-65	1.1-3.9	1.3
Anchoa compressa	deepbody anchovy	1	56	2.0	4.6
Anchoa delicatissima	slough anchovy	1	58	1.2	3.1
Cymatogaster aggregata	shiner surfperch	1	74	8.1	8.1
Sardinops sagax	Pacific sardine	1	77	3.1	11.9
unidentified fish	unid. fish	1	-	4.6	284.0
Xenistius califoriensis	salema	1	44	1.3	5.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	20	23-41	2.6-12.9	113.4
Pugettia producta	northern kelp crab	1	80	5.4	5.4
Taliepus nuttallii	globose kelp crab				
	Total:	**38**			

Survey: EPSIA018 | **Survey Date; October 20 - 21, 2004**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	114	52-193	1.4-32.0	905.9
Seriphus politus	queenfish	35	28-77	0.4-7.1	61.0
Xenistius califoriensis	salema	32	30-50	0.4-2.0	30.0
Anchoa compressa	deepbody anchovy	18	40-68	1.3-3.7	41.0
Engraulis mordax	northern anchovy	16	54-70	1.8-4.0	42.6
Brachyistius frenatus	kelp surfperch	14	62-102	6.0-25.0	135.6
Atractoscion nobilis	white seabass	4	223-243	135.2-185.0	640.2
Lepomis cyanellus	green sunfish	4	104-126	26.0-68.0	194.7
Ameiurus natalis	yellow bullhead	3	162-175	65.0-80.0	220.0
Paralichthys californicus	California halibut	3	110-151	21.0-45.0	111.0
Strongylura exilis	California needlefish	3	370-397	67.0-84.0	221.0
Acanthogobius flavimanus	yellowfin goby	2	115-148	18.0-37.2	55.2
Anisotremus davidsonii	sargo	2	44-69	1.8-7.0	8.8
Anchoa spp.	anchovy	1	-	6.8	6.8
Cymatogaster aggregata	shiner surfperch	1	84	7.5	7.5
Hypsopsetta guttulata	diamond turbot	1	125	53.0	53.0
Paralabrax clathratus	kelp bass	1	48	2.0	2.0
Porichthys myriaster	specklefin midshipman	1	47	1.0	1.0
Sardinops sagax	Pacific sardine	1	65	3.0	3.0
Sphyraena argentea	California barracuda	1	72	2.0	2.0
SHARKS/RAYS					
Myliobatis californica	bat ray	1	300	200	200.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	6	21-46	2.1-12.4	38.4
Pugettia producta	northern kelp crab	6	4-15	0.1-1.4	2.8
Loxorhynchus spp.	spider crabs	2	5	0.1-0.5	0.6
Brachyuran unid.	unidentified crab	1	8	0.4	0.4
Caridean unid.	unidentified shrimp	1	159	28.0	28.0
	Total:	**274**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA019 **Survey Date: October 27 - 28, 2004**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	64	52-134	1.0-27.0	256.5
Xenistius califoriensis	salema	41	19-45	0.3-1.7	43.8
Seriphus politus	queenfish	32	32-78	1.3-6.4	94.4
Lepomis cyanellus	green sunfish	10	95-117	30.5-77.5	442.8
Micropterus salmoides	large mouth bass	9	49-57	2.4-3.4	26.9
Cymatogaster aggregata	shiner surfperch	8	63-82	5.9-11.6	66.0
Engraulis mordax	northern anchovy	8	59-64	2.1-2.7	19.0
Strongylura exilis	California needlefish	5	392-577	70.0-230	635.0
Anchoa delicatissima	slough anchovy	4	42-66	1.7-7.1	22.2
Lepomis macrochirus	bluegill	3	34-121	1.8-55.5	111.3
Anchoa compressa	deepbody anchovy	2	60-77	2.5-5.7	8.2
Paralichthys californicus	California halibut	2	42-44	1.2-1.3	2.5
Phanerodon furcatus	white surfperch	2	89-119	13.5-27.4	40.9
Sphyraena argentea	California barracuda	2	48-63	0.9-1.6	2.5
Tilapia spp.	tilapia	2	27-46	2.4-4.2	6.6
Trachurus symmetricus	jack mackerel	2	37-38	1.1	2.2
Rhacochilus vacca	pile surfperch	1	263	465	465.0
Heterostichus rostratus	giant kelpfish	1	96	5.4	5.4
Porichthys myriaster	specklefin midshipman	1	342	221	221.0
Porichthys notatus	plainfin midshipman	1	385	460	460.0
Syngnathus spp.	pipefishes	1	161	1.3	1.3
unidentified fish, damaged	unid. damaged fish	1	-	16.0	16.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	4	272-550	165-1,100	1,775.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	31	7-41	0.9-13.9	195.5
Octopus bimaculatus	California two-spot octopus	4	-	5.2-25.3	58.1
Loxorhynchus crispatus	moss crab	1	7	0.3	0.3
Pugettia spp.	kelp crabs	1	2	0.1	0.1
	Total:	**243**			

Survey: EPSIA020 **Survey Date: November 03 - 04, 2004**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	35	37-85	0.9-7.1	101.6
Engraulis mordax	northern anchovy	30	57-76	1.9-4.6	85.8
Atherinopsidae	silverside	20	50-147	1.1-33.0	148.5
Seriphus politus	queenfish	9	34-66	0.8-4.3	19.8
Xenistius califoriensis	salema	2	37-42	0.9-1.3	2.1
Cymatogaster aggregata	shiner surfperch	1	70	8.7	8.7
Trachurus symmetricus	jack mackerel	1	-	2.0	2.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	1	304	120	120.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	8	21-29	3.8-9.7	58.4
Brachyuran unid.	unidentified crab	1	17	2.8	2.8
Crangon spp.	bay shrimp	1	107	20.9	20.9
Loligo opalescens	market squid	1	-	-	-
Rhithropanopeus harrisii	Harris' mud crab	1	30	18.0	18.0
	Total:	**111**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA021
Sample Count: 13

Survey Date: November 10 - 11, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	14	62-164	2.0-21.3	76.0
Seriphus politus	queenfish	5	46-82	1.4-7.1	13.9
Scorpaena guttata	spotted scorpinfish	1	110	38.0	38.0
Xenistius califoriensis	salema	1	40	1.1	1.1
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	26	15-60	0.9-15.7	193.5
Pachygrapsus crassipes	striped shore crab	2	12-27	0.5	0.5
Cycloxanthops novemdentatus	ninetooth pebble crab	1	19	2.6	2.6
	Total:	50			

Survey: EPSIA022
Sample Count: 13

Survey Date: November 17 - 18, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsis californiensis	jacksmelt	29	45-146	0.8-33.0	123.9
Seriphus politus	queenfish	18	37-89	0.8-11.1	41.6
Atherinops affinis	topsmelt	4	70-124	2.5-17.6	27.3
Hyperprosopon argenteum	walleye surfperch	2	135-160	61.5-101	162.0
Paralichthys californicus	California halibut	2	49-132	1.8-35.6	37.3
Anchoa compressa	deepbody anchovy	1	66	3.5	3.5
Cheilotrema saturnum	black croaker	1	127	38.6	38.6
Leuresthes tenuis	California grunion	1	63	1.7	1.7
Sarda chiliensis	Pacific bonito	1	336	500	500.0
Xenistius califoriensis	salema	1	48	2.0	2.0
SHARKS/RAYS					
Urolophus halleri	round stingray	1	80	27.7	27.7
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	9	16-36	2.0-17.0	68.4
Pachygrapsus crassipes	striped shore crab	3	32-35	15.0-18.8	49.5
	Total:	73			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA023 | **Survey Date; November 22 - 23, 2004**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Leuresthes tenuis	California grunion	12	59-155	1.6-31.2	70.1
Seriphus politus	queenfish	11	30-82	0.7-6.7	22.3
Anchoa compressa	deepbody anchovy	5	55-70	1.5-4.8	12.9
Atherinopsis californiensis	jacksmelt	3	62-160	2.3-45.3	56.1
Atractoscion nobilis	white seabass	2	255-291	200-302	502.1
Engraulis mordax	northern anchovy	2	65	2.0-2.9	4.9
Hypsoblennius spp.	blennies	1	50	3.5	3.5
Menticirrhus undulatus	California corbina	1	72	5.1	5.1
Micrometrus minimus	dwarf surfperch	1	70	8.3	8.3
Paralabrax clathratus	kelp bass	1	40	1.7	1.7
Paralichthys californicus	California halibut	1	50	1.7	1.7
unidentified fish, damaged	unid. damaged fish	1	250	200	200.0
Xenistius califoriensis	salema	1	47	1.8	1.8
SHARKS/RAYS					
Myliobatis californica	bat ray	1	400	460	460.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	34	18-46	2.4-18.2	154.9
Cancer magister	dungeness crab	1	-	-	-
Pugettia richii	cryptic kelp crab	1	12	1.3	1.3
Pugettia spp.	kelp crabs	1	-	-	-
	Total:	**80**			

Survey: EPSIA024 | **Survey Date: December 01 - 02, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	801	50-112	0.7-12.1	2,471.4
Xenistius californiensis	salema	514	40-60	1.1-5.3	1,404.0
Seriphus politus	queenfish	320	29-100	0.5-19.3	1,941.7
Cymatogaster aggregata	shiner surfperch	212	61-94	5.1-18.1	2,343.6
Leuresthes tenuis	California grunion	65	31-125	0.3-18.5	265.2
unidentified fish, damaged	unid. damaged fish	6	-	-	-
Anisotremus davidsonii	sargo	4	51-70	2.9-8.3	22.5
Atherinops affinis	topsmelt	4	57-118	1.2-14.2	19.2
Atherinopsis californiensis	jacksmelt	4	63-108	2.2-10.5	19.8
Sardinops sagax	Pacific sardine	3	82-91	4.8-7.5	17.2
Genyonemus lineatus	white croaker	1	115	30.0	30.0
Heterostichus rostratus	giant kelpfish	1	65	5.3	5.3
Hypsoblennius gentilis	bay blenny	1	56	2.6	2.6
Hypsoblennius gilberti	rockpool blenny	1	70	4.3	4.3
Menticirrhus undulatus	California corbina	1	74	5.0	5.0
Paralichthys californicus	California halibut	1	160	60.1	60.1
Sphyraena argentea	California barracuda	1	115	7.4	7.4
Strongylura exilis	California needlefish	1	462	115.1	115.1
Syngnathus spp.	pipefishes	1	249	3.0	3.0
Umbrina roncador	yellowfin croaker	1	67	5.4	5.4
SHARKS/RAYS					
Platyrhinoidis triseriata	thornback	2	181-192	305-342	647.0
Urolophus halleri	round stingray	2	149-155	183-210	393.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	13	20-65	2.7-23.6	110.9
Loligo opalescens	market squid	4	88-114	-	-
Pachygrapsus crassipes	striped shore crab	3	6-35	0.2-19.5	31.3
Pugettia spp.	kelp crabs	1	9	0.3	0.3
	Total:	**1,968**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA025 **Survey Date: December 08 - 09, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Leuresthes tenuis	California grunion	96	49-130	1.1-26.5	440.8
Seriphus politus	queenfish	90	27-175	0.5-58.9	512.7
Anchoa compressa	deepbody anchovy	71	53-111	0.9-12.6	223.8
Xenistius califoriensis	salema	23	20-70	0.9-5.6	51.4
Cymatogaster aggregata	shiner surfperch	16	65-105	7.1-25.1	223.8
Sardinops sagax	Pacific sardine	10	73-108	3.7-13.3	70.9
Atherinops affinis	topsmelt	7	63-140	2.2-11.0	30.7
unidentified fish, damaged	unid. damaged fish	4	-	14.8	14.8
Strongylura exilis	California needlefish	2	455-482	120-125	245.0
Chromis punctipinnis	blacksmith	1	105	27.0	27.0
Micrometrus minimus	dwarf surfperch	1	54	4.4	4.4
Paraclinus integripinnis	reef finspot	1	65	3.7	3.7
SHARKS/RAYS					
Myliobatis californica	bat ray	1	305	400	400.0
Platyrhinoidis triseriata	thornback	1	490	650	650.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	14	23-60	3.0-19.0	101.5
Pachygrapsus crassipes	striped shore crab	4	5-40	0.1-20.9	29.7
Pugettia spp.	kelp crabs	2	10-13	0.4-1.1	1.5
Octopus spp.	octopus	1	-	200	200.0
Pyromaia tuberculata	tuberculate pea crab	1	22	2.3	2.3
	Total:	**346**			

Survey: EPSIA026 **Survey Date: December 15 - 16, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Leuresthes tenuis	California grunion	99	20-124	0.6-21.2	341.8
Seriphus politus	queenfish	44	47-102	1.4-13.5	268.2
Xenistius califoriensis	salema	28	38-57	1.1-3.5	55.3
Cymatogaster aggregata	shiner surfperch	11	64-83	7.8-16.5	112.9
Atractoscion nobilis	white seabass	8	229-295	150-310	1,655.0
Engraulis mordax	northern anchovy	6	38-109	0.5-13.6	24.1
Anchoa compressa	deepbody anchovy	5	55-92	1.0-8.6	15.4
Atherinops affinis	topsmelt	2	53-84	1.4-6.2	7.6
Chromis punctipinnis	blacksmith	1	39	1.0	1.0
Hyperprosopon argenteum	walleye surfperch	1	140	75.4	75.4
Sardinops sagax	Pacific sardine	1	86	4.1	4.1
Umbrina roncador	yellowfin croaker	1	94	9.7	9.7
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	15	25-83	3.6-11.0	103.1
Pachygrapsus crassipes	striped shore crab	3	9-42	0.5-28.0	33.6
Loligo opalescens	market squid	1	52	24.1	24.1
Pugettia spp.	kelp crabs	1	9	0.5	0.5
	Total:	**227**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA027 | **Survey Date: December 20 - 21, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	25	23-95	0.5-11.7	102.4
Anchoa compressa	deepbody anchovy	16	40-112	0.8-14.3	93.7
Leuresthes tenuis	California grunion	10	57-113	1.5-10.3	37.5
Atherinopsis californiensis	jacksmelt	6	62-133	2.4-23.6	37.3
Atherinopsidae	silverside	3	73-105	2.3-8.3	13.5
Sardinops sagax	Pacific sardine	2	80-89	4.5-5.7	10.2
Anchoa delicatissima	slough anchovy	1	68	3.3	3.3
Atractoscion nobilis	white seabass	1	290	265	265.0
Hyperprosopon argenteum	walleye surfperch	1	169	115	115.0
Xenistius califoriensis	salema	1	37	1.0	1.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	17	23-61	2.8-19.6	166.1
Cancer spp.	cancer crabs	1	26	28.0	28.0
Pachygrapsus crassipes	striped shore crab	1	15	2.2	2.2
Pugettia spp.	kelp crabs	1	11	1.4	1.4
	Total:	**86**			

Survey: EPSIA028 | **Survey Date: December 29 - 30, 2004**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsidae	silverside	721	43-145	1.2-28.2	2,746.2
Xenistius califoriensis	salema	283	39-59	0.5-3.0	529.6
Anchoa compressa	deepbody anchovy	57	19-105	0.3-10.0	204.5
Cymatogaster aggregata	shiner surfperch	29	70-110	7.9-21.3	409.1
Sardinops sagax	Pacific sardine	21	72-85	2.8-5.2	83.7
Seriphus politus	queenfish	8	40-140	0.9-31.6	67.2
Strongylura exilis	California needlefish	5	400-508	79.4-160	532.0
Paralabrax clathratus	kelp bass	2	45-73	1.7-7.2	8.9
Syngnathus spp.	pipefishes	2	171-194	1.4-2.4	3.8
Atherinops affinis	topsmelt	1	-	-	-
Chub unid.	unid. chub	1	75	7.3	7.3
Citharichthys stigmaeus	speckled sanddab	1	69	4.6	4.6
Hypsopsetta guttulata	diamond turbot	1	225	250	250.0
Lepomis spp.	sunfishes	1	102	29.9	29.9
Micrometrus minimus	dwarf surfperch	1	56	4.5	4.5
Paralichthys californicus	California halibut	1	65	3.0	3.0
Phanerodon furcatus	white surfperch	1	69	9.4	9.4
Porichthys myriaster	specklefin midshipman	1	73	3.3	3.3
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	6	337-478	425-1,100	4,395.0
Myliobatis californica	bat ray	3	321-500	255-500	1,135.0
INVERTEBRATES					
Cancer spp.	cancer crabs	18	16-33	0.1-2.3	18.7
Pachygrapsus crassipes	striped shore crab	8	10-31	0.2-9.5	26.8
Portunus xantusii	Xantus' swimming crab	8	21-58	0.2-24.9	55.4
Pugettia spp.	kelp crabs	5	5-22	0.1-4.1	7.4
Loligo opalescens	market squid	3	78-100	19.4-34.7	80.8
Taliepus nuttallii	globose kelp crab	2	7-8	0.2-0.5	0.7
Brachyuran unid.	unidentified crab	1	-	-	-
	Total:	**1,191**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA029 **Survey Date: January 05 - 06, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	344	48-137	0.9-33.5	2,151.8
Leuresthes tenuis	California grunion	60	53-159	1.2-36.4	361.6
Xenistius califoriensis	salema	42	41-55	1.1-3.3	80.9
Cymatogaster aggregata	shiner surfperch	14	78-100	6.5-27.2	240.6
Anchoa delicatissima	slough anchovy	10	55-81	1.6-4.4	24.8
Strongylura exilis	California needlefish	10	408-563	90.0-270	1,620.0
unidentified fish, damaged	unid. damaged fish	10	50-65	0.4-2.4	26.5
Sardinops sagax	Pacific sardine	7	44-88	0.7-4.7	25.1
Anisotremus davidsonii	sargo	4	48-81	2.5-11.6	30.1
Anchoa compressa	deepbody anchovy	3	60-100	2.0-12.2	23.7
Seriphus politus	queenfish	3	44-144	1.2-34.0	40.4
Atractoscion nobilis	white seabass	2	270	85.0-180	265.0
Engraulis mordax	northern anchovy	2	42-45	0.6	1.3
Paralabrax clathratus	kelp bass	2	62-64	2.8-5.1	7.9
Phanerodon furcatus	white surfperch	2	179-224	115-240	355.2
Hyperprosopon argenteum	walleye surfperch	1	98	20.7	20.7
Hyperprosopon spp.	surfperch	1	165	115	115.0
Hypsopsetta guttulata	diamond turbot	1	28	0.5	0.5
Lepomis macrochirus	bluegill	1	114	45.0	45.0
Lepomis spp.	sunfishes	1	106	35.6	35.6
Symphurus atricauda	California tonguefish	1	92	8.1	8.1
Syngnathus spp.	pipefishes	1	248	4.5	4.5
SHARKS/RAYS					
Myliobatis californica	bat ray	2	274-307	320-410	730.0
Ophichthus zophochir	yellow snake eel	2	489-520	120	240.0
Gymnura marmorata	California butterfly ray	1	465	648	648.0
Platyrhinoidis triseriata	thornback	1	-	178.0	177.9
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	22	19-55	2.6-19.7	198.2
Pachygrapsus crassipes	striped shore crab	5	10-31	0.4-10.2	18.7
Pugettia spp.	kelp crabs	3	7-25	1.1-6.1	8.7
Callianassa californiensis	ghost shrimp	2	41-49	1.0-1.9	2.9
Cancer jordani	hairy rock crab	2	21-30	1.3-5.8	7.1
Octopus spp.	octopus	2	-	20.4-114.8	135.2
Cancer antennarius	brown rock crab	1	21	2.3	2.3
Cancer productus	red rock crab	1	37	10.5	10.5
Pugettia producta	northern kelp crab	1	15	1.5	1.5
Taliepus nuttallii	globose kelp crab	1	10	0.5	0.5
	Total:	**568**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA030 | **Survey Date: January 12 - 13, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	2,551	35-184	0.5-67.1	23,391.9
Anchoa delicatissima	slough anchovy	861	38-127	0.9-17.0	2,654.2
Hyperprosopon argenteum	walleye surfperch	460	57-195	4.0-128	18,405.7
Anchoa compressa	deepbody anchovy	222	50-122	1.1-20.8	2,131.7
Paralabrax maculatofasciatus	spotted sand bass	181	43-240	1.4-310	1,596.9
Cymatogaster aggregata	shiner surfperch	118	38-136	1.9-54.9	2,175.8
Seriphus politus	queenfish	86	37-225	0.7-165	773.4
Paralabrax clathratus	kelp bass	79	44-154	1.0-70.0	526.4
Micrometrus minimus	dwarf surfperch	47	54-91	4.0-19.8	484.8
Menticirrhus undulatus	California corbina	39	58-341	3.0-580	1,599.6
Phanerodon furcatus	white surfperch	38	83-227	13.9-350	2,830.4
Paralabrax nebulifer	barred sand bass	33	43-88	1.2-35.0	185.7
Amphistichus argenteus	barred surfperch	32	68-195	8.6-220	1,242.5
Paralichthys californicus	California halibut	28	45-255	1.1-261	593.3
Sardinops sagax	Pacific sardine	28	73-180	2.5-65.0	364.7
Xenistius califoriensis	salema	26	36-74	0.6-6.5	45.0
Anisotremus davidsonii	sargo	21	51-244	2.0-370	834.4
Hypsopsetta guttulata	diamond turbot	15	22-240	14.1-310	2,128.0
Roncador stearnsi	spotfin croaker	15	51-421	2.0-1,500	5,531.5
Atractoscion nobilis	white seabass	12	127-316	26.4-350	2,846.4
Fundulus parvipinnis	California killifish	9	49-79	1.8-7.1	48.0
Engraulis mordax	northern anchovy	8	65-86	1.4-5.5	26.7
Umbrina roncador	yellowfin croaker	7	55-298	3.1-355	398.5
Chub unid.	unid. chub	4	62-81	4.5-7.6	24.5
Heterostichus rostratus	giant kelpfish	4	98-161	8.7-28.5	70.9
Citharichthys stigmaeus	speckled sanddab	3	49-65	1.5-3.6	6.6
Hermosilla azurea	zebra perch	3	66-71	7.3-11.9	27.3
Sphyraena argentea	California barracuda	3	198-224	55.4-68.5	181.4
Albula vulpes	bonefish	2	320-340	590-602	1,192.0
Ictaluridae	unid. catfish	2	162-177	55.0-100.5	155.5
Citharichthys sordidus	Pacific sanddab	1	50	0.5	0.5
Cynoscion parvipinnis	shortfin corvina	1	412	900	900.0
Rhacochilus vacca	pile surfperch	1	176	160	160.0
Genyonemus lineatus	white croaker	1	43	1.0	1.0
Hypsoblennius gentilis	bay blenny	1	65	5.0	5.0
Hypsoblennius gilberti	rockpool blenny	1	65	5.0	5.0
Scorpaena guttata	spotted scorpinfish	1	110	38.0	38.0
Strongylura exilis	California needlefish	1	716	90.0	90.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	33	275-525	185-1,520	24,459.0
Urolophus halleri	round stingray	10	146-206	180-630	3,834.0
Ophichthus zophochir	yellow snake eel	6	526-800	115-600	1,920.0
Mustelus californicus	gray smoothhound	3	442-687	300-1,100	1,850.0
Myliobatis californica	bat ray	3	355-447	640-1,300	3,240.0
Platyrhinoidis triseriata	thornback	1	186	550	550.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	73	13-58	1.5-42.0	492.1
Octopus spp.	octopus	10	-	40.0-700	2,011.5
Pachygrapsus crassipes	striped shore crab	5	11-35	0.5-9.0	25.7
Cancer productus	red rock crab	2	32-33	4.2-6.0	10.2
Cancer antennarius	brown rock crab	1	36	7.2	7.2
Lophopanopeus spp.	black-clawed crabs	1	80	8.0	8.0
Pandalus platyceros	spot shrimp	1	55	1.8	1.8
Pugettia richii	cryptic kelp crab	1	28	11.0	11.0
Sicyonia ingentis	Ridgeback rock shrimp	1	-	16.0	16.0
	Total:	**5,096**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA031 | **Survey Date: January 19 - 20, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	492	50-179	1.0-30.0	2,256.5
Sardinops sagax	Pacific sardine	32	55-127	2.5-15.5	180.4
Atractoscion nobilis	white seabass	18	80-235	40.0-160	1,521.0
Anchoa delicatissima	slough anchovy	12	55-79	1.0-5.0	29.7
Anchoa compressa	deepbody anchovy	8	60-96	2.5-10.0	36.0
Cymatogaster aggregata	shiner surfperch	6	69-110	9.0-35.0	103.0
Xenistius califoriensis	salema	5	39-55	1.0-3.0	10.0
Hyperprosopon argenteum	walleye surfperch	4	106-141	33.0-72.0	189.0
Paralabrax clathratus	kelp bass	4	53-66	3.0-6.0	20.0
Anisotremus davidsonii	sargo	2	55	2.5-7.0	9.5
Paralabrax maculatofasciatus	spotted sand bass	2	65-79	4.5-9.5	14.0
Paralabrax nebulifer	barred sand bass	2	63-75	4.0-8.0	12.0
Seriphus politus	queenfish	2	47-74	1.0-5.0	6.0
Citharichthys stigmaeus	speckled sanddab	1	38	1.0	1.0
Hypsoblennius spp.	blennies	1	70	7.0	7.0
Hypsopsetta guttulata	diamond turbot	1	253	350	350.0
Leuresthes tenuis	California grunion	1	91	5.0	5.0
Micrometrus minimus	dwarf surfperch	1	67	7.5	7.5
Pleuronichthys ritteri	spotted turbot	1	70	6.5	6.5
SHARKS/RAYS					
Myliobatis californica	bat ray	2	182-404	460-850	1,310.0
Platyrhinoidis triseriata	thornback	2	159-349	200-260	460.0
Gymnura marmorata	California butterfly ray	1	392	380	380.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	40	12-60	1.0-22.0	286.0
Pachygrapsus crassipes	striped shore crab	5	12-33	1.0-10.0	24.5
Blepharipoda occidentalis	spiny mole crab	1	24	9.0	9.0
Cancer productus	red rock crab	1	35	7.0	7.0
Octopus bimaculatus	California two-spot octopus	1	80	110	110.0
Pugettia spp.	kelp crabs	1	32	7.5	7.5
	Total:	649			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA032 | **Survey Date; January 26 - 27, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	243	46-277	1.0-65.0	1,435.4
Anchoa compressa	deepbody anchovy	16	70-111	3.0-15.0	146.9
Seriphus politus	queenfish	11	35-96	1.0-13.0	75.5
Atractoscion nobilis	white seabass	9	159-284	50.0-210	722.0
Cymatogaster aggregata	shiner surfperch	5	62-110	7.0-38.0	86.0
Hypsopsetta guttulata	diamond turbot	3	162-225	85.0-310	615.0
Sardinops sagax	Pacific sardine	3	79-145	5.0-29.0	56.0
Xenistius califoriensis	salema	3	38-52	1.5-3.0	6.5
Phanerodon furcatus	white surfperch	2	87-95	16.0-23.0	39.0
Anchoa delicatissima	slough anchovy	1	61	2.0	2.0
Heterostichus rostratus	giant kelpfish	1	75	3.1	3.1
Hyperprosopon argenteum	walleye surfperch	1	98	21.0	21.0
Micrometrus minimus	dwarf surfperch	1	74	16.0	16.0
Paralabrax clathratus	kelp bass	1	-	0.5	0.5
Paralabrax maculatofasciatus	spotted sand bass	1	65	5.5	5.5
unidentified fish, damaged	unid. damaged fish	1	182	70.0	70.0
SHARKS/RAYS					
Myliobatis californica	bat ray	2	309-395	400-490	890.0
Gymnura marmorata	California butterfly ray	1	365	390	390.0
Torpedo californica	Pacific electric ray	1	311	3,750.0	3,750.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	30	24-51	1.5-23.5	325.0
Pachygrapsus crassipes	striped shore crab	4	12-50	2.0-18.0	42.0
Cancer spp.	cancer crabs	2	28-32	2.0-3.0	5.0
Cancer productus	red rock crab	1	35	5.0	5.0
Caridean unid.	unidentified shrimp	1	-	7.0	7.0
Panulirus interruptus	California spiny lobster	1	-	30.0	30.0
	Total:	**345**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA033 — **Survey Date: February 20 - 03, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	189	38-325	0.5-270	1,381.3
Sardinops sagax	Pacific sardine	19	66-124	4.8-16.0	153.7
Anchoa compressa	deepbody anchovy	10	62-116	3.0-16.0	70.5
Xenistius califoriensis	salema	6	45-59	1.0-4.0	11.5
Hyperprosopon argenteum	walleye surfperch	5	122-165	50.0-100	339.6
Syngnathus spp.	pipefishes	4	162-224	1.1-4.0	9.3
Anisotremus davidsonii	sargo	3	57-69	4.0-7.0	17.5
Micrometrus minimus	dwarf surfperch	2	62-67	7.5-9.0	16.5
Anchoa delicatissima	slough anchovy	1	75	5.0	5.0
Atractoscion nobilis	white seabass	1	307	360	360.0
Cymatogaster aggregata	shiner surfperch	1	77	10.0	10.0
Rhacochilus vacca	pile surfperch	1	214	280	280.0
Paralabrax clathratus	kelp bass	1	65	5.6	5.6
Peprilus simillimus	Pacific butterfish	1	79	11.0	11.0
Phanerodon furcatus	white surfperch	1	87	15.0	15.0
Sarda chiliensis	Pacific bonito	1	362	510	510.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	17	20-58	2.0-18.0	137.8
Pugettia spp.	kelp crabs	4	6-23	0.4-9.0	11.9
Cancer jordani	hairy rock crab	1	33	8.5	8.5
Cancer productus	red rock crab	1	56	17.0	17.0
Dosidicus gigas	jumbo squid	1	625	500	500.0
Pachygrapsus crassipes	striped shore crab	1	10	0.2	0.2
Podochela hemphilli	Hemphill's kelp crab	1	20	3.0	3.0
	Total:	**272**			

Survey: EPSIA034 — **Survey Date: February 09 - 10, 2005**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	115	58-302	2.0-205	903.8
Anchoa delicatissima	slough anchovy	25	39-98	0.3-9.5	60.9
Anchoa compressa	deepbody anchovy	17	73-112	3.0-17.0	192.2
Seriphus politus	queenfish	16	45-112	1.0-20.0	82.7
Cymatogaster aggregata	shiner surfperch	14	70-113	11.0-31.0	251.6
Umbrina roncador	yellowfin croaker	8	74-96	7.0-14.5	82.5
Atractoscion nobilis	white seabass	5	190-265	70.0-245	675.0
Engraulis mordax	northern anchovy	5	42-89	1.0-5.5	14.4
Xenistius califoriensis	salema	5	50-60	2.0-3.5	13.9
Hyperprosopon argenteum	walleye surfperch	4	101-135	45.0-70.0	235.0
Sardinops sagax	Pacific sardine	2	108-111	9.0-12.0	21.0
Hypsopsetta guttulata	diamond turbot	1	206	270	270.0
Paralabrax clathratus	kelp bass	1	65	5.0	5.0
Paralabrax nebulifer	barred sand bass	1	51	2.0	2.0
Paralichthys californicus	California halibut	1	94	13.0	13.0
Roncador stearnsi	spotfin croaker	1	57	3.0	3.0
Syngnathus spp.	pipefishes	1	163	0.6	0.6
unidentified fish, damaged	unid. damaged fish	1	-	100	100.0
SHARKS/RAYS					
Myliobatis californica	bat ray	2	272-530	305-2,000	2,305.0
Ophichthus zophochir	yellow snake eel	1	638	295	295.0
Urolophus halleri	round stingray	1	140	170	170.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	14	16-78	3.0-14.0	99.6
Pachygrapsus crassipes	striped shore crab	3	8-18	0.4-3.0	4.9
Cancer productus	red rock crab	2	33-49	12.0-17.0	29.0
	Total:	**246**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA035 **Survey Date: February 16 - 17, 2005**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	5	-	40.2	40.2
Seriphus politus	queenfish	5	44-52	3.0	15.0
Atherinops affinis	topsmelt	4	-	8.7	8.7
Hyperprosopon argenteum	walleye surfperch	2	131-134	45.0-81.0	126.0
Paralabrax maculatofasciatus	spotted sand bass	2	-	14.6	14.6
Paralabrax nebulifer	barred sand bass	2	50-84	3.2-14.0	17.2
Atherinopsis californiensis	jacksmelt	1	273	160	160.0
Hypsoblennius jenkinsi	mussel blenny	1	57	4.3	4.3
Porichthys myriaster	specklefin midshipman	1	380	800	800.0
INVERTEBRATES					
Pachygrapsus spp.	shore crab	417	-	50.0	871.0
Pachygrapsus crassipes	striped shore crab	274	3-37	0.5-21.5	768.5
Cancer productus	red rock crab	13	10-55	1.0-22.0	130.1
Portunus xantusii	Xantus' swimming crab	7	20-35	2.0-7.0	30.0
Brachyuran unid.	unidentified crab	1	-	150-200	350.0
Pugettia producta	northern kelp crab	1	22	3.5	3.5
Pugettia spp.	kelp crabs	1	-	0.5	0.5
	Total:	737			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA036
Sample Count: 13

Survey Date: February 23 - 24, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	306	54-120	2.0-21.0	3,203.2
Atherinops affinis	topsmelt	304	57-171	1.2-54.7	4,887.9
Cymatogaster aggregata	shiner surfperch	189	72-188	8.9-61.0	5,211.9
Chub unid.	unid. chub	91	62-164	3.0-100	845.5
Paralabrax maculatofasciatus	spotted sand bass	88	43-315	2.0-670	1,318.9
Paralabrax nebulifer	barred sand bass	64	42-94	2.0-15.0	439.8
Hyperprosopon argenteum	walleye surfperch	36	110-164	36.0-116.4	2,564.4
Ictaluridae	unid. catfish	33	124-259	60.0-300	4,123.0
Fundulus parvipinnis	California killifish	31	66-91	4.0-12.0	235.5
Anchoa delicatissima	slough anchovy	24	57-74	2.0-5.0	73.5
Seriphus politus	queenfish	21	49-172	2.0-79.0	410.5
Lepomis macrochirus	bluegill	16	42-135	2.0-86.9	513.7
Lepomis cyanellus	green sunfish	15	47-168	3.0-138	532.0
Anisotremus davidsonii	sargo	10	53-81	3.5-13.0	68.4
Hypsopsetta guttulata	diamond turbot	7	25-233	0.8-260	956.8
Paralichthys californicus	California halibut	6	47-221	1.5-170	200.8
Atractoscion nobilis	white seabass	4	239-432	155-260	775.0
Pylodictis olivaris	flathead catfish	4	158-210	90.0-170	480.0
Chromis punctipinnis	blacksmith	3	55-101	4.0-21.0	32.0
Phanerodon furcatus	white surfperch	3	156-191	85.8-180	385.8
unidentified fish, damaged	unid. damaged fish	3	40-95	1.0-60.0	62.5
Paralabrax clathratus	kelp bass	2	65-90	5.0-14.0	19.0
Ameiurus nebulosus	brown bullhead	1	149	100	100.0
Citharichthys stigmaeus	speckled sanddab	1	45	3.0	3.0
Embiotoca jacksoni	black surfperch	1	225	370	370.0
Heterostichus rostratus	giant kelpfish	1	183	50.0	50.0
Lepomis spp.	sunfishes	1	141	130	130.0
Micrometrus minimus	dwarf surfperch	1	57	5.0	5.0
Micropterus dolomieu	smallmouth bass	1	186	150	150.0
Pleuronectiformes unid.	flatfishes	1	38	0.5	0.5
Syngnathus spp.	pipefishes	1	105	1.0	1.0
Xenistius califoriensis	salema	1	48	1.8	1.8
SHARKS/RAYS					
Ophichthus zophochir	yellow snake eel	4	549-769	150-450	1,380.0
INVERTEBRATES					
Octopus spp.	octopus	17	17-117	16.0-520	3,170.0
Portunus xantusii	Xantus' swimming crab	15	11-52	1.3-14.0	73.8
Pachygrapsus crassipes	striped shore crab	6	11-22	1.0-4.0	13.0
Octopus bimaculatus	California two-spot octopus	3	90-95	240-370	940.0
Blepharipoda occidentalis	spiny mole crab	1	18	3.0	3.0
	Total:	**1,316**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA037 — **Survey Date; March 02 - 03, 2005**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	18	47-74	1.2-5.5	45.4
Atherinops affinis	topsmelt	8	65-112	0.4-13.7	55.7
Roncador stearnsi	spotfin croaker	5	70-550	5.5-1,700	3,024.6
Anchoa compressa	deepbody anchovy	3	64-98	3.0-8.6	20.0
Phanerodon furcatus	white surfperch	3	79-175	10.9-130.8	179.1
Citharichthys stigmaeus	speckled sanddab	2	60-68	3.4-4.0	7.4
Anisotremus davidsonii	sargo	1	61	4.5	4.5
Cymatogaster aggregata	shiner surfperch	1	107	26.5	26.5
Dorosoma petenense	threadfin shad	1	69	3.4	3.4
Hypsopsetta guttulata	diamond turbot	1	215	226	226.0
Micrometrus minimus	dwarf surfperch	1	69	7.9	7.9
Paralabrax nebulifer	barred sand bass	1	65	5.7	5.7
Paralichthys californicus	California halibut	1	128	30.3	30.3
Syngnathus spp.	pipefishes	1	127	0.5	0.5
unidentified fish, damaged	unid. damaged fish	1	-	1.2	1.2
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	13	19-48	1.3-15.2	84.2
Pachygrapsus crassipes	striped shore crab	6	8-42	0.6-48.5	73.9
Octopus spp.	octopus	1	95	266.5	266.5
	Total:	**68**			

Survey: EPSIA038 — **Survey Date: March 09 - 10, 2005**
Sample Count: 13

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Seriphus politus	queenfish	36	45-80	1.7-7.4	124.6
Atherinops affinis	topsmelt	25	60-152	2.0-33.5	299.9
Cymatogaster aggregata	shiner surfperch	17	76-119	12.0-35.5	350.7
Hypsopsetta guttulata	diamond turbot	10	185-235	160-281	2,126.3
Paralabrax clathratus	kelp bass	6	49-65	2.2-5.6	22.9
Paralabrax maculatofasciatus	spotted sand bass	5	43-80	2.0-11.1	33.2
Paralabrax nebulifer	barred sand bass	4	50-83	2.5-14.1	27.5
Anchoa compressa	deepbody anchovy	3	90-110	9.1-12.8	34.7
Roncador stearnsi	spotfin croaker	3	67-81	4.8-9.5	20.4
Anchoa delicatissima	slough anchovy	2	58-62	2.3-2.8	5.1
Atherinopsis californiensis	jacksmelt	2	110-158	14.8-31.8	46.6
Engraulis mordax	northern anchovy	2	35-38	0.3-0.5	0.8
Anisotremus davidsonii	sargo	1	56	3.9	3.9
Citharichthys stigmaeus	speckled sanddab	1	60	5.2	5.2
Fundulus parvipinnis	California killifish	1	65	4.9	4.9
Gillichthys mirabilis	longjaw mudsucker	1	125	34.4	34.4
Leptocottus armatus	Pacific staghorn sculpin	1	98	15.1	15.1
Micrometrus minimus	dwarf surfperch	1	64	7.3	7.3
Peprilus simillimus	Pacific butterfish	1	85	13.8	13.8
Phanerodon furcatus	white surfperch	1	123	35.9	35.9
Porichthys myriaster	specklefin midshipman	1	330	500	500.0
Sardinops sagax	Pacific sardine	1	114	8.9	8.9
unidentified fish	unid. fish	1	39	0.9	0.9
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	2	347-423	362-671	1,032.7
Platyrhinoidis triseriata	thornback	2	196-395	365-371	735.8
Myliobatis californica	bat ray	1	343	647.0	647.3
Urolophus halleri	round stingray	1	180	448.0	447.7
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	66	16-46	1.1-9.4	260.7
Pachygrapsus crassipes	striped shore crab	5	10-40	0.5-36.8	49.7
Pyromaia tuberculata	tuberculate pea crab	2	5-8	0.2-0.4	`
Octopus spp.	octopus	1	90	319.5	319.5
	Total:	**206**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA039
Sample Count: 13

Survey Date: March 16 - 17, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	6	76-138	4.2-28.4	138.6
Anchoa delicatissima	slough anchovy	3	63-72	2.7-3.8	9.5
Cymatogaster aggregata	shiner surfperch	3	40-120	1.4-45.6	83.4
Roncador stearnsi	spotfin croaker	3	57-71	4.7-7.1	17.8
Seriphus politus	queenfish	3	55-65	2.0-3.7	9.3
Hypsopsetta guttulata	diamond turbot	2	210-235	233-281	513.5
Anchoa compressa	deepbody anchovy	1	58	1.7	1.7
Brachyistius frenatus	kelp surfperch	1	80	17.0	17.0
Fundulus parvipinnis	California killifish	1	70	5.4	5.4
Hyperprosopon argenteum	walleye surfperch	1	129	51.2	51.2
Leuresthes tenuis	California grunion	1	74	3.1	3.1
Lyopsetta exilis	slender sole	1	124	25.9	25.9
Paralabrax maculatofasciatus	spotted sand bass	1	54	2.7	2.7
Paralabrax nebulifer	barred sand bass	1	62	3.9	3.9
Syngnathus spp.	pipefishes	1	190	1.8	1.8
Xenistius califoriensis	salema	1	53	2.8	2.8
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	10	21-44	1.0-11.3	30.8
Pachygrapsus crassipes	striped shore crab	6	10-28	1.1-8.4	31.2
	Total:	**46**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA040
Sample Count: 19

Survey Date: March 23 - 24, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	77	60-155	2.0-50.2	776.2
Cymatogaster aggregata	shiner surfperch	62	33-123	0.8-41.6	1,385.7
Seriphus politus	queenfish	31	35-111	1.3-14.0	155.4
Anchoa compressa	deepbody anchovy	25	54-80	1.6-5.4	73.2
Anchoa delicatissima	slough anchovy	14	55-70	2.3-3.7	40.6
Roncador stearnsi	spotfin croaker	9	64-83	3.0-12.4	57.6
Syngnathus spp.	pipefishes	9	183-235	1.6-3.5	22.0
Strongylura exilis	California needlefish	6	330-538	37.5-181	592.8
Genyonemus lineatus	white croaker	4	31-34	0.6	2.7
Leuresthes tenuis	California grunion	4	70-104	3.3-9.2	20.9
Paralabrax nebulifer	barred sand bass	4	59-64	3.8-5.2	18.3
Hypsopsetta guttulata	diamond turbot	3	205-224	184.4-203.0	574.8
Leptocottus armatus	Pacific staghorn sculpin	3	60-105	3.3-18.8	28.6
Phanerodon furcatus	white surfperch	3	41-166	8.8-87.7	116.2
Anisotremus davidsonii	sargo	2	55-59	4.3-5.0	9.3
Chromis punctipinnis	blacksmith	2	119-125	32.7-35.0	67.7
Hyperprosopon argenteum	walleye surfperch	2	39-177	1.5-190	191.1
Paralabrax clathratus	kelp bass	2	74-76	5.6-8.0	13.6
Pleuronectiformes unid.	flatfishes	2	55-60	3.2-3.7	6.9
Citharichthys stigmaeus	speckled sanddab	1	60	2.9	2.9
Engraulis mordax	northern anchovy	1	87	3.9	3.9
Fundulus parvipinnis	California killifish	1	66	5.2	5.2
Hypsoblennius gilberti	rockpool blenny	1	70	6.3	6.3
Paralabrax maculatofasciatus	spotted sand bass	1	53	2.6	2.6
Peprilus simillimus	Pacific butterfish	1	87	14.3	14.3
Pleuronichthys verticalis	hornyhead turbot	1	138	68.9	68.9
Porichthys myriaster	specklefin midshipman	1	370	350	350.0
Umbrina roncador	yellowfin croaker	1	70	5.4	5.4
unidentified fish	unid. fish	1	156	77.6	77.6
unidentified fish, damaged	unid. damaged fish	1	65	1.6	1.6
Xenistius califoriensis	salema	1	51	2.9	2.9
SHARKS/RAYS					
Ophichthus zophochir	yellow snake eel	2	750-752	393-457	849.4
Urolophus halleri	round stingray	2	119-120	95.2-98.0	193.2
Gymnura marmorata	California butterfly ray	1	395	185.0	185.0
Rhinobatos productus	shovelnose guitarfish	1	775	1,800.0	1,800.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	56	9-46	0.9-19.0	200.2
Pachygrapsus crassipes	striped shore crab	9	15-40	1.0-31.9	95.6
	Total:	**347**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA041
Sample Count: 19

Survey Date: March 30 - 31, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	85	58-135	2.5-21.7	552.4
Seriphus politus	queenfish	44	40-130	1.8-33.4	258.7
Cymatogaster aggregata	shiner surfperch	36	32-125	0.6-43.9	798.4
Anchoa compressa	deepbody anchovy	13	65-111	1.6-17.3	98.9
Paralabrax nebulifer	barred sand bass	11	49-75	2.4-8.6	50.9
Hyperprosopon argenteum	walleye surfperch	8	27-43	0.5-1.8	10.8
Anchoa delicatissima	slough anchovy	5	58-69	2.0-3.4	13.3
Anisotremus davidsonii	sargo	5	54-68	3.8-7.0	26.7
Embiotoca jacksoni	black surfperch	5	46-64	3.0-6.8	20.5
Leuresthes tenuis	California grunion	5	64-131	1.2-17.0	43.3
Umbrina roncador	yellowfin croaker	5	65-108	4.8-20.0	45.2
Paralichthys californicus	California halibut	2	70-176	2.2-33.7	35.9
Phanerodon furcatus	white surfperch	2	41-50	1.8-2.5	4.3
Genyonemus lineatus	white croaker	1	45	1.6	1.6
Hypsoblennius gentilis	bay blenny	1	42	1.6	1.6
Menticirrhus undulatus	California corbina	1	262	277.5	277.5
Paralabrax maculatofasciatus	spotted sand bass	1	80	9.6	9.6
Roncador stearnsi	spotfin croaker	1	77	7.5	7.5
Strongylura exilis	California needlefish	1	324	26.3	26.3
Syngnathus spp.	pipefishes	1	207	3.6	3.6
Xenistius califoriensis	salema	1	55	3.1	3.1
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	2	330-398	305-550	855.2
Urolophus halleri	round stingray	2	104-108	56.0-62.1	118.1
Platyrhinoidis triseriata	thornback	1	279	1,500.0	1,500.0
Rhinobatos productus	shovelnose guitarfish	1	1126	4,400.0	4,400.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	20	15-58	0.9-16.8	77.1
Pachygrapsus crassipes	striped shore crab	17	5-40	0.3-31.9	85.4
	Total:	277			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA042 **Survey Date: April 6 - 7, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	29	42-131	3.0-65.2	732.7
Atherinops affinis	topsmelt	23	60-127	3.0-24.0	238.0
Seriphus politus	queenfish	17	55-81	4.0-10.0	94.5
Hyperprosopon argenteum	walleye surfperch	6	40-161	2.0-100	204.0
Anchoa compressa	deepbody anchovy	4	68-78	4.0-6.5	19.0
Atherinopsis californiensis	jacksmelt	4	75-252	5.0-140	177.0
Leuresthes tenuis	California grunion	4	78-151	3.8-28.0	58.8
Embiotoca jacksoni	black surfperch	3	53-218	4.5-452	464.0
Porichthys myriaster	specklefin midshipman	3	370-410	800-1,250	2,950.0
Paralabrax nebulifer	barred sand bass	2	50-56	3.0-4.0	7.0
Amphistichus argenteus	barred surfperch	1	42	2.0	2.0
Anchoa delicatissima	slough anchovy	1	63	3.5	3.5
Anisotremus davidsonii	sargo	1	68	8.5	8.5
Chromis punctipinnis	blacksmith	1	95	18.5	18.5
Engraulis mordax	northern anchovy	1	57	2.5	2.5
Genyonemus lineatus	white croaker	1	110	21.0	21.0
Paralabrax maculatofasciatus	spotted sand bass	1	65	7.0	7.0
Sardinops sagax	Pacific sardine	1	128	19.5	19.5
Strongylura exilis	California needlefish	1	345	45.0	45.0
Syngnathus leptorhynchus	bay pipefish	1	208	4.0	4.0
Xenistius califoriensis	salema	1	52	4.0	4.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	2	415-462	600-1,050	1,650.0
Urolophus halleri	round stingray	1	168	420	420.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	40	17-70	1.5-20.0	300.0
Pachygrapsus crassipes	striped shore crab	8	17-32	3.0-13.5	43.0
Hippolytidae unid.	hippolytid shrimps	1	-	-	-
	Total:	**158**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA043 **Survey Date: April 13 - 14, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	93	48-143	6.9-59.8	1,565.9
Atherinops affinis	topsmelt	35	65-155	3.0-39.9	415.6
Anisotremus davidsonii	sargo	13	40-91	3.9-25.2	127.2
Paralabrax maculatofasciatus	spotted sand bass	10	65-263	3.9-259.1	398.9
Anchoa compressa	deepbody anchovy	9	80-120	6.6-22.5	123.9
Leuresthes tenuis	California grunion	6	110-160	7.6-23.1	83.4
Hyperprosopon argenteum	walleye surfperch	5	40-50	1.6-2.5	10.1
Atherinopsis californiensis	jacksmelt	3	194-325	61.4-223	462.1
Paralabrax clathratus	kelp bass	3	65-75	3.2-5.6	12.5
Seriphus politus	queenfish	3	61-84	3.5-7.7	15.2
Chromis punctipinnis	blacksmith	2	154-156	106.6-143.1	249.7
Embiotoca jacksoni	black surfperch	2	56-58	4.3-4.4	8.7
Girella nigricans	opaleye	2	140-190	86.0-260.1	346.1
Hermosilla azurea	zebra perch	2	73-255	10.9-445	455.9
Hypsopsetta guttulata	diamond turbot	2	155-198	107.3-185.1	292.4
Leptocottus armatus	Pacific staghorn sculpin	2	58-66	3.5	7.0
Porichthys myriaster	specklefin midshipman	2	263-352	271-673	943.5
Roncador stearnsi	spotfin croaker	2	80-222	9.5-174.1	183.6
Anchoa delicatissima	slough anchovy	1	70	3.8	3.8
Genyonemus lineatus	white croaker	1	169	92.6	92.6
Heterostichus rostratus	giant kelpfish	1	88	4.9	4.9
Hypsoblennius gentilis	bay blenny	1	58	4.7	4.7
Hypsoblennius jenkinsi	mussel blenny	1	91	13.0	13.0
Paralabrax nebulifer	barred sand bass	1	221	266.7	266.7
Paralichthys californicus	California halibut	1	107	18.2	18.2
Phanerodon furcatus	white surfperch	1	213	215.1	215.1
Umbrina roncador	yellowfin croaker	1	60	4.6	4.6
unidentified fish, damaged	unid. damaged fish	1	-	91.8	91.8
Xenistius califoriensis	salema	1	50	2.4	2.4
SHARKS/RAYS					
Urolophus halleri	round stingray	9	96-198	37.6-521.1	2,298.0
Gymnura marmorata	California butterfly ray	2	365-393	443.8-512.9	956.7
Myliobatis californica	bat ray	2	352-354	673-790	1,463.2
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	170	7-31	0.3-14.8	544.1
Portunus xantusii	Xantus' swimming crab	13	18-51	1.5-19.2	85.9
Cancer productus	red rock crab	1	19	-1.4	1.4
	Total:	**404**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA044
Sample Count: 19

Survey Date: April 20 - 21, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	32	43-122	1.9-31.8	477.6
Anchoa compressa	deepbody anchovy	16	65-119	3.2-18.7	159.0
Hyperprosopon argenteum	walleye surfperch	11	41-225	1.7-275.3	465.4
Anisotremus davidsonii	sargo	7	60-75	4.8-9.0	46.8
Atherinops affinis	topsmelt	7	73-133	3.7-23.3	112.1
Seriphus politus	queenfish	6	68-99	4.7-15.7	48.3
Anchoa delicatissima	slough anchovy	4	65-74	2.6-4.9	14.9
Porichthys myriaster	specklefin midshipman	2	270-335	227-482	708.8
Cheilopogon pinnatibarbatus	spotted flyingfish	1	114	2.9	2.9
Leptocottus armatus	Pacific staghorn sculpin	1	65	4.6	4.6
Leuresthes tenuis	California grunion	1	110	11.0	11.0
Paralabrax nebulifer	barred sand bass	1	50	2.3	2.3
Phanerodon furcatus	white surfperch	1	36	1.0	1.0
Porichthys spp.	midshipman	1	-	200	200.0
Roncador stearnsi	spotfin croaker	1	77	8.6	8.6
Strongylura exilis	California needlefish	1	390	57.9	57.9
unidentified fish, damaged	unid. damaged fish	1	-	200	200.0
SHARKS/RAYS					
Urolophus halleri	round stingray	2	100	63.3-150	213.3
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	12	18-40	1.5-13.7	65.9
Pachygrapsus crassipes	striped shore crab	10	4-50	0.2-53.0	82.5
Octopus spp.	octopus	1	-	139.7	139.7
	Total:	**119**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA045 **Survey Date: April 27 - 28, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	63	39-122	1.2-42.0	810.1
Atherinops affinis	topsmelt	10	78-136	6.1-23.7	135.0
Hyperprosopon argenteum	walleye surfperch	5	39-115	1.1-49.3	103.2
Leptocottus armatus	Pacific staghorn sculpin	4	70-80	4.9-7.7	27.5
Paralabrax nebulifer	barred sand bass	4	53-91	4.4-14.0	28.4
Anchoa compressa	deepbody anchovy	3	80-100	2.3-13.3	21.9
Anchoa delicatissima	slough anchovy	2	61-97	2.9-9.1	12.0
Anisotremus davidsonii	sargo	2	63-72	5.7-10.3	16.0
Paralabrax clathratus	kelp bass	2	61-76	5.1-8.1	13.2
Mugil cephalus	striped mullet	1	57	3.4	3.4
Paralichthys californicus	California halibut	1	101	14.6	14.6
Peprilus simillimus	Pacific butterfish	1	47	2.2	2.2
Porichthys myriaster	specklefin midshipman	1	252	190.0	189.5
Seriphus politus	queenfish	1	71	6.9	6.9
Xenistius califoriensis	salema	1	70	7.6	7.6
SHARKS/RAYS					
Myliobatis californica	bat ray	1	566	2,500.0	2,500.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	6	19-33	1.8-4.9	18.1
Pachygrapsus crassipes	striped shore crab	2	11-12	2.9-3.4	6.3
	Total:	**110**			

Survey: EPSIA046 **Survey Date: May 4 - 5, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	169	29-148	0.6-78.6	1,251.5
Anchoa compressa	deepbody anchovy	35	48-100	1.5-13.7	145.2
Atherinops affinis	topsmelt	23	60-126	2.0-26.0	211.4
Hyperprosopon argenteum	walleye surfperch	14	48-157	2.2-94.9	162.4
Seriphus politus	queenfish	6	60-91	2.6-10.3	38.0
Leuresthes tenuis	California grunion	5	71-112	3.5-17.4	37.3
Paralabrax nebulifer	barred sand bass	5	61-80	4.7-11.6	38.1
Paralabrax maculatofasciatus	spotted sand bass	4	75-82	9.1-90.0	122.6
Sebastes atrovirens	kelp rockfish	4	68-90	5.6-16.4	39.8
Paralichthys californicus	California halibut	3	22-80	6.2-9.3	21.9
Citharichthys stigmaeus	speckled sanddab	2	70-79	5.5-6.4	11.9
Leptocottus armatus	Pacific staghorn sculpin	2	73-84	5.3-7.3	12.6
Porichthys myriaster	specklefin midshipman	2	80-82	9.9-12.1	22.0
Anisotremus davidsonii	sargo	1	64	7.4	7.4
Heterostichus rostratus	giant kelpfish	1	85	2.9	2.9
Strongylura exilis	California needlefish	1	400	66.0	66.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	1	555	1,508.0	1,508.0
Ophichthus zophochir	yellow snake eel	1	-	17.8	17.8
Urolophus halleri	round stingray	1	204	525	525.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	4	10-30	1.3-4.8	9.2
Portunus xantusii	Xantus' swimming crab	3	40-50	2.2-11.9	19.4
	Total:	**287**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA047
Sample Count: 19

Survey Date: May 11 - 12, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	89	33-112	0.7-39.2	1,120.1
Phanerodon furcatus	white surfperch	30	30-161	0.7-90.6	179.2
Atherinops affinis	topsmelt	20	45-145	0.7-74.5	232.0
Anchoa compressa	deepbody anchovy	11	75-110	4.1-15.2	103.7
Leptocottus armatus	Pacific staghorn sculpin	9	68-94	5.7-15.7	82.5
Seriphus politus	queenfish	8	71-91	4.6-12.5	64.5
Amphistichus argenteus	barred surfperch	4	53-62	3.7-6.0	18.1
Hyperprosopon argenteum	walleye surfperch	3	50-138	2.8-65.0	72.6
Leuresthes tenuis	California grunion	3	64-140	2.3-17.8	25.7
Porichthys myriaster	specklefin midshipman	3	179-422	258-1,141	1,729.3
Xenistius califoriensis	salema	3	56-70	3.7-7.4	18.1
Anchoa delicatissima	slough anchovy	2	60	2.3-2.4	4.7
Strongylura exilis	California needlefish	2	465-509	105-181	286.0
Anisotremus davidsonii	sargo	1	66	8.7	8.7
Engraulis mordax	northern anchovy	1	40	0.7	0.7
Hypsoblennius gentilis	bay blenny	1	40	1.5	1.5
Paralabrax maculatofasciatus	spotted sand bass	1	73	6.9	6.9
Paralabrax nebulifer	barred sand bass	1	76	8.7	8.7
Syngnathus leptorhynchus	bay pipefish	1	223	2.9	2.9
SHARKS/RAYS					
Urolophus halleri	round stingray	7	119-250	100-541	2,377.5
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	6	15-56	2.1-21.8	43.0
Pachygrapsus crassipes	striped shore crab	4	12-36	1.3-27.9	59.8
Octopus spp.	octopus	1	110	226.0	225.6
	Total:	**211**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA048 **Survey Date: May 18 - 19, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	211	30-127	0.5-34.9	782.1
Phanerodon furcatus	white surfperch	21	31-72	0.8-7.1	66.6
Anchoa compressa	deepbody anchovy	11	62-116	2.8-18.1	102.1
Hyperprosopon argenteum	walleye surfperch	11	33-117	0.8-31.2	69.0
Atherinops affinis	topsmelt	9	31-134	7.6-24.5	138.8
Porichthys myriaster	specklefin midshipman	9	245-315	167-392	2,419.8
Paralabrax nebulifer	barred sand bass	4	65-73	4.4-7.2	23.5
Seriphus politus	queenfish	4	70-83	4.8-8.4	25.2
Roncador stearnsi	spotfin croaker	3	59-76	3.5-7.4	16.9
Anchoa delicatissima	slough anchovy	2	65-77	3.4-4.8	8.2
Heterostichus rostratus	giant kelpfish	2	63-87	1.7-4.0	5.7
Leptocottus armatus	Pacific staghorn sculpin	2	68-69	6.2-6.7	12.9
Anchoa spp.	anchovy	1	-	1.8	1.8
Anisotremus davidsonii	sargo	1	74	10.3	10.3
Atractoscion nobilis	white seabass	1	155	37.2	37.2
Citharichthys stigmaeus	speckled sanddab	1	63	3.6	3.6
Hypsopsetta guttulata	diamond turbot	1	53	3.6	3.6
Leuresthes tenuis	California grunion	1	40	0.7	0.7
Paralichthys californicus	California halibut	1	50	1.5	1.5
Strongylura exilis	California needlefish	1	470	145.0	145.2
Syngnathus leptorhynchus	bay pipefish	1	221	1.9	1.9
Umbrina roncador	yellowfin croaker	1	95	14.1	14.1
SHARKS/RAYS					
Urolophus halleri	round stingray	13	74-200	23.7-504	3,456.7
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	11	12-24	1.2-9.7	42.6
Portunus xantusii	Xantus' swimming crab	5	25-45	3.9-11.2	40.1
Cancer productus	red rock crab	1	24	2.2	2.2
Loxorhynchus crispatus	moss crab	1	5	0.2	0.2
Pugettia producta	northern kelp crab	1	20	5.2	5.2
Pugettia spp.	kelp crabs	1	23	6.3	6.3
	Total:	**332**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA049
Sample Count: 19

Survey Date: May 25 - 26, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	94	33-110	0.9-30.1	539.1
Seriphus politus	queenfish	20	55-94	2.9-11.8	160.7
Anchoa compressa	deepbody anchovy	18	66-160	2.8-20.5	194.0
Atherinops affinis	topsmelt	14	47-132	1.0-32.8	151.8
Phanerodon furcatus	white surfperch	7	50-75	2.9-6.6	31.8
Hyperprosopon argenteum	walleye surfperch	6	55-147	3.6-88.1	184.8
Porichthys myriaster	specklefin midshipman	6	73-311	5.8-425	994.7
Leptocottus armatus	Pacific staghorn sculpin	5	73-95	7.7-15.4	54.1
Roncador stearnsi	spotfin croaker	5	90-337	13.3-780	840.5
Amphistichus argenteus	barred surfperch	3	54-70	4.7-6.8	18.1
Anchoa delicatissima	slough anchovy	2	61-63	2.7-3.1	5.8
Strongylura exilis	California needlefish	2	281-367	22.8-58.4	81.2
Anisotremus davidsonii	sargo	1	81	11.9	11.9
Rhacochilus vacca	pile surfperch	1	71	10.1	10.1
Embiotoca jacksoni	black surfperch	1	65	7.1	7.1
Engraulis mordax	northern anchovy	1	77	3.3	3.3
Paralabrax clathratus	kelp bass	1	65	4.8	4.8
Paralabrax maculatofasciatus	spotted sand bass	1	62	4.3	4.3
Paralabrax nebulifer	barred sand bass	1	111	30.4	30.4
Paralichthys californicus	California halibut	1	117	22.2	22.2
Sardinops sagax	Pacific sardine	1	165	47.7	47.7
Syngnathus spp.	pipefishes	1	85	0.2	0.2
SHARKS/RAYS					
Urolophus halleri	round stingray	2	119-176	87.3-378	465.1
Gymnura marmorata	California butterfly ray	1	395	581	580.9
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	13	10-40	0.4-40.0	82.6
Portunus xantusii	Xantus' swimming crab	5	23-29	1.1-5.7	18.2
Cancer productus	red rock crab	2	26-30	2.5-3.7	6.2
	Total:	**215**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA050 | **Survey Date: June 1 - 2, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	140	27-110	1.2-29.4	693.4
Phanerodon furcatus	white surfperch	19	51-78	3.1-8.7	115.6
Atherinops affinis	topsmelt	11	86-130	4.6-26.9	105.4
Anchoa compressa	deepbody anchovy	9	76-105	4.8-14.2	90.2
Porichthys myriaster	specklefin midshipman	6	240-280	134-281	1,152.8
Seriphus politus	queenfish	6	38-81	0.7-7.6	17.7
Anchoa delicatissima	slough anchovy	5	35-67	0.8-3.2	8.2
Hyperprosopon argenteum	walleye surfperch	5	51-60	3.6-5.3	22.8
Paralichthys californicus	California halibut	4	40-155	2.9-41.1	106.3
Citharichthys stigmaeus	speckled sanddab	3	41-71	1.0-5.7	10.5
Paralabrax clathratus	kelp bass	3	57-75	3.8-6.2	15.8
Genyonemus lineatus	white croaker	2	82-86	9.0-10.7	19.7
Heterostichus rostratus	giant kelpfish	2	75-122	2.8-12.0	14.8
Paralabrax nebulifer	barred sand bass	2	63	4.2-5.9	10.1
Atractoscion nobilis	white seabass	1	441	980	980.0
Hypsopsetta guttulata	diamond turbot	1	55	3.0	3.0
Leuresthes tenuis	California grunion	1	51	1.1	1.1
Paralabrax maculatofasciatus	spotted sand bass	1	250	293.0	292.5
Sardinops sagax	Pacific sardine	1	40	1.0	1.0
SHARKS/RAYS					
Gymnura marmorata	California butterfly ray	2	226-339	119-274	393.0
Urolophus halleri	round stingray	2	171-297	276-460	735.7
Myliobatis californica	bat ray	1	940	975	975.0
Rhinobatos productus	shovelnose guitarfish	1	374	160.8	160.8
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	10	12-25	1.5-3.6	26.9
Pyromaia tuberculata	tuberculate pea crab	4	10-18	1.0-3.3	7.8
Portunus xantusii	Xantus' swimming crab	2	30-37	3.9-8.6	12.5
Cancer spp.	cancer crabs	1	28	3.0	3.0
Majidae	spider crabs	1	13	1.8	1.8
Pugettia spp.	kelp crabs	1	11	0.9	0.9
	Total:	**247**			

Encina Power Station Impingement Abundance: Traveling Screen and Bar Rack Survey Data

Survey: EPSIA051 | **Survey Date: June 8 - 9, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	129	30-93	1.1-19.1	491.1
Atherinops affinis	topsmelt	28	18-209	0.8-51.2	366.3
Anchoa compressa	deepbody anchovy	14	24-82	0.4-7.3	28.5
Paralichthys californicus	California halibut	11	50-128	2.1-30.3	163.3
Engraulis mordax	northern anchovy	10	36-110	0.2-10.5	19.9
Seriphus politus	queenfish	10	68-110	4.6-19.2	95.4
Porichthys myriaster	specklefin midshipman	7	235-413	156-739	1,796.8
Phanerodon furcatus	white surfperch	4	48-67	3.2-7.6	19.6
Amphistichus argenteus	barred surfperch	3	60-74	5.5-10.9	25.7
Leptocottus armatus	Pacific staghorn sculpin	3	81-85	8.5-13.7	35.3
Strongylura exilis	California needlefish	3	368-534	42.3-225	430.6
Heterostichus rostratus	giant kelpfish	2	80-95	3.6-6.0	9.6
Sardinops sagax	Pacific sardine	2	131-132	23.7-25.6	49.3
Anchoa spp.	anchovy	1	-	8.5	8.5
Hyperprosopon argenteum	walleye surfperch	1	57	4.2	4.2
Hypsoblennius gentilis	bay blenny	1	69	6.4	6.4
Hypsopsetta guttulata	diamond turbot	1	54	3.7	3.7
SHARKS/RAYS					
Myliobatis californica	bat ray	2	206-255	188-290	477.8
Ophichthus zophochir	yellow snake eel	1	787	595.0	594.6
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	5	18-20	0.9-5.5	13.0
	Total:	**239**			

Survey: EPSIA052 | **Survey Date: June 15 - 16, 2005**
Sample Count: 19

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	19	45-109	2.2-25.2	105.4
Engraulis mordax	northern anchovy	4	59-67	1.0-2.6	7.4
Porichthys myriaster	specklefin midshipman	3	230-290	142-243	594.3
Atherinops affinis	topsmelt	2	90-95	4.5-5.3	9.8
Heterostichus rostratus	giant kelpfish	2	61-95	1.3-5.6	6.9
Anchoa compressa	deepbody anchovy	1	-	4.2	4.2
Atractoscion nobilis	white seabass	1	340	411	411.0
Citharichthys stigmaeus	speckled sanddab	1	70	4.9	4.9
Paralabrax maculatofasciatus	spotted sand bass	1	300	761.0	761.4
Phanerodon furcatus	white surfperch	1	60	5.8	5.8
Seriphus politus	queenfish	1	50	1.6	1.6
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	7	15-27	0.5-6.6	18.4
Portunus xantusii	Xantus' swimming crab	1	35	6.1	6.1
	Total:	**45**			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS001
Survey Date: July 03-04, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	6,554	47-115	2.9-31.1	31,301.3
Anchoa compressa	deepbody anchovy	6,439	65-120	2.2-20.5	61,726.7
Atherinops affinis	topsmelt	5,061	52-108	1.1-15.0	16,090.2
Sardinops sagax	Pacific sardine	4,401	47-106	0.8-8.5	8,798.2
Heterostichus rostratus	giant kelpfish	532	47-122	1.1-19.4	3,587.8
Atractoscion nobilis	white seabass	75	108-366	19.0-650	16,045.0
Girella nigricans	opaleye	72	44-221	3.0-390	6,223.0
Seriphus politus	queenfish	54	83-188	8.0-80.0	2,293.0
Strongylura exilis	California needlefish	53	102-630	1.0-480	806.0
Paralabrax maculatofasciatus	spotted sand bass	49	100-358	30.0-980	8,941.7
Embiotoca jacksoni	black surfperch	39	82-197	17.0-270	1,754.0
Porichthys myriaster	specklefin midshipman	28	124-403	140-820	8,733.0
Chromis punctipinnis	blacksmith	26	65-163	6.0-140	720.0
Hypsoblennius gentilis	bay blenny	26	40-91	3.0-25.0	354.3
Syngnathus spp.	pipefishes	25	128-251	1.0-3.0	29.3
Hypsoblennius spp.	blennies	23	35-54	1.0-3.0	46.7
Ophichthus zophochir	yellow snake eel	14	488-790	110-650	4,750.0
Roncador stearnsi	spotfin croaker	12	80-145	11.0-48.0	395.0
Hyperprosopon argenteum	walleye surfperch	8	78-150	12.0-60.0	366.0
Paralabrax nebulifer	barred sand bass	8	119-252	40.0-320	819.0
Hypsopsetta guttulata	diamond turbot	4	195-228	210-300	980.0
Hypsypops rubicundus	garibaldi	3	122-169	73.0-230	523.0
Trachurus symmetricus	jack mackerel	3	111-142	17.0-40.0	78.0
Umbrina roncador	yellowfin croaker	2	137-150	43.0-61.0	104.0
Xenistius califoriensis	salema	2	88-98	17.0-60.0	77.0
Anisotremus davidsonii	sargo	1	130	44.0	44.0
Cheilotrema saturnum	black croaker	1	48	3.0	3.0
Paraclinus integripinnis	reef finspot	1	49	3.0	3.0
Paralabrax clathratus	kelp bass	1	157	82.0	82.0
Pleuronichthys ritteri	spotted turbot	1	152	98.0	98.0
Scorpaenidae	scorpionfishes	1	122	62.0	62.0
Sphyraena argentea	California barracuda	1	91	5.0	5.0
SHARKS/RAYS					
Urolophus halleri	round stingray	439	125-230	100-700	118,655.1
Myliobatis californica	bat ray	64	221-660	140-4,700	29,566.1
Gymnura marmorata	California butterfly ray	12	240-550	120-950	4,321.8
Mustelus californicus	gray smoothhound	1	575	520	520.0
Triakis semifasciata	leopard shark	1	411	260	260.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	49	32-46	22.0-45.0	269.0
Octopus spp.	octopus	20	-	2,500.0	2,500.0
Pyromaia tuberculata	tuberculate pea crab	19	-	-	-
Panulirus interruptus	California spiny lobster	1	176	120	120.0
Pugettia spp.	kelp crabs	1	42	26.0	26.0
	Total:	24,127			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS002
Survey Date: August 28, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	5,324	72-120	5.9-20.9	59,754.9
Atherinops affinis	topsmelt	3,201	51-100	1.0-10.6	17,701.4
Cymatogaster aggregata	shiner surfperch	2,801	56-104	5.0-24.5	28,011.1
Sardinops sagax	Pacific sardine	1,206	65-130	1.8-25.0	7,355.5
Leuresthes tenuis	California grunion	998	43-115	0.8-10.4	2,058.8
Heterostichus rostratus	giant kelpfish	299	78-185	2.9-53.6	3,440.4
Seriphus politus	queenfish	265	65-225	2.3-172.3	12,690.8
Atractoscion nobilis	white seabass	64	115-265	40.4-260.7	7,425.4
Cheilotrema saturnum	black croaker	38	64-155	4.8-53.2	617.9
Strongylura exilis	California needlefish	27	109-478	1.0-145.2	1,624.8
Paralabrax maculatofasciatus	spotted sand bass	20	43-335	1.5-925	7,724.0
Hypsoblennius jenkinsi	mussel blenny	18	39-95	0.8-14.7	97.8
Sciaenidae unid.	croaker	17	120-200	32.8-138.0	1,212.0
Chromis punctipinnis	blacksmith	15	55-165	7.0-105	458.8
Girella nigricans	opaleye	14	55-211	4.5-321	1,567.7
Scomber japonicus	Pacific mackerel	14	67-187	14.5-86.8	650.0
Hermosilla azurea	zebra perch	13	35-68	1.1-8.7	41.8
Hypsoblennius gentilis	bay blenny	11	42-95	1.4-15.5	99.5
Paralabrax nebulifer	barred sand bass	11	160-278	82.3-490	2,866.9
Syngnathus spp.	pipefishes	11	154-208	1.0-2.0	16.0
Ophichthus zophochir	yellow snake eel	10	262-900	7.6-750	4,045.4
Hypsoblennius gilberti	rockpool blenny	8	55-101	3.2-29.4	77.1
Paralichthys californicus	California halibut	8	201-322	142-600	2,482.0
Embiotoca jacksoni	black surfperch	7	70-345	15.0-500	1,049.7
Hypsoblennius spp.	blennies	7	45-85	1.3-10.5	20.6
Anisotremus davidsonii	sargo	6	38-180	1.0-142	389.3
Paralabrax spp.	sand bass	6	43-75	1.5-5.8	18.5
Xenistius califoriensis	salema	6	87-132	11.4-34.5	117.0
Atherinopsidae	silverside	5	47-55	1.1-2.9	11.3
Pleuronichthys ritteri	spotted turbot	5	197-220	200-250	1,158.0
Seriola lalandi	yellowtail jack	4	33-99	1.0-32.0	56.0
Sphyraena argentea	California barracuda	4	245-268	55.9-78.2	272.6
Trachurus symmetricus	jack mackerel	4	90-160	7.1-46.8	105.6
Engraulis mordax	northern anchovy	3	64-65	1.8-2.2	5.9
Porichthys myriaster	specklefin midshipman	3	255-328	151-260	586.0
Umbrina roncador	yellowfin croaker	2	150-165	43.9-63.3	107.2
unidentified fish, damaged	unidentified damaged fish	2	165-308	21.6-200	221.6
Hyperprosopon argenteum	walleye surfperch	1	140	64.2	64.2
Menticirrhus undulatus	California corbina	1	510	1,600.0	1,600.0
Paralabrax clathratus	kelp bass	1	138	48.6	48.6
Peprilus simillimus	Pacific butterfish	1	117	33.4	33.4
SHARKS/RAYS					
Urolophus halleri	round stingray	198	198-355	75.0-412	39,361.7
Myliobatis californica	bat ray	31	230-484	200-900	12,310.0
Gymnura marmorata	California butterfly ray	3	265-460	120-700	1,220.0
Mustelus californicus	gray smoothhound	2	805-905	1,400-1,600	3,000.0
Dasyatis dipterura	diamond stingray	1	274	850	850.0

(table continued)

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS002 (continued)
Survey Date: August 28, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
INVERTEBRATES					
Lophopanopeus spp.	black-clawed crabs	26	10-16	0.3-1.8	27.1
Octopus spp.	octopus	17	27-470	1.1-450	1,851.3
Pachygrapsus crassipes	striped shore crab	15	17-35	2.3-24.1	139.7
Panulirus interruptus	California spiny lobster	6	180-211	125-229	944.9
Cancer spp.	cancer crabs	5	21-32	1.7-6.2	16.9
Pugettia producta	northern kelp crab	2	12.5-25	1.3-8.7	10.0
Pandalus spp.	unidentified shrimp	1	42	0.7	0.7
	Total:	**14,768**			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS003
Survey Date: October 23, 2004

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinopsis californiensis	jacksmelt	4,450	59-150	1.7-37.9	44,009.9
Leuresthes tenuis	California grunion	4,296	56-124	1.5-22.5	25,732.5
Anchoa compressa	deepbody anchovy	1,694	67-114	3.7-19.8	20,669.4
Xenistius califoriensis	salema	718	40-68	1.4-7.7	1,510.9
Cymatogaster aggregata	shiner surfperch	512	58-96	4.5-20.5	6,092.9
Sardinops sagax	Pacific sardine	507	65-242	3.2-150	6,274.8
Cheilotrema saturnum	black croaker	249	93-132	16.8-61.5	8,408.2
Paralabrax nebulifer	barred sand bass	207	55-173	4.5-160.7	4,308.5
Paralabrax maculatofasciatus	spotted sand bass	188	45-170	2.1-122.3	3,038.3
Anisotremus davidsonii	sargo	185	54-95	2.6-28.8	1,974.4
Paralabrax clathratus	kelp bass	128	28-96	0.6-23.2	876.0
Hyperprosopon argenteum	walleye surfperch	116	90-152	30.6-118.5	8,891.7
Atractoscion nobilis	white seabass	100	140-264	90.0-320	18,017.0
Hypsoblennius spp.	blennies	83	-	-	422.0
Hypsoblennius jenkinsi	mussel blenny	65	30-80	2.0-16.0	332.0
Engraulis mordax	northern anchovy	59	64-82	2.4-4.9	194.9
Heterostichus rostratus	giant kelpfish	58	80-200	5.1-79.4	1,531.1
Medialuna californiensis	halfmoon	49	43-117	2.5-54.6	1,278.5
Seriphus politus	queenfish	43	40-160	1.0-80.0	1,428.0
Hermosilla azurea	zebra perch	36	37-71	1.7-11.4	216.0
Sphyraena argentea	California barracuda	36	135-233	16.9-74.4	1,250.4
Girella nigricans	opaleye	24	49-256	2.8-740	6,270.3
Seriola lalandi	yellowtail jack	17	80-194	7.8-145.7	922.3
Strongylura exilis	California needlefish	17	400-574	80.0-360	2,650.0
Ophichthus zophochir	yellow snake eel	13	560-790	170-520	4,589.0
Phanerodon furcatus	white surfperch	11	69-120	8.6-39.3	195.0
Chromis punctipinnis	blacksmith	10	47-83	6.1-13.1	96.2
Hyperprosopon spp.	surfperch	7	-	-	552.0
Embiotoca jacksoni	black surfperch	6	78-163	13.7-171.1	525.3
Fundulus parvipinnis	California killifish	3	-	-	6.9
Menticirrhus undulatus	California corbina	3	210-340	110-550	860
Amphistichus argenteus	barred surfperch	1	96	25.4	25.4
Hyporhamphus rosae	California halfbeak	1	-	-	-
Mugil cephalus	striped mullet	1	152	53.9	53.9
Pleuronichthys ritteri	spotted turbot	1	185	180	180.0
Sarda chiliensis	Pacific bonito	1	340	540	540.0
Scomber japonicus	Pacific mackerel	1	250	230	230.0
Trachurus symmetricus	jack mackerel	1	144	39.6	39.6
SHARKS/RAYS					
Urolophus halleri	round stingray	55	230-350	130-560	13,610.0
Myliobatis californica	bat ray	4	280-480	320-1,700	2,930.0
Mustelus californicus	gray smoothhound	1	790	1,500.0	1,500.0
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	375	20-40	1.5-10.1	2,489.6
Octopus bimaculatus	California two-spot octopus	74	-	2.1-230	2,805.9
Octopus spp.	octopus	36	-	1,562.0	1,562.0
Cancer antennarius	brown rock crab	18	-	18.0	18.0
Cancer productus	red rock crab	11	15-55	1.2-10.5	40.0
Pilumnus spinohirsutus	retiring hairycrab	4	9-23	0.6-2.5	4.6
Pugettia producta	northern kelp crab	4	21-28	1.7-4.3	11.3
Portunus xantusii	Xantus' swimming crab	2	45	4.0-6.1	10.1
Panulirus interruptus	California spiny lobster	1	21	8.1	8.1
	Total:	**14,482**			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS004
Survey Date: February 13-14, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Atherinops affinis	topsmelt	3,847	62-151	1.5-90.0	17,444.3
Atherinopsidae	silverside	2,100	-	-	8,650.0
Hyperprosopon argenteum	walleye surfperch	1,828	110-177	34.9-135	80,128.0
Atractoscion nobilis	white seabass	1,375	104-352	65.5-600	289,213.3
Anchoa compressa	deepbody anchovy	643	58-122	1.9-18.8	5,786.5
Xenistius califoriensis	salema	602	43-70	1.4-10.0	2,102.3
Sardinops sagax	Pacific sardine	437	45-184	1.6-71.0	3,190.0
Paralabrax nebulifer	barred sand bass	416	50-127	2.4-43.4	3,323.5
Cymatogaster aggregata	shiner surfperch	343	11-134	1.1-72.8	10,082.7
Leuresthes tenuis	California grunion	330	56-82	1.4-4.8	706.0
Paralabrax clathratus	kelp bass	293	53-102	2.2-20.5	2,397.8
Hypsoblennius gentilis	bay blenny	288	38-102	1.3-23.7	1,334.3
Paralabrax maculatofasciatus	spotted sand bass	271	43-265	1.4-440	3,222.3
Anisotremus davidsonii	sargo	195	49-352	3.4-1,300	33,558.2
Girella nigricans	opaleye	171	28-240	1.6-510	2,674.8
Seriphus politus	queenfish	57	38-292	0.1-225	641.0
Atherinopsis californiensis	jacksmelt	18	112-299	10.9-210	1,142.0
Roncador stearnsi	spotfin croaker	13	238-555	300-3,400	13,831.0
Hypsopsetta guttulata	diamond turbot	12	36-246	1.0-350	2,694.6
Syngnathus spp.	pipefishes	12	146-233	0.3-4.4	20.5
Chromis punctipinnis	blacksmith	11	46-102	2.2-79.5	179.2
Ophichthus zophochir	yellow snake eel	11	394-758	32.7-470	3,222.7
Embiotoca jacksoni	black surfperch	10	105-255	40.9-600	1,403.2
Amphistichus argenteus	barred surfperch	9	96-227	27.3-377.6	680.4
Heterostichus rostratus	giant kelpfish	9	90-225	5.1-110.0	322.1
Genyonemus lineatus	white croaker	8	80-95	8.2-14.3	68.8
Anchoa delicatissima	slough anchovy	7	51-60	0.9-1.9	9.7
Chub, unid.	unid. chub	7	68-81	4.5-7.8	43.7
Hermosilla azurea	zebra perch	7	50-365	2.8-590	2,481.3
Brachyistius frenatus	kelp surfperch	6	76-120	11.0-55.8	198.4
Engraulis mordax	northern anchovy	6	80-125	3.8-15.2	54.1
Pleuronichthys ritteri	spotted turbot	5	200-230	215-250	1,145.0
Mugil cephalus	striped mullet	4	345-400	800-1,100	3,800.0
Phanerodon furcatus	white surfperch	4	112-126	37.7-55.0	190.4
Umbrina roncador	yellowfin croaker	4	185-280	70.0-300	730.0
Paraclinus integripinnis	reef finspot	3	58-70	2.0-4.0	9.2
Paralichthys californicus	California halibut	3	222-350	113-700	1,433.0
Sphyraena argentea	California barracuda	3	167-222	21.9-65.0	127.6
Trachurus symmetricus	jack mackerel	3	95-110	10.0-17.0	42.4
Fundulus parvipinnis	California killifish	2	7.5-7.8	0.4	0.8
Porichthys myriaster	specklefin midshipman	2	395-396	820-900	1,720.0
Strongylura exilis	California needlefish	2	480-490	120-150	270.0
Albula vulpes	bonefish	1	380	900	900.0
Citharichthys spp.	sanddabs	1	-	3.4	3.4
Medialuna californiensis	halfmoon	1	234	410	410.0
Sarda chiliensis	Pacific bonito	1	-	0.1	0.1
Scorpaenidae	scorpionfishes	1	44	1.9	1.9
unidentified fish, damaged	unidentified damaged fish	-	-	-	1,543.2

(table continued)

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS004 (continued)
Survey Date: February 13-14, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
SHARKS/RAYS					
Urolophus halleri	round stingray	10	135-245	101-530	2,576.1
Myliobatis californica	bat ray	4	335-460	200-1,500	3,130.0
Gymnura marmorata	California butterfly ray	2	430-450	800	1,600.0
INVERTEBRATES					
Portunus xantusii	Xantus' swimming crab	44	20-67	1.1-34.4	337.5
Cancer jordani	hairy rock crab	18	28-47	3.2-16.3	85.5
Octopus bimaculatus	California two-spot octopus	11	19-180	12-590	2,424.3
Pachygrapsus crassipes	striped shore crab	9	13-23	1.0-4.4	16.6
Cancer antennarius	brown rock crab	8	40-50	14.9-27.8	138.2
Cancer magister	dungeness crab	1	50	18.1	18.1
Caridean unid.	unidentified shrimp	1	-	-	-
Octopus spp.	octopus	1	30	300	300.0
Pandalus spp.	unidentified shrimp	1	12	2.3	2.3
Panulirus interruptus	California spiny lobster	1	93	150	150.0
Pugettia producta	northern kelp crab	1	17	1.8	1.8
	Total:	**13,494**			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS005
Survey Date: April 10, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Cymatogaster aggregata	shiner surfperch	2,372	90-120	18.0-46.0	93,799.4
Leuresthes tenuis	California grunion	1,443	75-145	3.5-37.9	12,351.6
Anchoa compressa	deepbody anchovy	1,112	58-120	2.0-21.0	10,598.8
Paralabrax nebulifer	barred sand bass	508	54-97	2.6-98.0	4,270.9
Seriphus politus	queenfish	306	56-152	3.1-49.6	2,284.2
Hyperprosopon argenteum	walleye surfperch	298	101-167	30.2-119	19,132.6
Paralabrax clathratus	kelp bass	181	50-94	3.4-18.3	1,546.0
Anisotremus davidsonii	sargo	180	55-100	3.6-30.3	22,582.2
Paralabrax maculatofasciatus	spotted sand bass	139	50-185	3.0-140.3	2,564.2
Hypsoblennius jenkinsi	mussel blenny	92	25-90	1.1-11.6	516.3
Umbrina roncador	yellowfin croaker	90	73-290	7.4-474.2	20,568.5
Xenistius califoriensis	salema	90	50-74	2.1-7.4	409.2
Girella nigricans	opaleye	72	33-197	1.4-309	13,859.1
Hypsopsetta guttulata	diamond turbot	51	75-260	11.2-424	11,199.9
Hypsoblennius gentilis	bay blenny	27	65-105	4.5-23.5	172.7
Porichthys myriaster	specklefin midshipman	24	320-440	100-1,300	20,380.0
Amphistichus argenteus	barred surfperch	19	110-130	26.2-66.4	1,562.7
Chromis punctipinnis	blacksmith	12	60-115	6.4-41.2	294.7
Brachyistius frenatus	kelp surfperch	9	95-145	20.9-65.7	324.9
Strongylura exilis	California needlefish	9	336-490	45.5-148.4	733.3
Engraulis mordax	northern anchovy	7	67-120	2.9-16.5	41.6
Hermosilla azurea	zebra perch	6	104-249	16.2-535	778.7
Syngnathus spp.	pipefishes	5	160-340	1.4-12.5	20.4
Roncador stearnsi	spotfin croaker	4	85-285	10.5-407	574.8
Atractoscion nobilis	white seabass	3	251-320	211-440	1,010.5
Embiotoca jacksoni	black surfperch	3	55-138	5.0-103	199.6
Leptocottus armatus	Pacific staghorn sculpin	3	60-65	3.0-5.0	12.9
Medialuna californiensis	halfmoon	3	117-147	43.6-77.6	175.5
Trachurus symmetricus	jack mackerel	3	115-430	15.9-270	360.5
Ophichthus zophochir	yellow snake eel	2	379-664	29.4-319	348.7
Citharichthys stigmaeus	speckled sanddab	1	115	29.5	29.5
Fundulus parvipinnis	California killifish	1	53	3.2	3.2
Genyonemus lineatus	white croaker	1	79	10.0	10.0
Halichoeres semicinctus	rock wrasse	1	124	32.5	32.5
Heterostichus rostratus	giant kelpfish	1	176	46.1	46.1
Menticirrhus undulatus	California corbina	1	305	430	430.0
Phanerodon furcatus	white surfperch	1	115	56.0	56.0
Pleuronichthys ritteri	spotted turbot	1	175	163.7	163.7
Pleuronichthys verticalis	hornyhead turbot	1	55	3.7	3.7
SHARKS/RAYS					
Urolophus halleri	round stingray	25	100-450	50.0-634	8,199.8
Gymnura marmorata	California butterfly ray	12	256-568	150-1,714	6,682.1
Myliobatis californica	bat ray	6	258-420	230-2,189	5,049.5
Heterodontus francisci	horn shark	1	460	850	850.0
Mustelus californicus	gray smoothhound	1	975	1,800.0	1,800.0

(table continued)

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS005 (continued)
Survey Date: April 10, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
INVERTEBRATES					
Pachygrapsus crassipes	striped shore crab	38	8-43	0.1-45.1	125.2
Cancer spp.	cancer crabs	31	20-30	1.2-3.4	70.4
Portunus xantusii	Xantus' swimming crab	13	20-50	2.1-18.1	95.4
Octopus bimaculatus	California two-spot octopus	6	25-80	5.6-100	233.7
Pugettia producta	northern kelp crab	2	20-30	4.0-11.5	15.5
Cancer antennarius	brown rock crab	1	46	14.2	14.2
Crangon nigromaculata	spotted bay shrimp	1	60	3.7	3.7
	Total:	**7,219**			

Encina Power Station Impingement Abundance: Heat Treatment Survey Data

Survey: EPSTS006
Survey Date: June 05, 2005

Taxon	Common Name	Survey Count	Length Range (mm)	Weight Range (g)	Total Weight (g)
FISHES					
Anchoa compressa	deepbody anchovy	8,144	29-130	1.3-24.3	95,729.6
Cymatogaster aggregata	shiner surfperch	5,779	37-100	1.1-28.1	50,780.1
Atherinops affinis	topsmelt	3,587	30-105	0.2-12.5	16,261.1
Paralabrax maculatofasciatus	spotted sand bass	869	52-204	3.2-255	82,072.6
Paralabrax nebulifer	barred sand bass	843	60-115	5.4-42.0	17,169.5
Anisotremus davidsonii	sargo	396	44-135	1.2-42.6	9,980.1
Paralabrax clathratus	kelp bass	372	45-136	2.1-63.1	8,328.2
Hyperprosopon argenteum	walleye surfperch	296	20-159	0.3-300	16,851.8
Seriphus politus	queenfish	204	26-170	2.1-105	2,053.4
Porichthys myriaster	specklefin midshipmar	161	190-440	49.3-1,085	35,440.5
Xenistius califoriensis	salema	159	45-175	4.7-60.5	1,937.9
Hypsoblennius gentilis	bay blenny	88	50-100	2.4-19.0	853.0
Chromis punctipinnis	blacksmith	77	60-186	8.0-100	2,682.2
Roncador stearnsi	spotfin croaker	77	85-140	15.1-55.2	2,359.5
Strongylura exilis	California needlefisł	50	260-543	28.4-294	5,815.3
Hypsopsetta guttulata	diamond turbot	45	121-300	146-374	9,509.2
Phanerodon furcatus	white surfperch	37	60-100	5.0-23.1	381.5
Umbrina roncador	yellowfin croaker	29	95-125	16.3-42.7	889.7
Sardinops sagax	Pacific sardine	27	70-178	1.8-56.5	648.0
Engraulis mordax	northern anchovy	17	36-129	0.7-19.4	77.5
Menticirrhus undulatus	California corbina	11	125-388	30.4-806	2,034.7
Fundulus parvipinnis	California killifisl	10	-	-	30.2
Paralichthys californicus	California halibu	10	72-264	6.7-172	854.2
Heterostichus rostratus	giant kelpfisł	9	60-203	1.1-75.2	160.8
Amphistichus argenteus	barred surfperch	5	60-160	6.2-75.2	259.3
Embiotoca jacksoni	black surfperch	4	65-155	15.2-151	435.1
Syngnathus spp.	pipefishes	3	20-217	0.4-1.8	3.8
Brachyistius frenatus	kelp surfperch	2	115-130	23.1-51.9	75.0
Girella nigricans	opaleye	2	160-180	87.6-140.9	228.5
Hypsypops rubicundus	garibald	2	222-232	668-705	1,373.7
Leptocottus armatus	Pacific staghorn sculpin	2	75	5.2-8.3	13.5
Sphyraena argentea	California barracuda	2	95-105	4.7-6.6	11.3
Atractoscion nobilis	white seabass	1	252	345.0	344.8
Ophichthus zophochir	yellow snake eel	1	650	347	347.0
Pleuronichthys verticalis	hornyhead turbot	1	197	248.0	247.7
Trachurus symmetricus	jack mackerel	1	200	75.8	75.8
Zoarcidae	eelpouts	1	152	17.1	17.1
SHARKS/RAYS					
Urolophus halleri	round stingray	363	105-239	54.3-800	118,389.8
Gymnura marmorata	California butterfly ray	41	244-609	182-1,629	22,997.3
Myliobatis californica	bat ray	23	226-649	205-1,925	15,585.9
Mustelus californicus	gray smoothhound	17	460-882	225-2,100	13,056.0
Dasyatis dipterura	diamond stingray	1	275	618.0	617.6
Triakis semifasciata	leopard shark	1	455	428.0	428.4
INVERTEBRATES					
Cancer productus	red rock crab	491	10-55	1.8-12.8	2,835.9
Pachygrapsus crassipes	striped shore crab	8	19-29	3.7-10.5	61.3
Majidae	spider crabs	6	10-15	2.1-5.2	20.2
Octopus spp.	octopus	2	20-45	9.7-86.2	95.9
Pugettia producta	northern kelp crab	2	22-30	2.4-5.4	7.8
	Total:	22,279			

ATTACHMENT 3

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

ENCINA POWER STATION
CABRILLO POWER I LLC

NPDES PERMIT NO. CA0001350

APRIL 1, 2006

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

ENCINA POWER STATION
CABRILLO POWER I LLC

NPDES PERMIT NO. CA0001350

Project No. 1009704003

April 1, 2006

Prepared for:

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Acronyms and Abbreviations

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

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

1.0 Introduction

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

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

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

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

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

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

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

1.1 Regulatory Applicability

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

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

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

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

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

1.2 Purpose

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

2.0 Facility Description

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

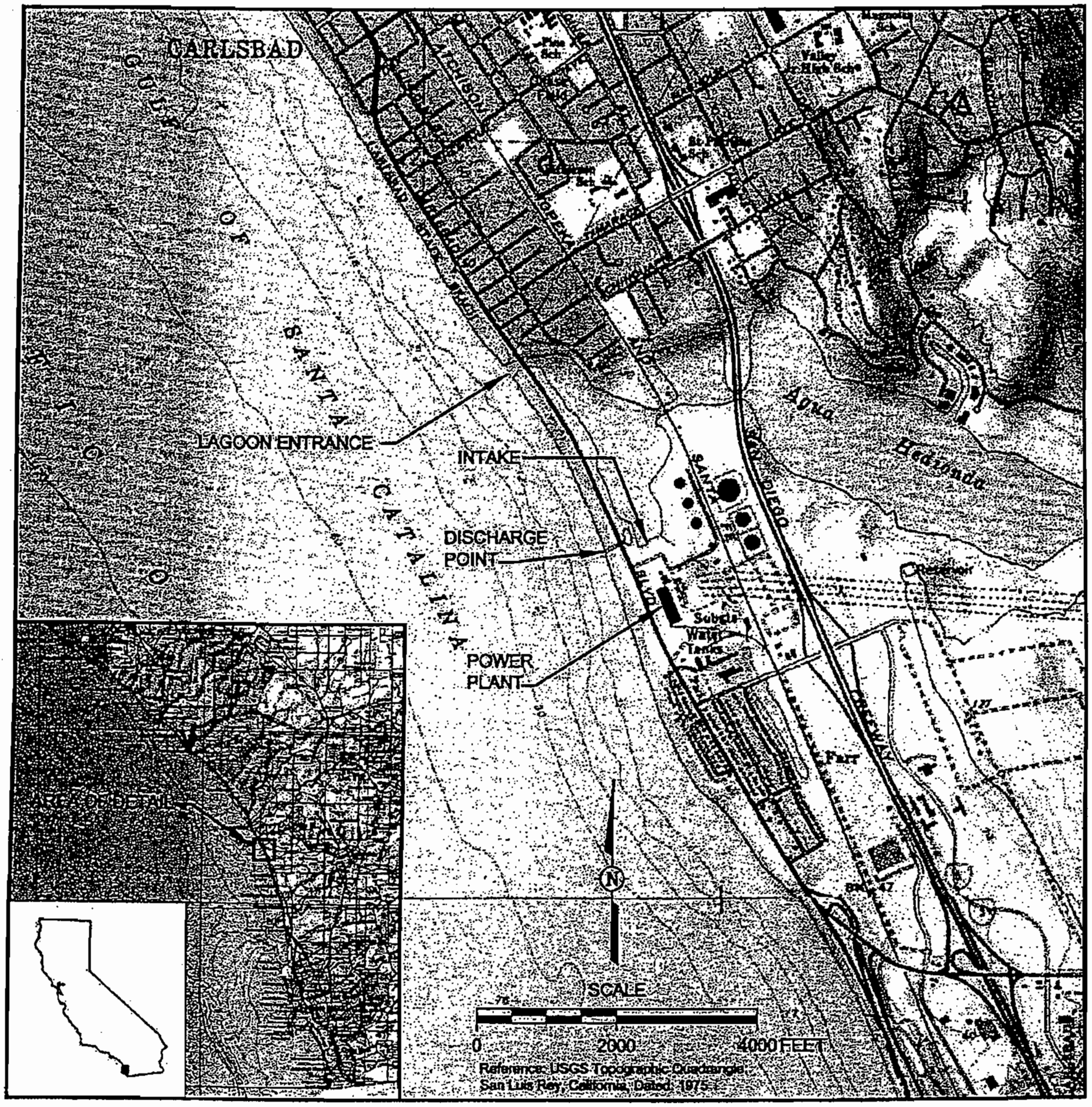
The EPS is a fossil-fueled steam electric power generating station that began operation in 1954. Thermal energy provided by the combustion of the fossil-fuels is used to generate steam to drive five steam turbine generators. The plant also has one air-cooled gas turbine generator achieving a combined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

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

2.1 Facility Location

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

Figure 2-1
Encina Power Station Location Map



2.2 Source Water Body Description

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

2.2.1 *Physical Characteristics*

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

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

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

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

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

2.2.2 Agua Hedionda Lagoon Ecological Characteristics

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

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

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

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

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

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

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

2.2.3 Pacific Ocean Ecological Resources

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

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

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

2.3 Cooling Water Intake Structure Design

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

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

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

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

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

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

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

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

2.4 Cooling Water Intake Structure Operation

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

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

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

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

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

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

2.5 Calculation Baseline

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

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

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

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

3.0 Historical Studies

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

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

3.1 EPS Impingement Mortality and Entrainment Characterization Studies

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

3.1.1 1980 EPS 316(b) Demonstration

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

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

3.1.1.1 Entrainment

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

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

Table 3-1
Critical Species Studied During 1979-1980

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

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

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

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

Note: English Sole not collected in source waterbody.

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

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

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

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

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

3.1.1.2 Impingement

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

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

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

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

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

Note: The top 10 species by number are listed.

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

3.1.2 1997 EPS Supplemental 316(b) Assessment Report

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

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

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

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

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

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

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

3.1.3 2004-2005 EPS 316(b) Demonstration

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.0 Agency Consultations

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

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

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

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

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

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

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

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

5.0 Evaluation of Intake Technology Alternatives

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

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

Table 5-1
Fish Protection Technologies

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

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

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

5.1 Technologies Selected For Further Evaluation

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

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

The evaluation will involve the following:

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

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

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

5.1.1 Fish Screens, Fish Handling, and Return Systems

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

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

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

5.1.2 New Fine Mesh Screening Structure

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

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

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

5.2 Technologies Considered Infeasible and Eliminated From Further Evaluation

5.2.1 Replacement of Existing Traveling Screens with Fine Mesh Screens

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

5.2.2 Cylindrical Wedge-Wire Screens – Fine Slot Width

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

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

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

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

5.2.3 Fish Barrier Net

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

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

5.2.4 Aquatic Filter Barrier

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

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

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

5.2.5 Fine Mesh Dual Flow Screens

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

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

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

5.2.6 Modular Inclined Screens

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

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

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

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

5.2.7 Angled Screen System – Fine Mesh

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

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

5.2.8 Behavior Barriers

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.0 Evaluation of Operational Measures

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

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

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

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

6.1 Circulating Water Flow Reduction / Caps

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

6.2 Variable Speed Drives For Circulating Water Pumps

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

6.3 Heat Treatment Operational Changes

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

7.0 Evaluation of Restoration Alternatives

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

7.1 Potential Restoration Measures

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

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

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

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

I. Restoration or Enhancement of AHL

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

II. Restoration or Enhancement of Agua Hedionda Watershed

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

III. Restoration or Enhancement of Nearshore Coastal Areas

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

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

7.2 Project Selection Criteria

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

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

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

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

8.0 Other Compliance Options for EPS

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

8.1 Site-Specific Determination of BTA

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

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

8.1.1 Cost/Cost Test

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

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

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

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

8.1.2 Cost/Benefit Test

A cost/benefit test may also be performed for EPS to compare the total costs of achieving compliance with the environmental benefits through implementation of the required technologies, operational, and/or restoration measures. Costs are the sum of direct costs and the indirect costs of any intake, operational or restoration mitigation actions. Direct costs include the costs of implementing compliance alternatives, including capital, O&M, and lost generation revenue due to extended outages. Indirect costs include any costs associated with impairment of navigation, higher energy prices, and negative ecological effects of the mitigation actions on the waterbody. An initial phase of the cost/benefit test will identify whether any of these indirect cost elements are relevant at the EPS. The cost/benefit test would specify the nature of the relevant direct and indirect cost components at the facility.

The benefits arise from reducing IM&E by the full amount of the 316(b) Phase II rule's performance standard relative to baseline conditions. The economic benefits of reductions in IM&E have been specified by the EPA in its evaluation of the national benefits of the rule. The classes of benefits identified by EPA in its assessment include direct use benefits (e.g. those from commercial and recreational fishing), indirect use benefits (e.g. increased forage organisms), and existence, or passive use benefits (e.g. improved biodiversity). These benefits are based on standard definitions of value used by economists in cost/benefit analysis. Methods for quantifying benefits to commercial and recreational fishing and other changes in natural resources have been widely employed by environmental and natural resource economists over the past several decades.

The exact nature of the data and methods required for a cost/benefit analysis will vary depending upon the magnitude of the potential IM&E effects on a local and regional scale, the availability of existing economic benefit studies that may be applied, as well as the comments of the regulators and natural resource agencies involved with reviewing this PIC. These can vary widely and will not really be well understood until the results of the IM&E study are complete. When the IM&E study is complete, the numbers of each species affected by operation of the intake can be quantified, and then a value for each species affected by IM&E at the EPS CWIS can be developed.

The benefit studies would be undertaken using a phased approach. Following an initial scoping phase to determine the approach to conducting a cost/benefit analysis, an outline of a benefits assessment approach will be determined. EPS will develop an approach to conducting a benefits valuation for use in supporting a site-specific determination of BTA if that becomes the selected approach for meeting compliance with the new rule. The approach will address the following requirements for such a study as outlined in the Phase II rule:

1. Description of the methodologies to be used to value commercial, recreational, and other ecological benefits;
2. Documentation of the basis for any assumptions and quantitative estimates; and
3. Analysis of the effects of significant sources of uncertainty.

If restoration is a component of the compliance approach, the ability of the restoration project(s) to generate benefits to offset impingement and/or entrainment effects must be demonstrated. This requires specification of a metric that can be used to quantify restoration benefits in a manner comparable to entrainment and impingement effects in the ecosystem.

Habitat assessment methods will be used for assessing the relative value of restoration actions. The approach taken will be to:

1. Identify the key species of concern affected by the facility;
2. Identify critical factors or habitat needs for those species;
3. Identify technically feasible and cost-effective restoration actions that address such critical factors and needs factors; and
4. Choose an appropriate ecological metric for scaling effects of mitigation and/or enhancing habitat needs within the adjacent ecosystem or area.

For example, if it is determined that the restoration project needs to compensate for entrainment of a species for which spawning habitat is a limiting factor, then creation of sufficient new spawning habitat to increase the population by the amount of entrainment would be required for full compliance with the Rule. This would then translate to acreage of created habitat with certain required structural characteristics.

If entrainment losses are of key concern, and the population of associated fish is of less concern, then biomass could also serve as the metric. The present value of the entrained biomass would be computed as the ecological debit. Then, a wetland or other habitat creation project could be scaled in size to produce the equivalent present value of biomass from the primary productivity of the wetland or new habitat.

8.1.3 Evaluation of a Site-Specific BTA

The 316(b) Phase II Rule allows facilities to seek site-specific determinations of BTA if it can be demonstrated that the costs of achieving full compliance with the IM&E performance criteria at a facility are either:

1. Significantly greater than those considered by the EPA in development of the rule (cost/cost test), or
2. Significantly greater than the net environmental benefits to be achieved (cost/benefit test).

If either of these methods is implemented, EPS may propose this as the compliance approach if the costs are significantly higher than either the expected costs at the time the rule was promulgated or, for the amount of benefits that would be derived.

8.2 Trading For Cooperative Mitigation Solutions

In the preamble to the EPA 316(b) Phase II rule, as published in the Federal Register (Vol. 69, No. 131, pgs 41576 - 41693), there is a discussion of the role of trading under the rule (VII. F.2). The preamble describes how trading "...raises complex issues on how to establish appropriate units of trade and how to measure these units effectively given the dynamic nature of the populations of aquatic organisms subject to impingement mortality and entrainment." However, EPA suggests that delegated authorities responsible for implementing the 316(b) Phase II rule wishing to develop trading options "...would be best off focusing on programs based on metric of compatibility between fish and shellfish gains and losses among trading facilities.". This section of the rule also states that if the delegated NPDES authority can demonstrate to the EPA Administrator that they have adopted a NPDES program within a watershed that provides for comparable reductions in IM&E, then the EPA Administrator must approve such alternative compliance alternative requirements.

EPS may consider a watershed-approach trading program as a possible compliance alternative if the right combination of coastal water users identify mutual goals for achieving compliance, either in whole or in part, with the new rule. EPS has not developed any specific alliance of water dependent organizations to implement such a watershed-approach trading compliance alternative. However, EPS expects that after field studies have characterized CWIS effects, that restoration may be the most feasible and cost-effective measure to meet the performance standards. This might be done alone, or in combination with other intake technologies or operational modifications. However, it might well be that different technologies implemented to achieve CWIS compliance at different electric generating facilities may result in mutual benefits for the regional ecosystem. If mutual benefits of mitigation are identified among different generating facilities, then EPS would then consider establishing a trading program with other generating facilities to achieve the lowest cost, most comprehensive and effective method to comply with the new 316 b rule.

EPS will remain open to seeking comprehensive solutions to the IM&E issues in the region and develop a plan for compliance with the possible cooperation of other water users such that the issue is addressed in the most comprehensive manner for the regional ecosystem.

9.0 Impingment Mortality & Entrainment Sampling

An IM&E sampling program was conducted to characterize the fishes and shellfishes affected by impingement and entrainment by the CWIS at the EPS. The data from the study will be used in calculating baseline levels of IM&E against which compliance with performance standards will be measured. A detailed IM&E sampling plan was developed for the IM&E studies (Attachment C) and was previously submitted to the SDRWQCB in August 2004. The sampling plan was approved by the SDRWQCB and the sampling was done for one year starting in June 2004 and continued into June 2005. The report is in the final stages of preparation.

As required in 40 CFR 125.95(b)(3), the results of the IM&E sampling program will be summarized in a report submitted as part of the CDS that includes the following:

- Taxonomic identifications of all life stages of fishes, shellfishes, and any threatened or endangered species collected in the vicinity of the CWIS and are susceptible to IM&E;
- Characterization of all life stages of the target taxa in the vicinity of the CWIS and a description of the annual, seasonal, and diel variations in IM&E; and
- Documentation of the current level of IM&E of all life stages of the target taxa.

The goal of the study was to characterize the fishes and shellfishes affected by impingement and entrainment by the EPS CWIS. The studies examined losses at the EPS resulting from impingement of juvenile and adult fishes and macroinvertebrates on traveling screens during normal operations and during heat treatment operations and entrainment of ichthyoplankton and invertebrates into the cooling water intake system. The sampling methodologies and analysis techniques were derived from recent impingement and entrainment studies conducted for the AES Huntington Beach Generating Station (MBC and Tenera 2005), and the Duke Energy South Bay Power Plant (Tenera 2004). The studies at Huntington Beach were performed as part of the CEC California Environmental Quality Act (CEQA) process for permitting power plant modernization projects, while the South Bay project was for 316(b) compliance.

9.1 Assessment of Cooling Water Intake System Effects

Considerable effort among regulatory agencies and the scientific community has been expended on the evaluation of power plant intake effects over the past three decades. Power plant intake effects occur due to impingement of larger organisms onto the intake screens and entrainment of smaller organisms through the CWIS that are smaller than the screen mesh on the intake screens. For the purposes of the EPS study we assumed that both processes lead to mortality of all impinged and entrained organisms. The variety of approaches developed to assess the CWIS impacts reflects the many differences in power plant locations and resource settings (MacCall et al. 1983). The various approaches have been divided into those that offer a judgment on the presence or absence of impact and those that describe the sensitivity of populations to varying operational conditions. These efforts have helped to establish the context for the modeling approaches being used to estimate impingement and entrainment effects at the EPS.

Impact assessment approaches that will be used in the analysis of the entrainment data include:

- Adult-Equivalent Loss (*AEL*) (Horst, 1975; Goodyear, 1978);
- Fecundity Hindcasting (*FH*) proposed by Alec MacCall, NOAA/NMFS, and is related to the adult-equivalent loss approach; and
- Empirical Transport Model (ETM), which is similar to the approach described by MacCall et al. (1983), and used by Parker and DeMartini (1989).

The application of several models to estimate power plant effects is not unique (Murdoch et al. 1989; PSE&G 1993; Tenera 2000a; Tenera 2000b). Equivalent Adult Modeling (*AEL* and *FH*) is an accepted method that has been used in many 316(b) demonstrations (PSE&G 1993; Tenera 2000a; Tenera 2000b). The advantage of demographic models like *AEL* and *FH* is that they translate losses into adult fishes that are familiar units to resource managers. Estimates of entrainment losses from these demographic models can be combined with estimated losses to adult and juvenile organisms due to impingement to provide combined estimates of cooling water system effects. The U.S. Fish and Wildlife Service proposed the empirical transport model (*ETM*) to estimate mortality rates resulting from cooling water withdrawals at power plants (Boreman et al. 1978, 1981). The *ETM* estimates the conditional mortality due to entrainment while accounting for spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The *ETM* provides an estimate of power plant effects that may be less subject to inter-annual variation than demographic model estimates. It also provides an estimate of population-level effects not provided by demographic approaches. But the *ETM* calculations require information about the composition and abundance of larval organism from the source water, necessitating the collection of samples from additional stations. A description of each of these models and how they will be used to evaluate data collected in the IM&E study is included in the study plan (Attachment C).

The assessment approach used in the final report in the CDS for the EPS will also depend upon the facility's baseline calculations and its method(s) of compliance with the 316(b) Phase II performance standards for reductions in impingement mortality and entrainment. Compliance at EPS may be achieved by implementing either singly, or in combination the following: technological or operational changes to the CWIS (TIOP), restoration methods, or site-specific BTA standards. To demonstrate compliance through the TIOP it is only necessary to analyze impingement and entrainment data to determine baseline levels and assess those levels against the improvements achieved through the implementation of the TIOP. In the case where restoration is limited to only commercially or recreationally important species (use species), impingement and entrainment data may also be adequate to assess the levels of restoration necessary to offset impingement and entrainment losses, assuming that scientifically valid population models exist for the species providing the lost benefits. In assessing compliance with the performance standard in whole or in part through restoration of habitat to include non-recreational and non-commercial species (non-use species) in addition to the losses of use species it is necessary to assess the impingement and entrainment losses also from the source water using a combination of assessment methods to determine the commensurate level of restoration. The same source water and entrainment data, and assessment methods would also be used to determine a site-specific BTA standard based on cost-benefit analysis of entrainment losses to all use and non-use species. Source water data would not be necessary for cost-benefit analysis based simply on the value of use species losses.

9.2 Target Species

Analysis of CWIS effects will be done on the most abundant organisms in the samples, and commercially or recreationally important species from entrainment and impingement samples. All fishes and shellfishes during the impingement sampling were identified and up to fifty individuals of each species of fishes, crabs, shrimp, lobsters, octopus, and squid were measured and weighed. In instances where more than fifty individual of any one species were collected, the first fifty were measured and the rest were counted and then weighted as a group. All other invertebrates were recorded as present. The following marine organisms were sorted, identified and enumerated from entrainment intake and source water plankton samples:

Vertebrates:

- Fishes (all life stages beyond egg)

Invertebrates:

- Rock crab megalopal larvae (*Cancer* spp.)
- California spiny lobster phyllosoma larvae (*Panulirus interruptus*)

These groups were also analyzed in most of the recent entrainment studies in southern California, including the AES Huntington Beach Generating Station. Fishes and rock crab larvae were selected because of their respective ecological roles or commercial and/or recreational fisheries importance. The California spiny lobster was selected because of its commercial and/or recreational importance in the area.

The organisms analyzed will be limited to taxa that are sufficiently abundant to provide reasonable assessment of impacts. For the purposes of this study plan, we will limit the analysis to the most abundant taxa that comprise 90 percent of all larvae entrained and/or juveniles and adults impinged by the EPS. The most abundant organisms are used in the assessment because they provide the most robust and reliable estimates of CWIS effects. Since the most abundant organisms may not necessarily be the organisms that experience the greatest effects on the population level, the data will be examined carefully before the final selection of target species to determine if additional species should be included in the assessment. This may include commercially or recreationally important species, and species with limited habitats.

9.3 Impingement

The following is a summary of the methods used to collect impingement samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C). Sampling was completed during both normal operations periods and tunnel recirculation (heat treatment) events.

Each normal operations impingement survey was conducted over a 24-hour period one day each week from mid June 2004 through mid June 2005. Prior to each survey any accumulated debris and organisms on the bar racks and traveling screens was removed and discarded. Each 24-hour survey was divided into six 4-hour cycles. The traveling screens at EPS take approximately 30-35 minutes to complete a complete rotation and washing. The traveling screens generally remained stationary for a period of about 3.5 hours and then are rotated and washed for 30-35 minutes depending on traveling screen rotation speed. All impinged material rinsed from the traveling screens was rinsed into its respective collection basket. The impinged material was removed from these baskets and all organisms removed from the debris. Due to the design of the intake traveling screens, there are three collection basket assemblies, one for Units 1-3, one for Unit 4, and one for Unit 5. All impinged material from each set of screens was processed and recorded separately. Length and weight of up to 50 individual of each taxa of impinged fishes, crabs, lobsters, shrimp, gastropods, some pelecypods, octopus, and squid were recorded. If more than 50 individuals of any taxa were impinged on any set of screens during a single cycle, this extra group was counted and its total bulk weight was determined and recorded. All other invertebrates were recorded as present when observed. The amount and general identity of the debris collected during each screen cycle was also recorded. The number of circulating water pumps in operation during each survey, obtained from operator logs was used to calculate the volume of water passing through the traveling screens during each survey. The number of screens rotated during each cycle was also recorded during the screen washing periods.

EPS conducts tunnel recirculations to control biofouling organisms growing on the intake conduits. During these events, all impinged organism washed off the traveling screens and rinsed into the collection baskets were removed from debris and identified, counted, and measured using the same procedures used during the normal operations surveys. A total of six tunnel recirculations took place during this 2004-2005 study period.

The abundance and biomass of the organisms impinged during the once per week normal operations sampling will be used to estimate the impingement for the entire year by first estimating the weekly impingement. This is done by combining the information on the impinged organisms with the total circulating water flow for the period between surveys. These weekly estimates are then combined to estimate the annual impingement rate during normal operations. All organism impinged during tunnel recirculation events are combined with those impinged during normal operations to generate an estimate of the overall annual impingement of the CWS.

9.4 Entrainment

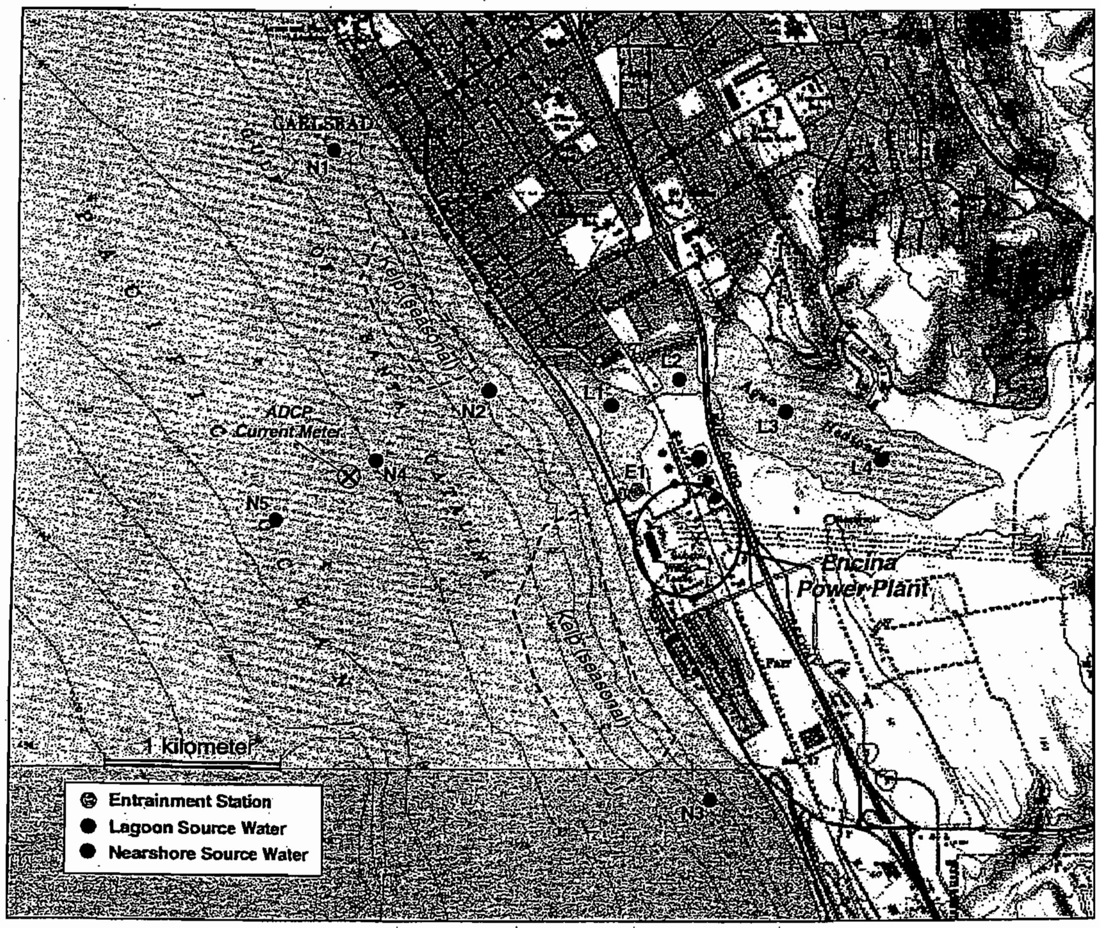
The following is a summary of the methods used to collect entrainment and source water plankton samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C).

Sampling to determine the composition and abundance of larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae at the EPS intake structure and in the local vicinity began in June 2004. The sampling was completed monthly thereafter, with the final sampling being completed in May 2005. Samples during each of these monthly surveys were collected over a 24-hour period, with sampling being divided into four 6-hour periods. Sampling was conducted near the intake structure to estimate larval entrainment, and at eight nearby stations in two sub-areas (~~three~~ Four stations in the AHL and five stations in the nearshore) to estimate larvae in the source water (Figure 7-1).

The samples at the entrainment location (E1), at all the nearshore stations (N#), and at the Outer Lagoon station (L1) were collected using a bongo net frame equipped with two 0.71 m (2.33 feet) diameter opening with attached 335 μm (0.013 in) mesh plankton nets and codends. Each net had a calibrated flowmeter that was used to determine the volume of water filtered during sample collection. Samples were collected by first lowering the frame and nets from the surface to as close to the bottom as practical without contacting it, and then moving the boat forward and retrieving the nets at an oblique angle. The target volume of the combined volume filter through both nets was at least 2,120 feet^3 (60 m^3). After retrieving the nets from the water, all collected material was rinsed into the codend. The collected material from both nets was placed into a labeled jar and preserved.

Due to the shallow depths in the vicinity of the Middle (L2) and Inner Lagoon (L3 and L4) stations, especially during low tides, samples at these stations were collected using a different sampling protocol. These stations are sampled using a single plankton net and frame attached to the bow of a small boat that pushes the net through the water and collects a sample from approximately the upper 1 meter of water. By placing the net on the bow of the boat, the net collects a sample from undisturbed water. The collected material was rinsed into the codend and then placed into a labeled jar and preserved.

Figure 9-1
Location of EPS Entrainment (E1) and Source Water Stations (L1 through L4, and N1 through N5).



10.0 Summary

This PIC has been prepared in accordance with 40 CFR 125.95(b)(1) and is being submitted to the SDRWQCB prior to implementation of information collection activities. The following is a brief summary of the information collection activities described in this document that will be undertaken to support the development of the CDS, the plan for compliance with IM&E performance standards outlined in the EPA 316(b) Phase II Rule.

10.1 Evaluation of IM&E Reduction Measures

The EPS has selected several intake technologies, operational measures, and restoration measures that will be evaluated to determine effectiveness and feasibility of implementation, either alone or in combination, to achieve the required reductions in IM&E. In summary, these include the following:

Intake Technologies:

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

Operational Measures:

- Circulating water flow reductions / caps
- Variable speed drives for circulating water pumps
- Heat Treatment Operational Changes

Restoration Measures:

- Restoration or Enhancement of AHL various)
- Restoration or Enhancement of Agua Hedionda Watershed (various)
- Restoration or Enhancement of Nearshore coastal projects (various)

Preliminary assessments of these IM&E reduction measures will be conducted to determine those which warrant further evaluation. A more detailed evaluation of those measures will be conducted and a combination of the most feasible measures proposed to meet IM&E performance standards will be presented in the CDS.

10.2 Impingement Mortality & Entrainment Sampling Plan

The IM&E Characterization Study Plan that was the basis for the 2004-2005 EPS IM&E Study is included in Attachment C. The study plan described the collection, analysis, and evaluation methodologies for the twelve months of impingement and entrainment sampling data at the EPS.

The following are the main components of the sampling effort:

Impingement:

1. Weekly impingement sampling at each CWIS during normal plant operations
2. Impingement sampling at the CWIS during each heat treatment cycle

Entrainment:

1. Monthly entrainment sampling at the CWIS
2. Source waterbody sampling at five near shore source water locations and four lagoon source water locations

The characterization study plan also describes the sampling, quality assurance / quality control (QA/QC), and data management procedures that will be used in the study. Results of the study will be used to:

1. Determine the current level of IM&E occurring at the CWIS.
2. Compare the level of IM&E occurring due to the location, design, and operation of each existing CWIS with that which would occur if the CWIS were designed as a "calculation baseline" intake.
3. Determine the additional level of reduction in IM&E that would be required to meet performance standards.
4. Assist in the determination of the most feasible combination of intake technologies, operational measures, and/or restoration measures that may be implemented to reduce IM&E to vulnerable species.

10.3 Agency Review of PIC

As required by the EPA 316(b) Phase II regulation, this PIC is being submitted in accordance with the schedule requested by EPS in a letter dated January 6, 2005 to the SDRWQCB. The regulation requires that the SDRWQCB *"provide their comments expeditiously (i.e. within 60 days) to allow facilities time to make response modifications in their information collection plans"* (Federal Register, Vol. 69, No. 131, Pg. 41635). EPS has completed the IM&E sampling following its approved plan (Attachment C) and is working toward completing the final study report. The EPS PIC represents the rest of the requirement information to comply with the PIC requirements of Phase II 316(b) and EPS respectfully requests that SCRWQCB approve the PIC within 60 days such that work may begin on the CDS in order to meet the January 8, 2008 due date.

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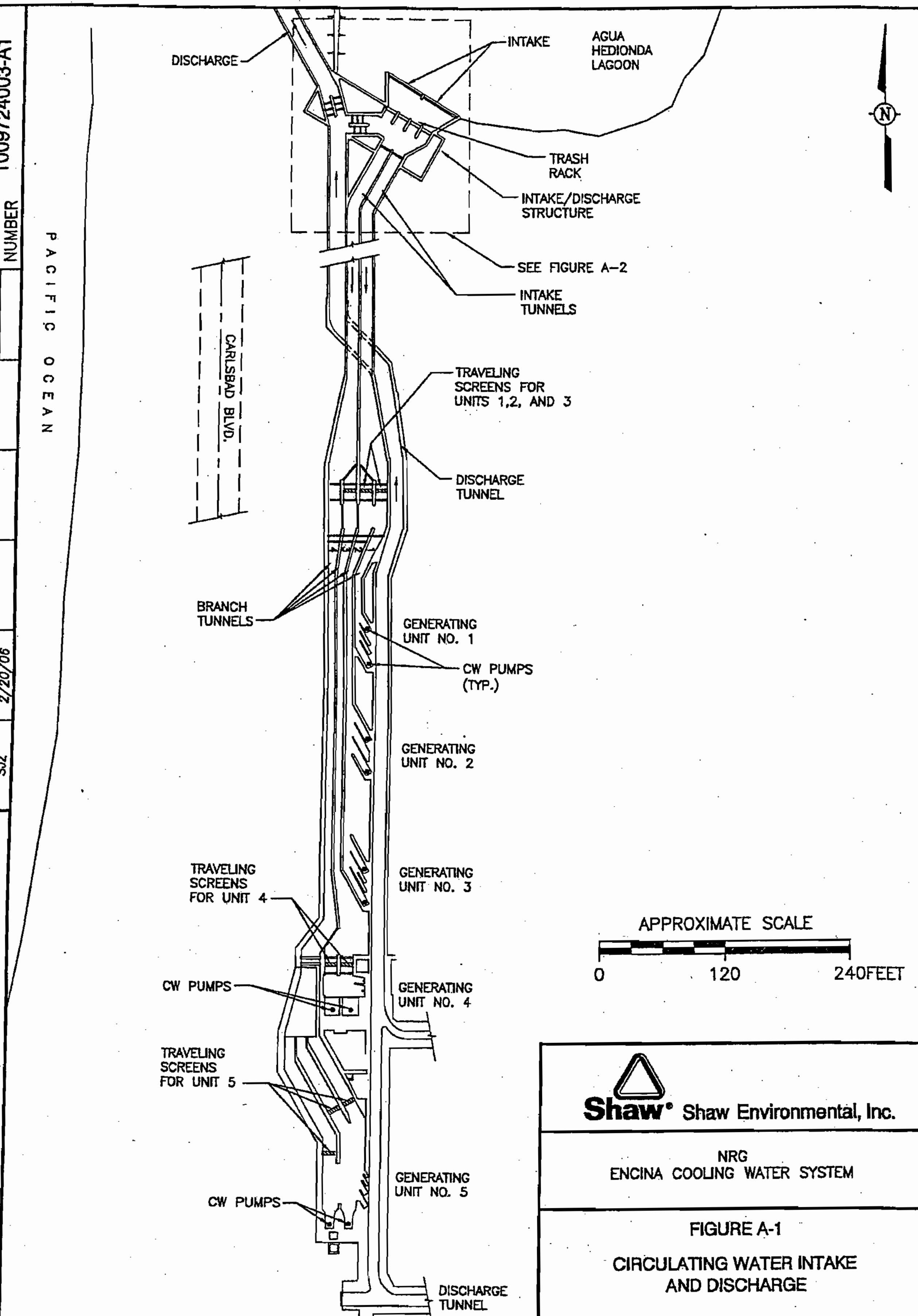
Attachment A
Structural Design Drawings



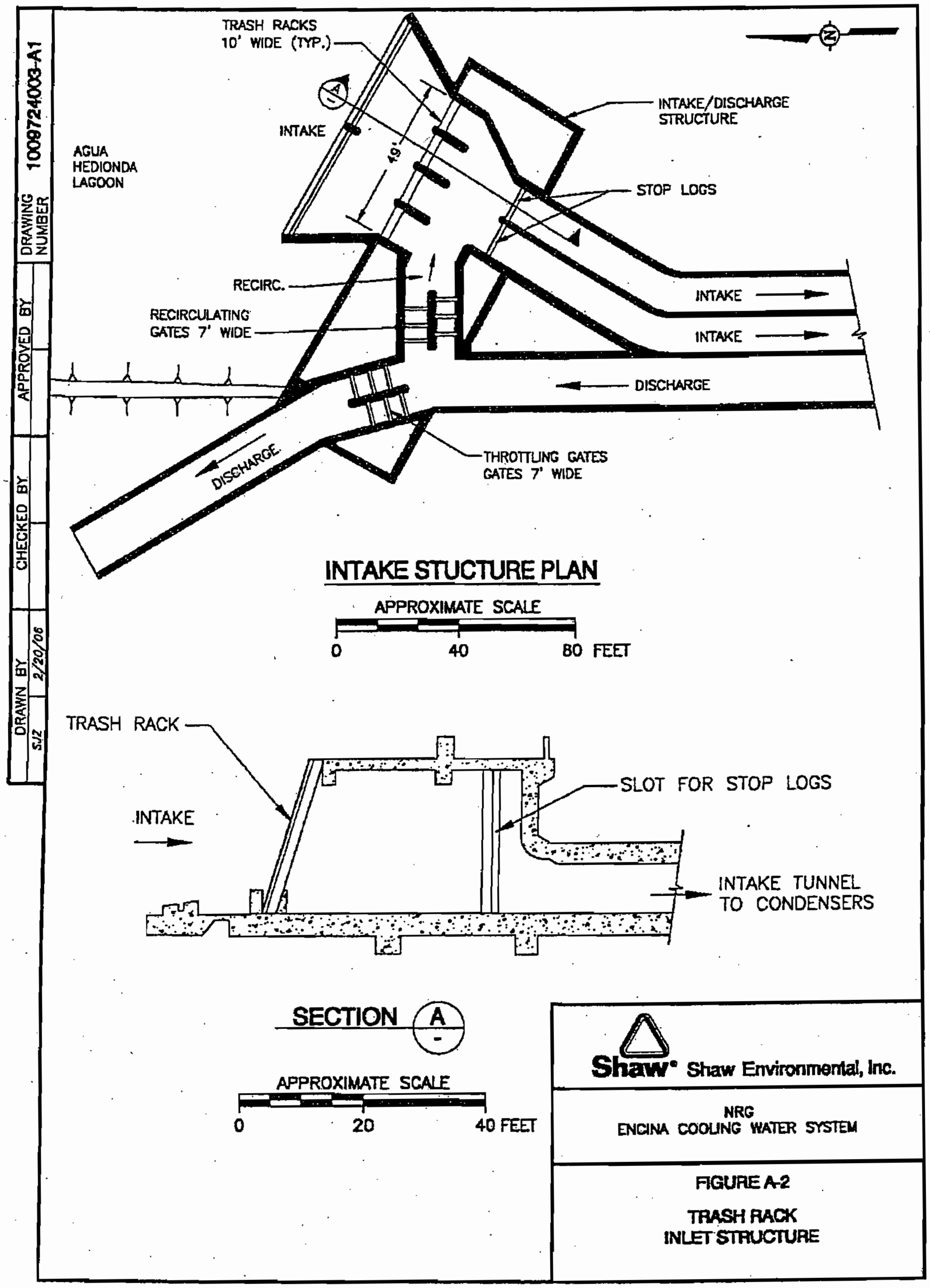
Shaw® Shaw Environmental, Inc.

NRG
ENCINA COOLING WATER SYSTEM

FIGURE A-1

CIRCULATING WATER INTAKE AND DISCHARGE

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
SJZ 2/20/06			1009724003-A1


DRAWING NUMBER 1009724003-A1
APPROVED BY
CHECKED BY
DRAWN BY SJZ 2/20/06
TRASH RACKS 10' WIDE (TYP.)
INTAKE
49'
AGUA HEDIONDA LAGOON
INTAKE/DISCHARGE STRUCTURE
STOP LOGS
RECIRC.
RECIRCULATING GATES 7' WIDE
INTAKE
INTAKE
DISCHARGE
DISCHARGE
THROTTLING GATES GATES 7' WIDE
INTAKE STUCTURE PLAN
APPROXIMATE SCALE
0
40
80 FEET
TRASH RACK
INTAKE
SLOT FOR STOP LOGS
INTAKE TUNNEL TO CONDENSERS
SECTION A
APPROXIMATE SCALE
0
20
40 FEET
Shaw Shaw Environmental, Inc.
NRG
ENCINA COOLING WATER SYSTEM
FIGURE A-2
TRASH RACK
INLET STRUCTURE

Encina Power Station
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

NRG CABRILLO POWER OPERATIONS INC.

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

RE: Cabrillo Power I LLC – Encina Power Station; Request for Schedule to Submit Information to Comply with the Phase II 316(b) Rule (40 CFR Part 125 Subpart J)

Ref: NPDES Permit Number CA0001350, Order No. 2000-03

Dear Mr. Phillips,

By this letter Cabrillo Power I LLC (Cabrillo) requests a schedule for submitting the information required by EPA's new Phase II 316(b) Rule for cooling water intake structures for the Encina Power Station (EPS). For the reasons to be presented in the following letter, Cabrillo requests your approval to allow the information required by 40 CFR 125.95 to be submitted to you no later than January 7, 2008. In our circumstances, this date is as "expeditious as practicable." The basis for our request is explained below.

As you know, on July 9, 2004, EPA published its final rule prescribing how "existing facilities" may comply with Section 316(b) of the Clean Water Act.[1] For most existing facilities, this rule will require a large amount of data to establish "best technology available" for the facility's intake structure and to demonstrate compliance with the rule.

EPS is a "Phase II existing facility" within the meaning of 40 CFR 125.91. As such, it is required to comply with the Phase II rule, and in particular to submit the studies and information required by 40 CFR 125.95.

Section 125.95 of the new rule requires detailed studies and other information to establish what intake structure technology or other measures will be used to comply with the rule. Ordinarily this material is to be submitted with the facility's next application for renewal of its NPDES permit.[2] For permits that expire less than four years after the rule was published on July 9, 2004 (that is, before July 9, 2008), the facility may have up to three and half years to submit the information, so long as it is submitted "as expeditiously as practicable."[3] The facility may

[1] 69 Fed. Reg. 41575, 41683 (July 9, 2004).
[2] 40 CFR 125.95, 122.21(r)(1)(ii), 122.21(d)(2).
[3] 40 CFR 125.95(a)(2)(ii).

have even longer, until the end of the permit term, under 40 CFR 122.21(d)(2)(i), if the permitting agency agrees.

The current NPDES permit for EPS expires on February 9, 2005, well before July 9, 2008. Therefore, Cabrillo hereby requests that you authorize the information called for in 125.95 to be submitted as expeditiously as practicable, which, as explained below, will require until January 7, 2008.

In order to satisfy the "expeditiously as practicable" requirement, it should be noted that Cabrillo began the process of collecting the necessary information even before the final rule was published. Cabrillo actually began as early as 2003 to begin collecting information and conducting internal evaluations on how the, at that time draft, requirements could be complied with at EPS. Such information collection included preliminary technology assessments and research into existing data and information. Cabrillo also initiated an impingement and entrainment sampling program in June 2004 that is scheduled to conclude toward the end of 2005.

Despite our early efforts, we will still need until January 7, 2008, to complete the studies and collect the information required by 40 CFR 125.95. Our detailed explanation is presented below by first summarizing the significant number of informational requirements that must be submitted and then concludes by presenting the schedule by which the information would be submitted.

Cooling Water System Data

First, all facilities covered by the Phase II Rule must submit "cooling water system data" as required by 40 CFR 122.21(r)(5). This includes a narrative description of the operation of the cooling water system, its relationship to cooling water intake structures, the proportion of the design intake flow that is used in the system, the number of days of the year the cooling water system is in operation, and the seasonal changes in the operation of the system, if applicable. It also includes design and engineering calculations prepared by a qualified professional and supporting data to support the description of the operation of the cooling water system.[4] This information must be submitted at the same time as the Comprehensive Demonstration Study as discussed below.[5]

Proposal for Information Collection

Under 40 CFR 125.95(a)(1), Cabrillo must also submit a Proposal for Information Collection (PIC). Preparing the PIC is a large undertaking. The PIC must contain the items listed in 40 CFR 125.95(b)(1), including a description of proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated, a list and description of historical studies characterizing impingement mortality and entrainment and/or the

[4] 40 CFR 122.21(R)(5)(i) and (ii).
[5] 40 CFR 125.95(a)(2).

physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to the proposed study. For existing data, it must demonstrate the extent to which the data are representative of current conditions and that the data were collected using appropriate quality assurance/quality control procedures. The PIC must also include a summary of past or ongoing consultations with federal, state and tribal fish and wildlife agencies and a copy of their written comments, as well as a sampling plan for any new field studies describing all methods and quality assurance/quality control procedures for sampling and data analysis. As you know, Cabrillo already submitted the sampling plan portion of the PIC on September 2, 2004, which was later approved by the San Diego Regional Water Quality Control Board (Regional Board). The impingement and entrainment sampling actually commenced in June 2004 and is expected to conclude toward the end of 2005.

Because of the magnitude and specialized nature of the information to be submitted in the PIC, Cabrillo will have to contract with an outside consulting firm to obtain qualified personnel to perform the work and to handle the increased workload. Cabrillo's contractor procurement process has precise steps that must be undertaken to conform to internal policies and procedures and applicable law.

Including the time it takes to contract with a qualified consulting firm and to develop the PIC using the impingement and entrainment data collected during 2004 and 2005, Cabrillo believes a comprehensive PIC could not be submitted for the Regional Board's review and approval any earlier than April 1, 2006. Cabrillo asks that the Regional Board either approve it or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

Comprehensive Demonstration Study

The Comprehensive Demonstration Study (CDS), as described in 40 CFR 125.95(b), includes many mandatory sections that require substantial effort and time to develop and submit. Many sections of the CDS require that the information collection process described in the PIC be completed prior to being able to initiate those sections of the CDS. Because the PIC data collection will not be completed until early 2006, as described below in the Impingement Mortality and/or Entrainment Characterization Study section, much of the CDS will have to be completed during calendar years 2006 and 2007. This will most likely be a significant time constraint due to the level of work required by the Phase II 316(b) regulation. Below, ESP will describe each section of the CDS in detail, providing ample justification that Cabrillo's proposed complete CDS submission schedule is "as expeditiously as practicable."

Source Water Flow Information

Because EPS does not operate on a river or a lake, no specific source waterbody flow information is required to be submitted.[6]

Impingement Mortality and/or Entrainment Characterization Study

Cabrillo must provide, pursuant to 40 CFR 125.95(b)(3), an Impingement Mortality and/or Entrainment Characterization Study. This study must include (i) taxonomic identifications of all life stages of fish, shellfish, and any species protected under federal, state, or tribal law that are in the vicinity of the cooling water intake structures and are susceptible to impingement and entrainment; (ii) a characterization of all life stages of fish, shellfish, and any protected species, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structures, based on sufficient data to characterize annual, seasonal, and diel variations in impingement mortality and entrainment (e.g., related to climate and weather differences, spawning, feedings, and water column migration). These may include historical data that are representative of current operation of the facility and of biological conditions at the site.

Cabrillo must also document the current impingement mortality and entrainment of all life stages of fish, shellfish, and protected species and provide an estimate of impingement mortality and entrainment to be used as the "calculation baseline."[7] This may include historical data representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations must be collected during periods of representative operational flows for the cooling water intake structure, and the flows associated with the samples must be documented.

Cabrillo expects to submit, within the PIC document, justification for using the historical and representative impingement and entrainment data as well as the new data being collected during calendar years 2004 and 2005. As described above, impingement and entrainment sampling at EPS was initiated in June 2004 and is expected to continue through the end of 2005, which includes the necessary time to complete taxonomic identification, modeling, and development of draft and final reports.

Cabrillo plans on submitting its final PIC after submittal and review of the Impingement and Entrainment Characterization Study Final Report so that all of the collected information and its results can be incorporated into the development of the PIC. This appears to be the most efficient and complete way to produce the PIC, as the information from that study is necessary to complete the other components of the PIC, as described above. Since the Impingement and Entrainment Characterization Study Final Report is not expected to be complete until the end of 2005, the most expeditious submittal date for the final PIC is April 1, 2006.

[6] 40 CFR 125.95(b)(2) only requires source water information for facilities that withdraw water from rivers or lakes other than the Great Lakes. Although not specifically required, a characterization of the source water will be provided in the report on the results of the Impingement and Entrainment Characterization Study.
[7] 40 CFR 125.95(b)(3)(iii).

Design and Construction Technology Plan

Another analysis that must be provided is the Design and Construction Technology Plan.[8] If Cabrillo decides to use design and construction technologies and/or operational measures to comply with the Phase II rule, a plan must be submitted that provides the capacity utilization rate for the intake structure at EPS and provide supporting data (including the average annual net generation of the facility in MWh) measured over a five-year period (if available) of representative operating conditions and the total net capacity of the facility in MW, along with the underlying calculations. The plan must explain the technologies and/or operational measures that Cabrillo has in place and/or have selected to meet the requirements of the rule.

This Design and Construction Technology Plan must contain a large amount of information, as described in 40 CFR 125.95(b)(4)(A)-(D). This information includes (A) a narrative description of the design and operation of all design and construction technologies and/or operational measures, including fish handling and return systems, and information that demonstrates the efficacy of the technologies and/or operational measures; (B) a narrative description of the design and operation of all design and construction technologies and/or operational measures and information that demonstrates the efficacy of the technologies and/or operational measures for entrainment; (C) calculations of the reduction in impingement mortality and entrainment of all life stages of fish and shellfish that would be achieved by the technologies and/or operational measures we have selected; and (D) design and engineering calculations, drawings, and estimates prepared by a qualified professional to support the descriptions described above.

Technology Installation and Operation Plan (TIOP)

Assuming Cabrillo decides that the best way to comply with the Phase II rule is to use design and construction technologies and/or operational measures, in whole or in part, we must submit to you the following information, in accordance with 40 CFR 125.95(b)(4)(ii): (A) A schedule for the installation and maintenance of any new design and construction technologies; (B) a list of operational and other parameters to be monitored and the location and frequency that we will monitor them; (C) a list of activities we will undertake to ensure to the degree practicable the efficacy of installed design and construction technologies and operational measures and our schedule for implementing them; (D) a schedule and methodology for assessing the efficacy of any installed design and construction technologies and operational measures in meeting applicable performance standards or site-specific requirements, including an "adaptive management plan" for revising design and construction technologies, operational measures, operation and maintenance requirements, and/or monitoring requirements in the event the assessment indicates that applicable performance or site-specific requirements are not being met; and (E) if Cabrillo chooses the compliance alternative in 125.94(a)(4) (wedge-wire screens or a technology approved by the state), documentation that the appropriate site conditions described in 125.99(a) or (b) exist at our facility.

[8] 40 CFR 125.95(b)(4).

Restoration Plan

If Cabrillo determines that restoration measures are the best method to comply with the new rule, in whole or in part, then a Restoration Plan must be submitted in the CDS. This plan must include the information described in 40 CFR 125.95(b)(5). It must include a plan using an adaptive management method for implementing, maintaining, and demonstrating the efficacy of the restoration measures that are selected and for determining the extent to which the restoration measures, or the restoration measures in combination with design and construction technologies and operational measures, have met the applicable performance standards.

Site-Specific Requirements

If Cabrillo determines that site-specific requirements are appropriate because the cost of complying with the Phase II rule will be "significantly greater" than either the cost that EPA considered in its rulemaking or the benefits of complying with the rule, then Cabrillo will have to submit the information described in 40 CFR 125.95(b)(6). This includes a Comprehensive Cost Evaluation Study and, for the cost-benefit analysis, a Benefits Evaluation Study. Cabrillo must also include a Site-Specific Technology Plan describing and justifying the site-specific requirements.

Verification Monitoring Plan

Finally, Cabrillo must prepare a Verification Monitoring Plan as part of a complete CDS.[9] This is a plan to conduct, at a minimum, two years of monitoring to verify the full-scale performance of the proposed or already implemented technologies and/or operational measures.

PIC and CDS Schedule

The first official submittal (besides this request for a schedule) that Cabrillo will make to the Regional Board in compliance with the Phase II 316(b) regulation will be the PIC. For the reasons explained above, Cabrillo proposes to submit a comprehensive PIC for the Regional Board's review and approval by April 1, 2006. Cabrillo asks that the Regional Board either approve the PIC or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

Because Cabrillo plans to collect substantial new information as part of the expected PIC, and since the report presenting the results of the new impingement and entrainment data collected in 2004 and 2005 will not be finalized until the end of 2005, and allowing for the period of time the Regional Board has to review and approve the PIC, it is unlikely that the information needed to commence the majority of the sections of the CDS (including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the

[9] 40 CFR 125.95(b)(7).

Restoration Plan (if applicable), the Site Specific Requirements (if applicable), and the Verification Monitoring Plan) will be available until mid to late 2006.

Due to the step by step process by which the data must be collected, processed, evaluated, and then turned into a detailed plan of action to achieve the new Phase II 316(b) standards, Cabrillo does not believe a comprehensive CDS can be submitted earlier than January 7, 2008. It is for these important reasons that Cabrillo believes the most expeditious schedule possible for submittal of a comprehensive CDS is by January 7, 2008.

Conclusion

Collecting, generating, compiling, and analyzing the large amount of information required by the Phase II 316(b) rule will require a substantial effort. Cabrillo will have to collect and review the large volumes of already-existing data on the plant and the source waterbody, as well as integrate the substantial new biological information currently being collected.

Because the Phase II rule is new and untried, we foresee the need to coordinate closely with your department as we collect the necessary information, analyze it, and determine what combination of technology, operational measures, or restoration measures will best meet the Phase II rule for EPS. Cabrillo hopes your staff will be available to consult with us throughout this schedule as we complete these efforts.

For the above reasons, we request that we be allowed until January 7, 2008, to submit the information required for a permit application by the Phase II Rule, 40 CFR Part 125 Subpart J.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Emil Hennig (Cabrillo)
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)

Attachment C
Impingement Mortality & Entrainment Characterization Study Sampling Plan

Encina Power Station
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

NRG CABRILLO POWER OPERATIONS INC.

September 2, 2004

Mr. John R. Phillips, P.E.
Senior Water Resource Control Engineer
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Subject: Cabrillo Power I LLC - Encina Power Station; Phase II 316(b) Entrainment and Impingement Sampling Plan

Dear Mr. Phillips;

Cabrillo Power I LLC (Cabrillo) is pleased to submit a plan to conduct entrainment and impingement sampling for the Encina Power Station (EPS) to comply with the US EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act. The approval of the EPS Entrainment & Impingement Sampling Plan (E&I Plan) is one of the early steps in the facility's compliance with the Phase II rule. Cabrillo requests expedited review and approval of this E&I Plan in order to optimize the sampling synergies available by virtue of the data collection efforts already underway on behalf of Poseidon Resources (Poseidon) for their proposed desalination project at EPS.

This sampling plan was prepared by Tenera Environmental (Tenera), which is the same firm that prepared the desalination sampling plan submitted to the San Diego Regional Water Quality Control Board (San Diego RWQCB) on behalf of Poseidon in July 2004. Consistent with that sampling plan, Poseidon has already collected several complete sets of entrainment and source water samples at EPS. The Poseidon study plan and collected data will produce information on the larval fish and target invertebrates contained in Poseidon's source of desalination feedwater (the power plant's cooling water discharge), as well as information on the larval fish and target invertebrates contained in the power plant's source waterbody and intake flows.

Data being collected for Poseidon on the power plant's source population of entrainable larval fish and target invertebrates is identical to the information Cabrillo will be required to collect and analyze for EPS Phase II 316(b) studies. Tenera has prepared this sampling plan to seamlessly and consistently continue the collection of the Poseidon entrainment data. In that way, Cabrillo can continue the sampling effort for compliance with the new Phase II performance standards in an efficient and cost-effective manner.

In the past five years, Tenera has completed 316(b) resource assessments for the Diablo Canyon Nuclear Power Plant, Moss Landing Power Plant, Morro Bay Power Plant and Potrero Plant. Tenera study design and assessment methods are also being employed in the ongoing 316(b) studies for the Huntington Beach Generating Station. Throughout these projects, Tenera has worked closely with State and Federal agencies in the development of their field study, impact assessment, and benefits evaluation methods. Tenera has also just recently completed a 316(b) resource assessment for the South Bay Power Plant that has been presented in final form to the San Diego RWQCB. Cabrillo's proposed E&I Plan has been developed in consideration of, and in keeping with, the 316(b) study rationales, content, sampling methodology, analysis and reporting that were used in the South Bay Power Plant 316(b) Assessment (Duke Energy South Bay, May 2004), as well as all of the power plants listed above.

This submission of the EPS E&I Plan is intended to meet part of the requirements for the Proposal for Information Collection (PIC) section of the Phase II 316(b) regulation, but not to address all of the PIC requirements at this time. All of the sampling plan requirements specified in Section 125.95(b)(1)(iv) are incorporated into the EPS E&I Plan. At a later date, Cabrillo will submit the remainder of the PIC requirements pursuant to Section 125.95(b)(1). Cabrillo requests approval of this E&I Plan specifying how new E&I data will be collected, but acknowledges that the San Diego RWQCB will be able to review the other portions of the PIC once submitted by Cabrillo.

Therefore, in order to provide continuous, efficient and cost-effective sampling at EPS, Cabrillo requests that the San Diego RWQCB expedite review and approval of this E&I Plan. Cabrillo understands that San Diego RWQCB is considering retaining an outside consultant in order to provide timely response to this request. Cabrillo is available and prepared to work with your staff and the consultant to provide any additional clarification necessary to obtain timely approval.

Please contact Tim Hemig directly at 760.268.4037 if there are any questions.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

Gregory J. Hughes

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig, Sheila Henika, John Steinbeck (Tenera)

Cabrillo Power I LLC, Encina Power Station

316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan

Submitted to the California Regional Water Quality Control Board – San Diego Region for Compliance with Section 316(b) of the Clean Water Act

September 2, 2004

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1.0 INTRODUCTION

1.1 Development of the 316(b) Sampling Plan

This document presents a sampling plan for conducting the entrainment and impingement sampling necessary for a cooling water intake assessment required under Section 316(b) of the Federal Clean Water Act (CWA). Our sampling plan is based on a survey and compilation of available background literature, results of completed Encina Power Station (EPS) intake studies, and cooling water system studies at other power plants. The data from this study will form the basis of demonstrating compliance with the new Phase II regulations recently developed by the U.S. Environmental Protection Agency (USEPA).

1.2 Overview of the 316(b) Program

Section 316(b) of the Clean Water Act requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact" (USEPA 1977). Because no single intake design can be considered to be the best technology available at all sites, compliance with the Act requires a site-specific analysis of intake-related organism losses and a site-specific determination of the best technology available for minimizing those losses. Intake-related losses include losses resulting from entrainment (the drawing of organisms into the cooling water system) and impingement (the retention of organisms on the intake screens).

1.2.1 Target Organisms Selected for Study

The USEPA in its original 316(b) lists several criteria for selecting appropriate target organisms for assessment including the following:

1. representative, in terms of their biological requirements, of a balanced, indigenous community of fish, shellfish, and wildlife;
2. commercially or recreationally valuable (e.g., among the top ten species landed—by dollar value);
3. threatened or endangered;
4. critical to the structure and function of the ecological system (i.e., habitat formers);
5. potentially capable of becoming localized nuisance species;
6. necessary, in the food chain, for the well-being of species determined in 1–4; and
7. meeting criteria 1–6 with potential susceptibility to entrapment/impingement and/or entrainment.

In addition to these USEPA criteria there are certain practical considerations that limit the selection of target organisms such as the following:

- identifiable to the species level;
- collected in sufficient abundance to allow for impact assessment, i.e., allowing the model(s) constraints to be met and confidence intervals to be calculated; and
- having local adult and larval populations (i.e., source not sink species). For example, certain species that may be relatively abundant as entrained larvae may actually occur offshore or in deep water as adults.

These criteria, results from the previous 316(b) studies at EPS completed in 1980, results from a supplemental 316(b) study completed in 1997 (EA Engineering 1997), results from more recent studies on the ecological resources of Aqua Hedionda Lagoon (MEC Analytical Systems 1995), and data collected from studies described in this document will be used to determine the appropriate target organisms that will be evaluated in detail. The final target taxa will include the fishes that are found to be most abundant in the entrainment and impingement samples. In addition to large invertebrates that may be abundant in impingement, megalopal (final) larval stage of all species of cancer crabs (*Cancer* spp., which includes the edible species of rock crabs) and the larval stages of California spiny lobster will be identified and enumerated from all processed entrainment and source water plankton samples.

1.3 Sampling Plan Organization

This sampling plan first describes the EPS environment, design, and operating characteristics. The methods for obtaining updated information on the types and concentrations of planktonic marine organisms entrained by the power plant's CWIS are then discussed. A discussion of the theoretical considerations behind the assessment methods for the entrainment and impingement data is then presented. The final 316(b) report will also include an overview of alternative intake technologies and an analysis of feasible alternatives and their cost-effectiveness to minimize adverse entrainment and impingement effects of the EPS CWIS.

2.0 Description of the Encina Power Station and Characteristics of the Source Water Body

2.1 Background

The Encina Power Station (EPS) is situated on the southern shore of the outer segment of the Agua Hedionda Lagoon in the city of Carlsbad, California, approximately 193 km (85 miles) south of Los Angeles and 16 km (35 miles) north of San Diego. EPS is a gas- and oil-fueled generating plant with five steam turbine generators (Units 1 through 5), which all use the marine waters of Agua Hedionda Lagoon for once-through cooling, and a small gas turbine generator. EPS began withdrawing cooling water from Agua Hedionda Lagoon in 1954 with the startup of commercial operation of Unit 1. Unit 2 began operation in 1956, Unit 3 in 1958, Unit 4 in 1973, and Unit 5 in 1978. The gas turbine was installed in 1968, which does not use cooling water in its operation. The combined net generation capacity of EPS is 966 megawatts electric (Mwe) (**Table 1**).

2.1.1 Plant Cooling Water System Description and Operation

Cooling water for the five steam electric generating units are supplied by two circulating and one or two service water pumps for each unit. The quantity of cooling water circulated through the plant is dependent upon the number of units in operation. With all units in full operation, the cooling water flow through the plant is 2,253 m^3/min (595,200 gallons per minutes [gpm]) or 3,244,430 m^3/day (857 million gallons per day [mgd]) based on the manufacturer ratings for the cooling water pumps (**Table 1**).

Table 1. Encina Power Station generation capacity and cooling water flow volume.

Unit	Gross Generation (MWe)	Cooling Water Flow m^3/min (gpm)	Daily Flow m^3/day (mgd)
1	107	193 (51,000)	278,000 (73)
2	104	193 (51,000)	278,000 (73)
3	110	204 (54,000)	294,350 (78)
4	300	806 (213,000)	1,161,060 (307)
5	325	856 (226,200)	1,233,010 (326)
Gas Turbine	20		
Total	**966**	**2,252 (595,200)**	**3,244,430 (857)**

Cooling water for all five steam-generating units is supplied through a common intake structure located at the southern end of the outer segment of Aqua Hedionda Lagoon, approximately 854 m (2,800 ft) from the opening of the lagoon to the ocean (**Figure 1**). Cooling water from the system is discharged into a small discharge pond that is located to the west of the intake structure. Water from the discharge pond flows through a culvert under Carlsbad Blvd and through a discharge canal across the beach and out to the ocean.

Seawater entering the cooling water system passes through metal trash racks on the intake structure that are spaced 8.9 cm (3½ in) apart and keep any large debris from entering the system. The trash racks are cleaned periodically. Behind the trash racks the intake tapers into two 3.7 m (12 ft) wide tunnels that further splits into four 1.8 m (6 ft) wide conveyance tunnels (**Figure 2**). Conveyance tunnels 1 and 2 provide cooling water for Units 1, 2 and 3, while conveyance tunnels 3 and 4 supply cooling water to Units 4 and 5, respectively. Vertical traveling screens prevent fish and debris from entering the cooling water system and potentially clogging the condensers. There are two traveling screens for Units 1, 2 and 3, two screens for Unit 4, and three screens for Unit 5. The mesh size on the screens for Units 1 through 4 is 0.95 cm (3/8 in), while the mesh size for Unit 5 is 1.6 cm (5/8 in).

The traveling screens can be operated either manually or automatically when a specified pressure differential is detected across the screens due to the accumulation of debris. When the specified pressure is detected the screens rotate and the material on the screen is lifted out of the cooling water intake. A screen wash system (70-100 psi), located at the head of the screen, washes the debris from each panel into a trough, which empties into collection baskets where it is accumulated until disposal.

The velocity of the water as it approaches the traveling screens has a large effect on impingement and entrainment and varies depending on the number of pumps operating, tidal level, and cleanliness of the screen faces. Approach velocities at high and low tide with all pumps operating were presented in the previous 316(b) study conducted in 1979 and 1980 (**Table 2**).

Table 2. Approach velocities at traveling screens for Encina Power Station with all circulating water and service water pumps in operation.

	Estimated Mean Approach Velocity (fps)	
Unit	**High Tide**	**Low Tide**
1	0.7	1.2
2	0.7	1.2
3	0.7	1.2
4	1.0	1.6
5	0.7	1.1

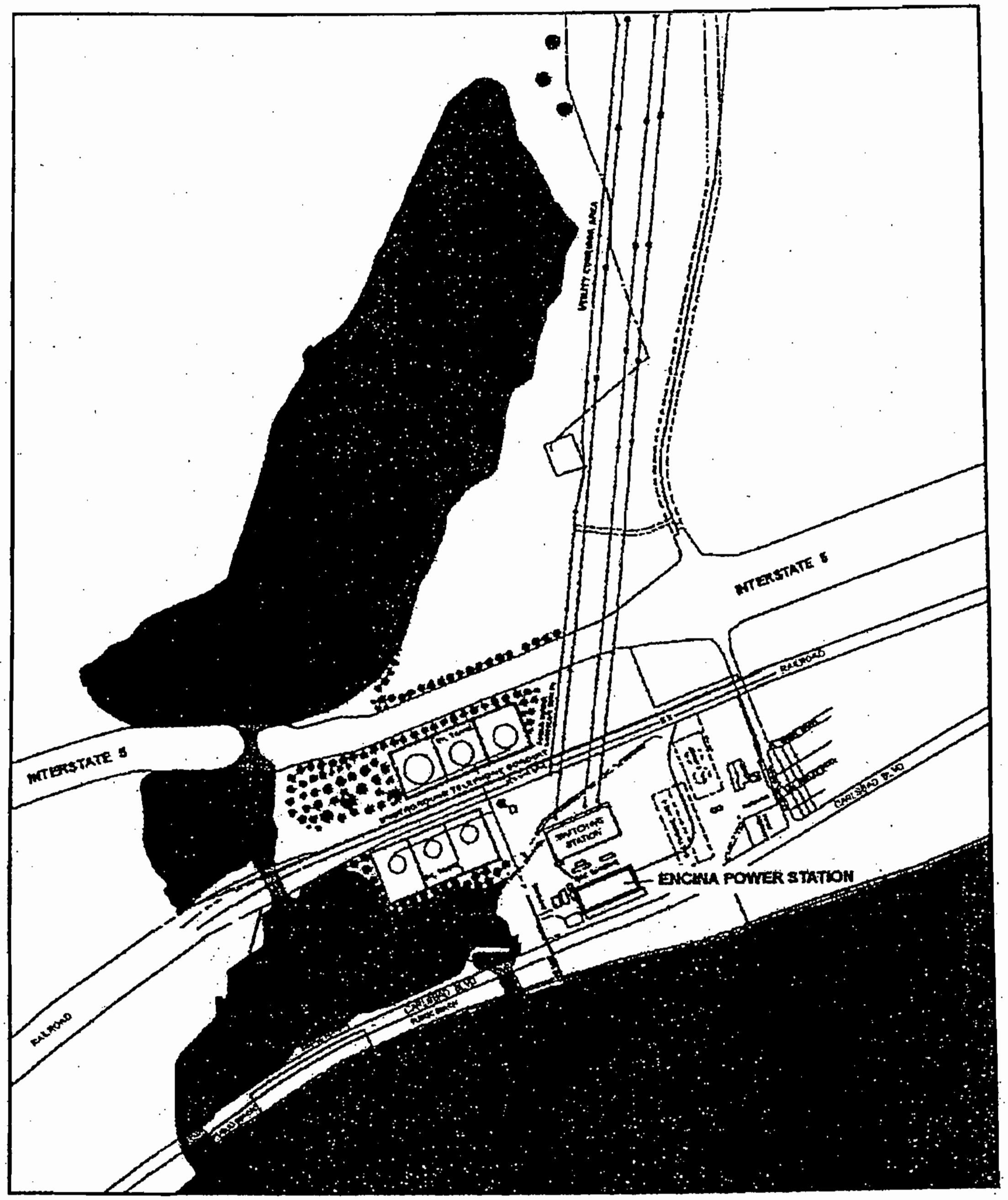

Figure 1. Location of Encina Power Station in Carlsbad, California

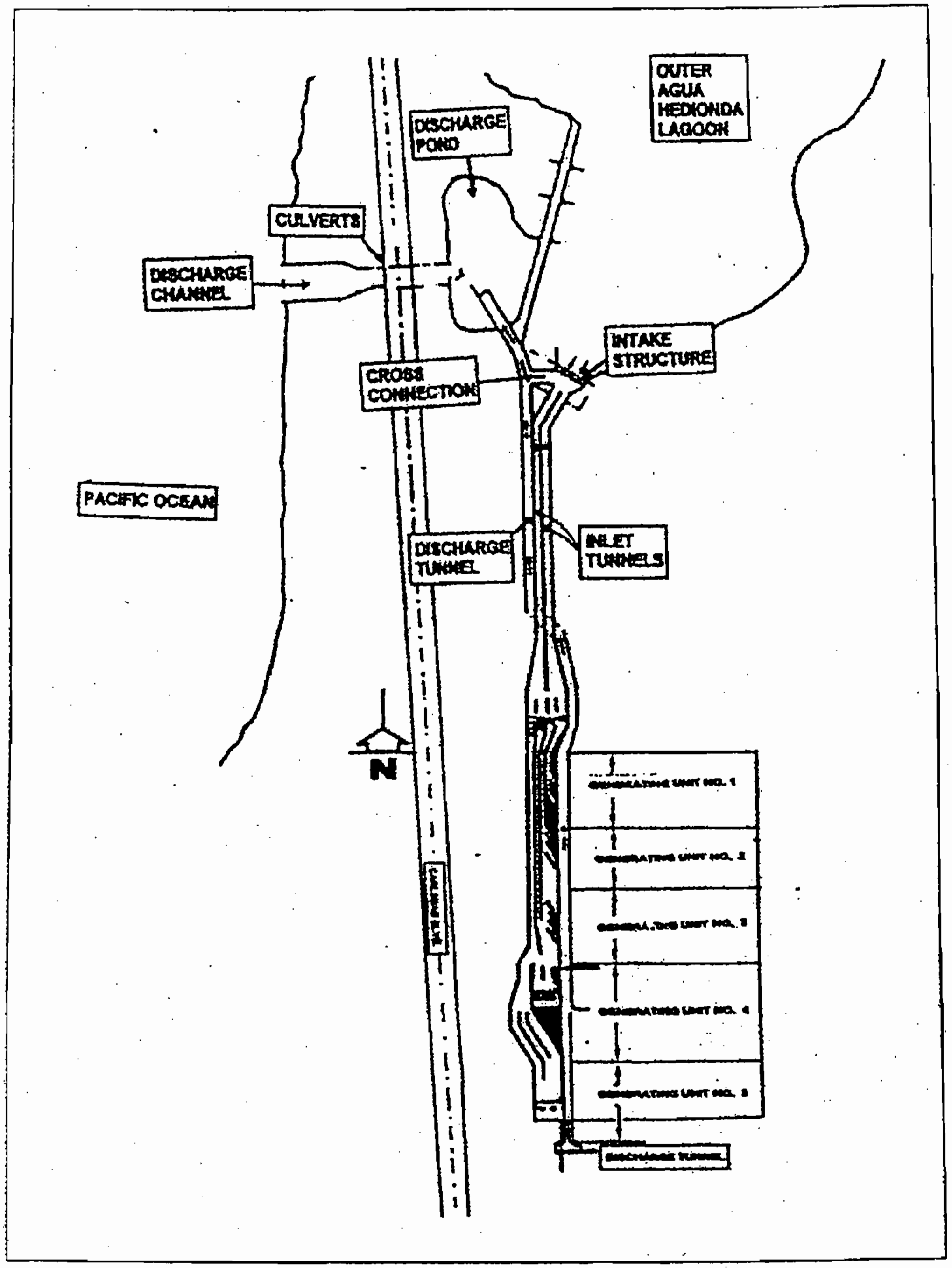

Figure 2. Schematic of Encina Power Station cooling water intake system.

2.2 Aquatic Biological Resources in the Vicinity of EPS

2.2.1 Agua Hedionda Lagoon

The Encina Power Station (EPS) is located on Agua Hedionda Lagoon, which is a man-made coastal lagoon that extends 2.7 km (1.7 miles) inland and is up to 0.8 km (0.5 mi) wide. The lagoon was constructed in 1954 to provide cooling water for the power plant. A railroad trestle and the Interstate Highway 5 bridge separate Agua Hedionda Lagoon into three interconnected segments: an Outer, Middle, and Inner lagoon. The surface areas of the Outer, Middle, and Inner lagoons are 26.7 (66 acres), 9.3 (23 acres), and 79.7 (197 acres) hectares, respectively. The lagoon is separated from the ocean by Carlsbad Boulevard and a narrow inlet 46 m [151 ft] wide and 2.7 m [9 ft] deep at the northwest end of the Outer Lagoon that passes under the highway and allows tidal exchange of water with the ocean.

Circulation and input into Aqua Hedionda Lagoon is dominated by semi-diurnal tides that bring approximately 2.0 million m^3 of seawater through the entrance to the Outer Lagoon on flood tides. Approximately half of this tidal volume flows into the Middle and Inner lagoons. On ebb tides this same tidal volume flows out through the entrance to the ocean. As a result of this tidal flushing the lagoon is largely a marine environment. Although freshwater can enter the lagoon through Buena Creek, which drains a 7,500 hectare (18,500 acres) watershed, for most of the year freshwater flow is minimal. Heavy rainfall in the winter can increase freshwater flows, reducing salinity, especially in the Inner Lagoon.

A study on the ecological resources of Agua Hedionda showed that it has good water quality and supports diverse infaunal, bird, and fish communities (MEC Analytical 1995). Eelgrass was found in all three lagoon segments, but was limited to shallower depths in the Inner Lagoon because water turbidity reduces photosynthetic light penetration in deeper areas. The eelgrass beds provide a valuable habitat for benthic organisms that are fed upon by birds and fishes. Although eelgrass beds were less well developed in areas of the Inner Lagoon, it also provides a wider range of habitats, including mud flats, salt marsh, and seasonal ponds that are not found elsewhere in Aqua Hedionda. As a result bird and fish diversity was highest in the Inner Lagoon.

A total of 35 species of fishes was found during the 1994 and 1995 sampling conducted by MEC (MEC Analytical 1995). The Middle and Inner lagoons had more species and higher abundances than the Outer Lagoon. During the 1995 survey only four species were collected in the Outer Lagoon, compared to 14 to 18 species in the Middle and Inner lagoons. The sampling did not include any surveys of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected. Silversides (Atherinopsidae) and gobies (Gobiidae) were the most abundant fishes collected. Silversides, including jacksmelt and topsmelt, that occur in large schools in shallow waters where water temperatures are warmest were most abundant in the shallower Middle and Inner lagoons. Gobies were most abundant in the Inner Lagoon which has large shallow mudflat areas that are their preferred habitat.

Special Status Species

The recent assessment of the ecological resources of Agua Hedionda did not collect any federally endangered tidewater goby (*Eucyclogobius newberryi*) that was once recorded from the lagoon (MEC Analytical 1995). The record of the occurrence may not be accurate or may predate the construction of the Outer Lagoon that provided a direct connection with the ocean. The current marine environment in the lagoon would not generally support tidewater gobies because they prefer brackish water habitats. No other listed fish species were collected in the study.

2.2.2 Pacific Ocean

Agua Hedionda Lagoon is tidally flushed through the small inlet in the Outer Lagoon by waters from the Pacific Ocean. The physical oceanographic processes of the southern California Bight that influence the lagoon include tides, currents, winds, swell, temperature, dissolved oxygen, salinity and nutrients through the daily tidal exchange of coastal seawater. Near the mouth of the lagoon the mean tide range is 3.7 ft (1.1 m) with a diurnal range of 5.3 ft (1.6 m). Waves breaking on the shore generally range in height from 2 to 4 ft (0.6 to 1.2 m), although larger waves (6 to 10 ft [1.8 to 3.0 m]) are not uncommon. Larger waves exceeding 15 ft (4.6 m) occur infrequently, usually associated with winter storms. Surface water in the local area ranges from a minimum of 57°F (13.9°C) to a maximum 72°F (22.2°C) with an average annual temperature between 63°F (17.2°C) and 66°F (18.9°C).

The outer coast has a diversity of marine habitats and includes zones of intertidal sandy beach, subtidal sandy bottom, rocky shore, subtidal cobblestone, subtidal mudstone and water column. Organisms typical of sandy beaches include polychaetes, sand crabs, isopods, amphipods, and clams. Grunion utilize the beaches around EPS during spawning season from March through August. Numerous infaunal species have been observed in subtidal sandy bottoms. Mollusks, polychaetes, arthropods, and echinoderms comprise the dominant invertebrate fauna. Sand dollars can reach densities of 1,200 per square meter. Typical fishes in the sandy subtidal include queenfish, white croaker, several surfperch species, speckled sanddab, and California halibut. Also, California spiny lobster and *Cancer* spp. crabs forage over the sand. Many of the typically outer coast species can occasionally occur within Agua Hedionda Lagoon, carried by incoming tidal currents.

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

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

3.0 ENTRAINMENT STUDY AND ASSESSMENT METHODS

Entrainment studies were previously conducted in 1979 and 1980 at the EPS as part of the plant's initial Section 316(b) Demonstration requirement. The original study was conducted using pump sampling for plankton at the intake structure and net sampling of plankton at three source water stations in the Outer Lagoon (SDG&E 1980). For this study, plankton net sampling at the intake station and at an array of source water stations will be used to collect data for impact models that will be used to update the previous 316(b) Demonstration study. The following questions will be addressed by the entrainment and source water studies:

- What is the baseline entrainment mortality?
- What are the species composition and abundance of larval fishes, cancer crabs, and lobsters entrained by the EPS?
- What are the estimates of local species composition, abundance and distribution of source water stocks of entrainable larval fishes, cancer crabs, and spiny lobsters in Agua Hedionda Lagoon and the nearshore oceanic source waters?

The basis for estimation of entrainment effects is accurate knowledge of the composition and densities of planktonic organisms that are at risk of entrainment through the power plant cooling water system. Recent studies addressing 316(b) issues have focused on larval fishes and commercially important crustacean species (Tenera 2001, 2004). The basic study design involves the collection of plankton samples directly from the intake cooling water flow (entrainment sampling) and comparing the densities of various target species from plankton samples taken concurrently from the source water body (source water sampling). In the case of Encina Power Station (EPS), two areas contribute to the source water body; the lagoon sub-area and the nearshore sub-area, each having a unique contribution to the cooling water flows in terms of species composition and probability of entrainment.

3.1 Entrainment Study

Field data on the composition and abundance of potentially entrained larval fishes, *Cancer* spp. megalopae, and larval spiny lobster *Panulirus interruptus* will provide a basis to estimate the total number and types of these organisms passing through the power plant's cooling water intake system. For the purposes of modeling and calculations, through-plant mortality will be assumed to be 100 percent; unless otherwise determined through a San Diego RWQCB approved entrainment mortality study. Monthly entrainment and source water surveys started in June 2004 will be continued on a monthly basis through May 2005.

3.1.1 Entrainment Sampling Methods

This study was designed to quantify the composition and abundance of entrained larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae. A map of the station locations that were sampled starting in June 2004 is shown in **Figure 3**. These stations will continued to be sampled through May 2005 on a monthly basis.

Sample collection methods are similar to those developed and used by the California Cooperative Oceanic and Fisheries Investigation (CalCOFI) in their larval fish studies (Smith and Richardson 1977) but modified for sampling in the shallow areas of Agua Hedionda Lagoon. Two replicate entrainment samples are collected from a single station (E1) located in front of the EPP intakes by towing plankton nets from a small boat. A net frame is equipped with two 0.71 m (2.33 ft) diameter openings each with a 335 μm (0.013 in) mesh plankton net and codend. The start of each tow begins close to the intake structure, proceeds in a northerly direction against the prevailing intake current, and ends approximately 100 m from the structure. It is assumed that all of the water sampled at the entrainment station would have been drawn through the EPS cooling water system.

The tows are done by first lowering the nets as close to the bottom as practical without contacting the substrate. Once the nets are near the bottom, the boat is moved forward and the nets retrieved at an oblique angle (winch cable at approximately 45° angle) to sample the widest strata of water depths possible. Total time of each tow is approximately two minutes at a speed of 1 kt during which a combined volume of at least $60m^3$ ($2{,}119\ ft^3$) of water is filtered through both nets. In similar studies conducted by Tenera, this volume has been shown to typically provide a reasonable number and diversity of larvae for data modeling. The water volume filtered is measured by calibrated flowmeters (General Oceanics Model 2030R) mounted in the openings of the nets. Accuracy of individual instruments differed by less than 5% between calibrations. The sample volume is checked when the nets reach the surface. If the target volume is not collected, the tow was repeated until the targeted volume is reached. The nets are then retrieved from the water, and all of the collected material rinsed into the codend. The contents of both nets are combined into one sample immediately after collection. The sample is placed into a labeled jar and preserved in 10 percent formalin. Each sample is given a serial number based on the location, date, time, and depth of collection. In addition, the information is logged onto a sequentially numbered data sheet. The sample's serial number is used to track it through laboratory processing, data analyses, and reporting.

Entrainment samples are collected over a 24-hour period, with each period divided into four 6-hour sampling cycles. Larval fishes show day-night differences in abundances related to their vertical migratory behavior and spawning periodicity, and the 24-hr sampling regime allows these differences to be averaged for assessing entrainment abundances. Concurrent surface water temperatures and salinities are measured with a digital probe (YSI Model 30).

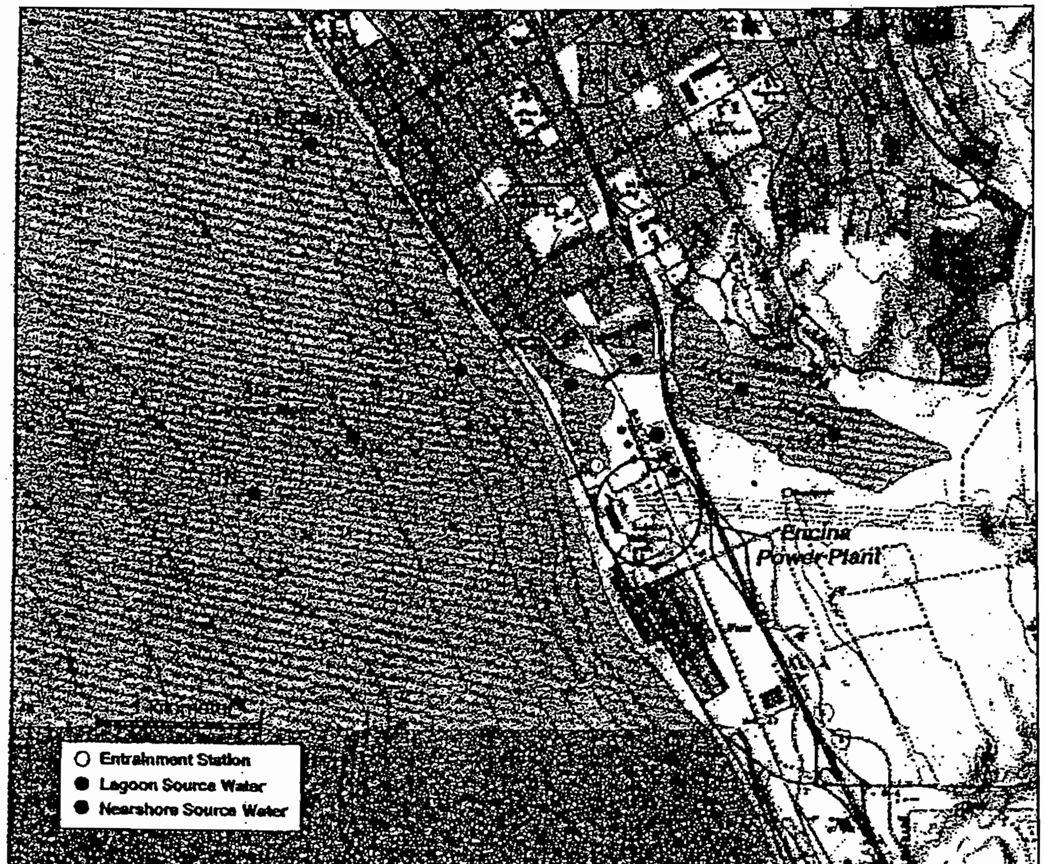

Figure 3. Location of Encina Power Station entrainment (E1) and source water stations (L1 through L4, and N1 through N5).

3.2 Source Water Study

This study was designed to quantify the local source water composition and abundance of larval fishes, *Cancer* spp. megalopae, and larval *Panulirus interruptus* in Agua Hedionda Lagoon and the nearshore source waters. The source water is partitioned into lagoon and nearshore sub-areas for modeling cooling water withdrawal effects (**Figure 3**). Collection methods are identical to the entrainment sample collection, with the exception that a single paired-net sample is collected at each station and the nearshore samples are be collected from a larger vessel capable of navigating open coastal waters in all weather conditions, day or night. The shallow waters in the Middle and Inner lagoons required a different sampling protocol than the oblique tows used at the Outer Lagoon and nearshore stations. The Inner Lagoon is sampled using a single frame plankton net mounted on the bow of a small boat which pushes the net through the water thereby eliminating any obstructions in front of the net during sampling. The net is raised and lowered during sampling to sample the range of depths available in the shallow Inner Lagoon.

The stations are stratified to include four lagoon stations within the inner (2), middle (1), and outer lagoons (1), and five nearshore stations that cover a depth range of 5–30 m (16–98 ft). The array of locations and depths was chosen to assure that all potential source water community types are represented. For example, stations in the inner lagoon will have a greater proportion of larvae from species with demersal eggs, such as gobies, that spawn in quiet water environments, while nearshore stations will have more larvae of species that spawn in open water such as California halibut and white seabass. The study will allow comparison to earlier larval fish studies done for the original EPS 316(b) in 1979-80 (SDG&E 1980).

A current meter is placed in the nearshore between Stations N4 and N5. The data from the meter will be used to characterize currents in the nearshore area that would directly affect the dispersal of planktonic organisms that could be entrained by the power plant. The data will be used to define the size of the nearshore component of the source water by using the current speed and the estimated larval durations of the entrained organisms.

The number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled. For example, a reduction in the number of stations may be recommended if analysis indicates that only one station is necessary to characterize the Inner Lagoon, or the Middle Lagoon is sufficiently similar to the Inner Lagoon that it does not need to be sampled separately. Analysis of current meter data may also indicate that Station N5 does not need to be sampled because the current is predominantly alongshore and can be adequately characterized using the other stations closer to shore.

3.2.1 Source Water Sampling Methods

Sampling is conducted using the same methods and during the same time period described earlier for the entrainment collections (Section 3.1.1) with target volumes for the oblique tows of approximately 60 m^3 (2–3 minute tow at approximately 1 knot).

3.3 Laboratory Processing and Data Management

Laboratory processing will remove all larval fishes, megalopal stages of *Cancer* spp., and larvae of spiny lobster from the samples. Fish eggs will not be sorted from the samples. Although many marine fish eggs are described in the scientific literature, most identifications are difficult and very time consuming, and impact models can be adequately parameterized without egg density data. Larval fishes and all species of cancer crab megalopae will be identified to the lowest taxonomic level possible by Tenera's taxonomists. In addition, the developmental stage of fish larvae (yolk-sac, preflexion, flexion, postflexion, transformation) will be recorded on the data sheet. A laboratory quality control (QC) program for all levels of laboratory sorting and taxonomic identification will be applied to all samples. The QC program will also incorporate the use of outside taxonomic experts to provide taxonomic QC and resolve identification uncertainties.

Many larval fish cannot be identified to the species level; these fish will be identified to the lowest taxonomic classification possible (e.g., genus and species are lower orders of classification than order or family). Myomere and pigmentation patterns are used to identify many species; however, this can be problematic for some species. For example, sympatric members of the family Gobiidae share similar characteristics during early life stages (Moser 1996), making identifications to the species level uncertain. Those gobiids that we are unable to identify to species will be grouped into an "unidentified goby" category.

Laboratory data sheets will be coded with species or taxon codes. These codes will be verified with species/taxon lists and signed off by the data manager. The data will be entered into a computer database for analysis.

Length measurements will be taken on a representative sample of the target larval fish taxa. Approximately 100 fish from each taxon will be measured using a video capture system and Optimus™ image analysis software. The 100 fish from each taxon will be selected from the entrainment station based on the percentage frequency of occurrence of a taxon in each survey. For example, if 20 percent of the California halibut larvae for the entire year-long study were collected from during the June survey then 20 fish will be measured from that survey.

3.4 Assessment Methods

Potential cooling water intake system (CWIS) entrainment effects will be evaluated using a suite of methods, with no single method being superior to any others. The potential entrainment effects of the EPS CWIS, assuming 100 percent through-plant mortality, will be estimated using the site-specific field data collected in this proposed study. The potential for any such CWIS effects to cause long-term population level impacts will be evaluated through the use of three analytical techniques: proportional entrainment (*PE*), adult equivalent loss (*AEL*), and fecundity hindcasting (*FH*). The results of these analytical steps will support assessments with respect to species population demographics (e.g., standing stock, age structure stability, fishery trends, and sustainable harvest management plans).

*3.4.1 Demographic Approaches (*FH *and* AEL*)*

The fecundity hindcasting or *FH* analysis approach (Horst 1975) compares larval entrainment losses with adult fecundity to estimate the amount of adult female reproductive output eliminated by entrainment. It thereby hindcasts the numbers of adult females effectively removed from the reproductively active population. The accuracy of these estimates of effects is dependent upon such factors as accurate estimates of age-specific mortality from the egg and early larval stages to entrainment, and also on age-specific estimates of adult fecundity, spawning periodicity, and reproductive lifespan. If it is assumed that the adult population has been stable at some current level of exploitation and that the male:female ratio is known and constant, then fecundity and mortality are integrated into an estimate of loss by converting entrained larvae back into females (i.e., hindcasting). In making this conversion, the number of eggs, derived from the number of larvae adjusted for egg to larvae mortality, are divided by the average number of eggs produced by each age class (size) of reproductive females in the stable population's ideal age structure. However this degree of information is rarely available for a population. In most cases, a simple range of eggs per females is reported without age-specificity.

An advantage of *FH* is that survivorship need only be estimated for a relatively short period of the larval stage (i.e., egg to larva). This method does not require source water sampling in addition to estimates of larval entrainment concentrations. This method assumes that the loss of a single female's reproductive potential is equivalent to the loss of adults. For the purpose of the resource assessment, if EPS-induced entrainment losses are to be equated to population level units in terms of fractional losses, it is still necessary to estimate the size of the population of interest. To this end, our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS.

The adult equivalent loss or *AEL* approach (Goodyear 1978) uses age-specific estimates of the abundance of entrained or impinged organisms to project the loss of equivalent numbers of adults based on mortality schedules and age at recruitment. The primary advantage of this approach is that it translates power plant-induced, early life-stage mortality into equivalent numbers of adult fishes, the units used by resource managers. Adult equivalent loss does not necessarily require source water estimates of larval abundance in addition to entrainment estimates, as required in *PE*. This latter advantage may be offset by the need to gather age-specific mortality rates to predict adult losses and the need for information on the adult population of interest for estimating population-level effects (i.e., fractional losses). However, the need for age-specific mortality estimates can be reduced by various approximations as shown by Saila et al. (1987), who used six years of entrainment and two years of impingement data for winter flounder *Pleuronectes americanus*, red hake *Urophycis chuss*, and pollock *Pollachius virens* at the Seabrook Station in New Hampshire. Their model assumed an adult population at equilibrium, a stable age distribution, a constant male:female ratio, and an absence of density-dependent (i.e., compensatory) mortality between entrainment and recruitment to the adult or fished stocks. Input data to their model parameters were gathered in field surveys of spawning populations, egg and larval production, and local hydrology.

Declining populations can be accounted for in both the *AEL* and *FH* approaches by using age-specific adult mortality estimates from fishery catch data and by assuming no compensatory mortality. However, we know that this is not an assumption that fits the reality of population dynamics. The removal (mortality) of any life stage will have an effect if it exceeds the number of reproductive adults required to produce that number of larvae. That is, the adult population will decline one for one with every larva lost. This is clearly not the case, nor does every larva survive to become an adult. Although we have essentially no way of estimating the degree to which a population can sustain losses and remain stable, it is an important issue when estimating long-range effects. The effect, known as density-dependence (sometimes called compensation), can affect the vital rates of impacted organisms. Density-dependence is not confined to acting through mortality; growth and fecundity may also be density-dependent. In fisheries management models, which we will take as our working models in forecasting long-term population trends, the level of compensation possible in species can be examined empirically by the response of its population to harvest rates.

Some entrainment studies have assumed that compensation is not acting between entrainment and the time when adult recruitment would have taken place, and further, that this specific assumption resulted in conservative estimates of projected adult losses (Saila et al. 1987). Others, such as Parker and DeMartini (1989), did not include compensatory mortality in estimates of equivalent adult losses because of a lack of consensus on how to include it in the models and, more importantly, uncertainty about how compensation would operate on the populations under study. The uncertainty arises because the effect of compensation on the ultimate number of adults is directly related to which of the vital processes (fecundity, somatic growth, mortality) and which life stages are being affected. In particular, Nisbet et al. (1996) showed that neglecting compensation does not always lead to conservative long-term estimates of equivalent adult losses.

3.4.2 Empirical Transport Model (ETM)

The *PE* approach (Boreman et al. 1978, Boreman et al. 1981) will provide an estimate of incremental (conditional, Ricker 1975) mortality imposed by EPS on local source water larval populations by using empirical data (plankton samples) rather than relying solely on hydrodynamic and demographic calculations. Consequently, *PE* requires an additional level of field sampling to characterize abundance and composition of larvae using results from the larval fish surveys defined in this document (Section 3.2.1). These estimates of species-specific fractional losses (entrainment losses relative to source water abundance) can then be expanded to predict regional effects on appropriate adult populations using an empirical transport model (*ETM*), as described below. Required parameters for the *PE* approach include the rate of cooling water withdrawal, estimates of entrained larval fish concentrations, and estimates of the larval fish concentrations in the source waters.

The use of *PE* as an input to the empirical transport model (*ETM*) has been proposed by the U.S. Fish and Wildlife Service to estimate mortality rates resulting from cooling water withdrawals by power plants (Boreman et al. 1978, and subsequently in Boreman et al. 1981). Variations of this model have been discussed in MacCall et al. (1983) and have been used to assess impacts at a southern California power plant (Parker and DeMartini 1989). The *ETM* has also been used to assess impacts at the Salem Nuclear Generating Station in Delaware Bay, New Jersey (PSE&G 1993) as well as other power stations along the East Coast. Empirical transport modeling permits the estimation of annual conditional mortality due to entrainment while accounting for the spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The generalized form of the *ETM* incorporates many time-, space-, and age-specific estimates of mortality as well as information regarding spawning periodicity and duration, many of which are limited or unknown for the marine taxa being investigated at EPS. The applicability of the *ETM* to the present study at EPS will be limited by a lack of either empirically derived or reported demographic parameters needed as input to the model. However, the concept of summarizing *PE* over time that originated with the *ETM* can be used to estimate entrainment effects over appropriate temporal scales either through modeling or by making assumptions about species-specific life histories. We will employ a *PE* approach that is similar to the method described by MacCall et al. (1983) and used by Parker and DeMartini (1989) in their final report to the California Coastal Commission (Murdoch et al. 1989), as an example for the San Onofre Nuclear Generating Station (SONGS). This estimate can then be summarized over appropriate blocks of time in a manner similar to that of the *ETM*.

4.0 IMPINGEMENT EFFECTS

The two primary ways cooling water withdrawal can affect aquatic organisms are through impingement and entrainment. Larger organisms are subjected to impingement on the screening system on the power plant's cooling water intake system (CWIS) that excludes debris from the circulating water pumps. EPS presently has seven sets of vertical traveling screens in three separate areas. Approach velocities vary from approximately 0.7 fps at high tide to 1.6 fps at low tide. Impingement occurs when an organism larger than the traveling screen mesh size is trapped against the screens. These impinged organisms are assumed to undergo 100 percent mortality for the purposes of this study. The following questions will be addressed by the impingement study:

- What is the baseline impingement mortality?
- What are the species composition and abundance of fishes and macroinvertebrates impinged by EPS?

4.1 Review of 1980 Impingement Study

In earlier impingement studies at EPS, fish samples were collected from screen washes during high and low impingement periods for one year (SDG&E 1980). Samples were collected over two-12 hour periods during each day to represent daytime and nighttime impingement. Since samples were collected every day the study provides a direct measure of EPS impingement. During the one-year period during normal plant operations 76 species of fishes and 45 species of macro-invertebrates totaling 85,943 individuals and weighing 1,548 kg (3,414 lb) were impinged. During the seven heat treatments conducted during the sampling period 108,102 fishes weighing 2422 kg (5,341 lb) were collected. The most abundant fishes collected in impingement samples were actively swimming, open-water schooling species such as deepbody and northern anchovy, topsmelt, and California grunion. Other abundant species included queenfish and shiner surfperch. During heat treatments larger fishes were collected that were less common during normal impingement. These larger fishes probably live in the CWIS and are able to avoid impingement during normal plant operation, but succumb to the warmer temperatures during heat treatment. Marine plants, largely eelgrass and giant kelp, made up the largest component of material in impingement samples.

Impingement losses at EPS were much less when compared with impingement at other coastal plant in southern California. Impingement was much greater at the Redondo Beach Generating Station and San Onofre Nuclear Generating Station Unit 1, even though the cooling water flows at those two facilities are less than the flow at EPS (673 and 500 MGD, respectively compared with 828 mgd at EPS). The intake approach velocities at the screenwells at EPS are lower than the velocities at these other facilities allowing most fishes to avoid impingement by continuous or burst swimming. The SDG&E report (SDG&E 1980) and a later evaluation (EA 1997) both concluded that the biological impact of EPS was insignificant in terms of impingement losses.

4.2 Impingement Study Methods

The purpose of the proposed 316(b) impingement study will be to characterize the juvenile and adult fishes and selected macroinvertebrates (e.g., shrimps, crabs, lobsters, squid, and octopus) impinged by the power plant's CWIS. The sampling program is designed to provide current estimates of the abundance, taxonomic composition, diel periodicity, and seasonality of organisms impinged at EPS. In particular, the study will focus on the rates (i.e., number or biomass of organisms per m^3 water flowing per time into the plant) at which various species of fishes and macroinvertebrates are impinged. The impingement rate is subject to tidal and seasonal influences that vary on several temporal scales (e.g., hourly, daily, and monthly) while the rate of cooling water flow varies with power plant operations and can change at any time. A review of the previous impingement study at EPS will provide context for interpreting changes in the magnitude and characteristics of the present day impingement effects. Studies of the Agua Hedionda fish assemblages independent of EPS (e.g., MEC Analytical 1995) will also provide information regarding the marine environment in southern and central Agua Hedionda Lagoon.

In accordance with procedures employed in similar studies, impingement sampling will occur over a 24-hour period one day per week. Before each sampling effort, the trash racks will be cleaned and the traveling screens will be rotated and washed clean of all impinged debris and organisms. The sluiceways and collection baskets will also be cleaned before the start of each sampling effort. The operating status of the circulating water pumps on an hourly basis will be recorded during the collection period. Each 24-hour sampling period at the traveling screens will be divided into six 4-hour cycles. The traveling screens will remain stationary for a period of 3.5 hours then they will be rotated and washed for 30 minutes. The trash racks will be cleaned once every 24 hours. The impinged material from the traveling screens will be rinsed into the collection baskets associated with each set of screens and the impinged material from the trash racks will be collected in the bin on the rake apparatus. The debris and organisms rinsed from each set of traveling screens and the trash racks will be kept separate and processed according to the procedures presented in the following section.

If the traveling screens are operating in the continuous mode, then sampling will be coordinated with the intake crew so samples can be collected safely. A log containing hourly observations of the operating status (on or off) of the circulating water pumps for the entire study period will be obtained from the power plant operation staff. This will provide a record of the amount of cooling water pumped by the plant, which will then be used to calculate impingement rates. The same procedure will be used to coordinate additional sampling efforts at the trash racks in case they need to be cleaned more frequently than once every 24 hours. The sampling at each of the three sets of traveling screens will be offset by one hour to allow screen wash and collection to occur at each set of screens separately.

Impingement sampling will also be conducted during heat treatment "tunnel shock" operations. Procedures for heat treatment will involve clearing and rinsing the traveling screens prior to the start of the heat treatment procedure. At the end of the heat treatment procedure normal pump operation is resumed and the traveling screens rinsed until no more fish are collected on the screens. Processing of the samples will occur using the same procedures used for normal impingement sampling. We anticipate that up to eight heat treatments will occur during the one-year study period.

A quality control (QC) program will be implemented to ensure the correct identification, enumeration, length and weight measurements of the organisms recorded on the data sheet. Random cycles will be chosen for QC re-sorting to verify that all the collected organisms were removed from the impinged material.

Depending on the number of individuals of a given target species present in the sample, one of two specific procedures is used, as described below. Each of these procedures involves the following measurements and observations:

1. The appropriate linear measurement for individual fishes and motile invertebrates is determined and recorded. These measurements are made in millimeters to the nearest 1 mm. The following standard linear measurements are used for the animal groups indicated:

Fishes	Total body length for sharks and rays and standard lengths (fork length) for bony fishes.
Crabs	Maximum carapace width.
Shrimps & Lobsters	Carapace length, measured from the anterior margin of carapace between the eyes to the posterior margin of the carapace.
Gastropod & Pelecypod Molluscs	Maximum shell length or maximum body length.
Octopus	Maximum "arm" spread, measured from the tip of one tentacle to the tip of the opposite tentacle.
Squid	Maximum body length, measured from the tip of one tentacle to the posterior end of the body.

2. The wet body weight of individual animals is determined after shaking loose water from the body. Total weight of all individuals combined is determined in the same manner. All weights are recorded to the nearest 1 g.

3. The qualitative body condition of individual fishes and macroinvertebrates is determined and recorded, using codes for decomposition and physical damage. These codes are shown on the attached form.

4. Other non-target, sessile macroinvertebrates are identified to species and their presence recorded, but they are not measured or weighed. Rare occurrences of other impinged animals, such as dead marine birds, are recorded and their individual weights determined and recorded.

5. The amount and type of debris (e.g., *Mytilus* shell fragments, wood fragments, etc.) and any unusual operating conditions in the screen well system are noted by writing specific comments in the "Notes" section of the data sheet.

The following specific procedures are used for processing fishes and motile invertebrates when the number of individuals per species in the sample or subsample is ≤ 29 :

1. For each individual of a given species the linear measurement, weight, and body condition codes are determined and recorded on separate lines.

The following specific subsampling procedures are used for fishes and motile invertebrates when the number of individuals per species is > 29:

1. The linear measurement, individual weight, and body condition codes for a subsample of 30 individuals are recorded on individual lines of the data sheet. The individuals selected for measurement should selected after spreading out all of the individuals in a sorting container, making sure that they are well mixed and not segregated into size groups. Individuals with missing heads or other major body parts are eliminated from consideration, since linear measurements of them are not representative.

2. The total number and total weight of all the remaining individuals combined are determined and recorded on a separate line.

4.2.1 Sampling Frequency

Results from the previous impingement study indicated that the impingement is much greater during the heat treatment "tunnel shock" events. Almost 60 percent of the total impinged fishes (over 60 percent by weight) were collected during the seven tunnel shock events. Impingement rates during normal operations were much less. Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks. The analysis will be done using the weekly data collected at EPS during this study and data from other southern California power plants with shoreline intake structures. The reduced sampling frequency may provide an adequate estimate of impingement especially since we will continue to sample impingement during each of the tunnel shock events when impingement is highest.

5.0 COOLING WATER SYSTEM IMPACT ASSESSMENT

The entrainment and impingement effects of the cooling water intake system for the EPS project will be assessed on the basis of historical studies and 12 months of recent plankton and 12 months of impingement survey information. The assessment will consider the effects of entraining larval fishes, crabs and lobsters, and impinging larger fishes and invertebrates in the CWIS. The three methods for assessing CWIS effects are fecundity hindcasting (*FH*), adult equivalent loss (*AEL*) and empirical transport modeling (*ETM*). These methods were explained in Section 3.5—Assessment Methods. The report will contain estimates of *AEL* and *FH* where data are available to parameterize these demographic approaches.

The impacts of impingement and entrainment on source water populations can be evaluated by estimating the fractional losses to the population attributable to the CWIS. Impingement rates and biomass estimates from the study will provide estimates of impingement losses that can then be translated directly to estimate potential impingement effects on local fisheries. Estimated entrainment losses are extrapolated to fishery losses using *FH* and *AEL* estimates. One constraint in the modeling approach is that life history data are available for only a portion of the entrained taxa and commercial fishery statistics will also only be available for a few of the entrained species (e.g., California halibut, northern anchovy, white croaker). Many of the fishes that have historically been entrained in highest numbers are small fishes that are not the focus of any recreational or commercial fishery.

Present-day findings on the EPS CWIS entrainment effects will be reviewed and assessed for the most abundant larval fish taxa, megalopal cancer crabs, and larval spiny lobster. By comparing the number of larvae and megalopae withdrawn by the power plant to the number available (i.e., at risk to entrainment), an estimate of the conditional mortality due to entrainment (*PE*) can be generated for each taxon or species. These estimates of conditional mortality will be combined in the *ETM* model to provide an estimate of the annual probability of mortality due to entrainment (P_m) that can be used for determining CWIS effects and the potential for long-term population declines. Fishery management practices and other forms of stock assessments will provide the context required to interpret P_m. In the case of a harvested species, P_m must be considered in addition to these harvest losses when assessing impacts and any potential for population decline.

5.1 Entrainment Effects Assessment

The assessment will focus on entrainment effects to the most abundant and to commercially or recreationally important fish taxa, cancer crab megalops and lobster larvae. Larval fishes analyzed will tentatively be the Goby complex, three Engraulid species, three Atherinopsid species, California halibut, white croaker, black croaker, spotted sand bass, and barred sand bass. These taxa likely comprise over 90 percent of all the entrained larval fishes based on earlier studies. Other species, which may occur in lower abundances, may also be included in the assessment because they represent species of commercial or recreational importance

5.2 Summary of Entrainment Effects

The length of time that a larval fish is in the plankton and subject to entrainment is a key parameter in *ETM* calculations. Length measurements taken from representative samples of the larval fish taxa presented in Section 4.0 will be used to estimate the number of days that larvae (for a specific taxon) are at risk to entrainment. Reports on larval duration from the scientific literature are likely to overestimate the period of time that larvae are exposed to entrainment. This is because ontogenetic changes during larval development result in increased swimming ability or behavioral changes, such as association with the bottom or other pre-settlement microhabitats. Possible outliers are eliminated by basing the minimum and maximum lengths on the central 98 percent of the length distribution for a taxon and excluding the lengths of the top and bottom percentiles. Estimates of larval growth rates (mm/day) are then used on this range to estimate the number of days the larvae are exposed to entrainment. The estimates of growth rates and their source from the literature will be presented in the impact assessment section for the different taxa. The average duration of entrainment risk for a taxon is calculated from the bottom percentile value to the mean value, while the maximum duration is calculated from the bottom percentile value to the 99 percentile value. Our estimates of the period of entrainment risk for cancer crabs and spiny lobster will be derived from literature values on the average age of the stages for each crustacean species.

5.3 Summary of Impingement Effects

Impingement effects in relation to source water fishery resources and potential ecological effects will be summarized based on data summarized from the earlier impingement study (SDG&E 1980), data on fish populations in Agua Hedionda Lagoon (MEC 1995), and CDF&G catch records for sport and commercial fishery resources.

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NRG CABRILLO POWER OPERATIONS INC.

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Subject: Cabrillo Power I LLC Response to Comments from Tetra Tech to San Diego Regional Water Quality Control Board on the Encina *316(b) Cooling Water Intake Effects Entrainment & Impingement Sampling Plan*

Dear Mr. Phillips:

Cabrillo Power I LLC (Cabrillo) appreciates the opportunity to respond to the comments from Tetra Tech on the *316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan* for the Encina Power Station (EPS) submitted to the San Diego Regional Water Quality Control Board (Regional Board) on September 2, 2004. Tenera Environmental prepared the plan for the EPS 316(b) studies, and Cabrillo had them respond to comments from Tetra Tech. The responses from Tenera are incorporated into this letter and identified accordingly.

The Tetra Tech comments generally call for further clarification of the study plan or additions to the plan that will not affect the sampling procedures currently being used. The Tetra Tech comments (numbered the same as on the Tetra Tech memo) with specific questions of Cabrillo have responses that are highlighted in boldface type. Tetra Tech also made several suggestions that we have responded to in the final section of this letter.

TETRA TECH COMMENTS AND CABRILLO RESPONSES:

1) *Page 2*: The authors state that they will use EPA's criteria for selecting appropriate target organisms for assessment, results from previous 316(b) studies, Aqua Hedionda Lagoon ecological surveys, and results from the upcoming study to "determine the appropriate target organisms that will be evaluated in detail." Final selection of target organisms should involve consultation with the appropriate resource agencies. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

Response: **The final selection of the specific target organisms will be made in collaboration with the Regional Board and other appropriate agencies. The**

sampling and processing is currently focused on fishes and selected macroinvertebrates; the same groups of organisms that were studied in San Diego Bay in 2001–2003 at the Duke Energy South Bay Power Plant in San Diego. The final list of target organisms will be based largely on their abundances in the entrainment and impingement samples. The impact assessment will be restricted to the most abundant taxa to ensure that there is have reasonable confidence in the results.

3) *Page 7*: The MEC Analytical (1995) ecological surveys will be used to provide "data on fish populations in Aqua Hedionda Lagoon" (see page 24) for the evaluation of EPS impingement effects in relation to source water fishery resources. The authors mention that the MEC Analytical sampling "did not include any areas of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected." It appears that the surveys focused on the Middle and Inner Lagoons. Since the MEC Analytical data will be used for impingement effects analyses, the search for and/or collection of supplemental information for Outer Lagoon fishes may be warranted (however, it should be noted that we have not reviewed the contents of the MEC Analytical report).

Response: **The MEC study utilized multiple gear types that effectively sampled most of the habitats in Aqua Hedionda Lagoon. Cabrillo is currently evaluating if supplemental studies of the habitats not sampled in the MEC study are necessary and will propose those to the Regional Board if warranted. These habitats include the shallow mudflats areas that are common in the middle and inner lagoon, the rocky habitat that lines the boundary of the outer lagoon, and the artificial substrates on the piers, docks and floats of the outer lagoon. Gobies that occur in burrows on the mudflats and combtooth blennies, garibaldi and rockfishes that occur on the rocky habitat and artificial substrates in the outer lagoon were not effectively sampled by any of the gear types used in the MEC study. The larvae from these fishes will likely be abundant in the entrainment samples and this study will provide an estimate of their adult source water populations that will be used in the assessment of cooling water intake system (CWIS) effects.**

6) *Page 11*: The authors state that entrainment sampling began in June 2004 and will continue through May 2005. Has this proposed index period changed, or was approval received for sampling commencement prior to the preparation and review of this sampling plan (Plan is dated September 2004)? Did source water sampling also begin before this plan was written?

Response: **Both entrainment and source water sampling began in June 2004. The sampling started before a sampling plan was submitted to the Regional Board to take advantage of studies of the cooling water system that were being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources. The original proposal for the Poseidon study did not include the more extensive source water sampling in the final study plan. The scope of the study was expanded to conform to other 316(b) demonstration studies Tenera has completed in California including the study recently completed at the Duke Energy South Bay Power Plant in San Diego Bay. This provided Cabrillo the opportunity to continue the sampling in response to EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act.**

7) *Page 11*: Entrainment samples will be collected from the lagoon, near the intake structure. Is entrainment sampling not possible from a location within the EPS CWIS?

Response: **Entrainment sampling conducted at ocean and estuarine power plants over the last ten years in California has been done in the source waters as near as possible to the intakes. This sampling location has been used because studies at the Diablo Canyon Power Plant in central California showed that large losses of planktonic organisms such as larval fishes can occur as a result of filtering by biofouling organisms that grow on the surfaces inside the power plant cooling water intake system. Studies have shown reductions in densities of greater than 90 percent between intake and discharge samples that have been attributed to biofouling losses. Although the entrainment sampling proposed for the EPS with plankton nets in the source waters at the power plant intake structure requires the assumption that the densities of organisms in the source waters are representative of the densities of organisms that are entrained, sampling inside the power plant introduces additional assumptions, sampling problems, and the known problem of cropping by biofouling organisms. One of these problems involves obtaining representative, well-mixed samples and sampling in rapidly flowing water. In addition, sampling inside the plant cooling water system usually requires pump sampling methods that are different than the towed net sampling used in the source waters, therefore introducing additional assumptions affecting comparisons between density estimates. All of these issues have resulted in the recommendation that entrainment sampling be done in the lagoon using nets towed as close as practical to the intake structure.**

8) *Page 11*: As part of the description of entrainment sampling methods, the authors mention that the "accuracy of individual instruments differed by less than 5% between calibrations." This is mentioned as a statement. Is it intended to be a quality standard?

Response: No, it is not intended as a quality standard, it is just a statement that the difference in rotor constants between calibrations was generally less than 5%. In addition to maintaining the flowmeters before and after each survey, they are calibrated every three months to recalculate a new rotor constant, which is used to calculate the flow of water through the net. If the value of a constant changes greater than 10% between calibrations, which is almost never the case, the readings from the field data sheets are reviewed to determine when the change occurred. If the change in the flowmeter can be detected from the data, the values will be adjusted using the average difference between the two flowmeters used on the bongo frame prior to that sample; otherwise the flowmeter reading for the instrument that is within the 10% calibration range will be used to estimate the volume of seawater filtered through both nets on the bongo frame.

9) *Page 11*: The authors state that if the target volume of water is not filtered during the entrainment tow, the tow will be repeated until the targeted volume is reached. Will the tow distance be extended to accomplish this, or will the tow truly be "repeated?"

Response: The tow will be continued at the lagoon and entrainment stations by extending the tow, covering the vertical depth of the water column until the target volume is collected. Some of the deeper nearshore samples cannot simply be extended because it would not be possible to collect an unbiased sample that extended across all depths without greatly increasing the sample volume. In these cases, or if flowmeters are fouled with kelp, the samples are discarded and the sampling is repeated at the station.

10) *Page 12*: The source water sampling methods are said to be "identical to the entrainment sample collection" (with a few noted exceptions). Does that mean that all source water stations will be sampled concurrently with entrainment sampling, and during the same (four) six-hour cycles? Is the source water sampling index period the same as the June 2004-May 2005 entrainment period?

Response: Yes, all of the stations, source water and entrainment, are sampled during the same four six-hour blocks on the day the survey is conducted. All of the stations are usually sampled within a 2-3 hour period. All of the

stations have been sampled since June 2004 with a total of eight surveys collected as of December 2004.

11) *Page 13*: The Inner Lagoon will be sampled with a single pushnet. Will the targeted volume of water be the same as the paired net (oblique) samples taken in the Outer Lagoon and nearshore ocean areas?

Response: **Yes. The targeted volume for the lagoon source water and entrainment samples is approximately 50 m^3. The volumes for samples from the nearshore stations may be greater, especially at the deepest stations, N4 and N5, where the minimum sample volume may exceed 50 m^3 because the nets are lowered through the entire water column and then retrieved.**

13) *Page 13*: The authors mention that "the number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

Response: **A proposal for this or any other change in the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by Regional Board and other reviewing agencies.**

14) *Page 14*: The authors state that, "A laboratory quality control (QC) program...will be applied to all samples." Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the specific data quality objectives for laboratory processing (e.g., sorting efficiencies, taxonomic agreement, etc.)?

Response: **The laboratory QC program is an internal Tenera document that was not cited in the study plan. The QC program includes a procedure for preserving, transferring, splitting, and sorting plankton samples. There is a separate procedure for identification of the organisms from the samples. The following data quality objectives are used for sorting:**

1. **The first ten samples that are sorted by an individual are completely resorted by a designated QC sorter. A sorter is allowed to miss one target organism when the original sorted count is 1-19. For original counts above 20 a sorter must maintain a sorting accuracy of 90%.**
2. **After the sorter has passed 10 consecutive sorts, the program is switched to a '1 sample in 10' QC program for that sorter. After the sorter has**

completed another 10 samples, one sample is randomly selected by the designated QC sorter for a QC resort.

3. **If the sorter maintains the 90% accuracy sorting rate for this sample, then the sorter continues in the '1 sample in 10' QC mode.**
4. **If a sample does not meet the 90% accuracy rate their subsequent samples will be resorted until 10 consecutive samples meet the criteria.**

A similar QC procedure is used for taxonomic identification except that the taxonomist must maintain an accuracy level of 95% for the identifications.

16) *Page 15*: The FH model requires specific input parameter data (e.g., age-specific mortality) that may not be readily available. The authors state that, "...this degree of information is rarely available for a population." They also mention that "...our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS." Will adequate input parameter data be available, or is it too early in the process to tell?

Response: **The initial review of the data showed that many of the same fish taxa that were analyzed from other studies were also abundant in the EPS samples. Also, similar to other studies, the majority of the fishes were small, forage species that do not have direct commercial/recreational fishery values. Therefore, while it has been possible to parameterize the adult equivalent models (FH and AEL) for many of these species in past studies, estimates of their adult populations that were necessary to interpret the results of the modeling efforts were usually not available. The MEC study on the fishes of Aqua Hedionda Lagoon and results from supplemental studies on adult fishes will help provide some of this information.**

19) *Page 19*: The impingement study methods do not mention an index period. Has impingement sampling begun, and will the sampling period coincide with entrainment sampling (June 2004-May 2005)?

Response: **Yes, impingement sampling began in early July 2004 and will continue through June 2005. Although it does not exactly coincide with entrainment sampling, it is close enough to capture the same seasonal changes in fish and target invertebrate abundance that will be present in the entrainment sampling. The sampling was started in July to take advantage of studies at the plant being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources (See *Tenera Response* to Comment 6).**

20) *Page 20*: The authors mention a quality control (QC) program for impingement sampling. Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the "random cycles for re-sorting" and the specific quality objectives (e.g., for sorting efficiency)?

Response: **Tenera has written procedures for conducting the impingement sampling at EPS that all participating samplers are required to follow. A quality control plan is part of this procedure. Each impingement sampling team is comprised of two qualified biologists familiar with the fish and invertebrate fauna likely to be impinged. The goal of the sampling is to correctly identify, and accurately count and weigh all impinged organisms according to the criteria in the sampling protocol. In addition to ongoing quality control checks by samplers (e.g., consultations among team members, supervisor involvement, preservation of specimens of uncertain identity), Tenera personnel will check the counts and identifications from two cycles of impinged material on a quarterly basis. Unlike the laboratory identification process where a 90% sorting accuracy objective is specified, a specific quantitative objective for the impingement QC program is not feasible because of the variability in the quantity and types of impinged material. The objective is 100% accuracy. Tenera will document the results of the QC checks and implement any corrective actions necessary to ensure compliance with the written procedures.**

21) *Page 22*: The authors state that, "Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

Response: **See response to Comment 13.**

22) *Page 23*: The authors state that, "Fishery management practices and other forms of stock assessments will provide the context required to interpret [the estimate of the annual probability of mortality due to entrainment]." The data types mentioned may not be available for some of the most frequently entrained fishes (e.g., non-commercial /non-recreational species). Will adequate evaluation data be available, or is it too early in the process to tell?

Response: **See response to Comment #16. The MEC study on the fishes of Agua Hedionda Lagoon will help provide this information for the small,**

estuarine, forage species that are not targeted by commercial or recreational fisheries.

23) *Page 23 and 24*: Potential target organisms are mentioned. Comment 1 (above) applies here. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

Response: **See response to Comment 1.**

SUGGESTIONS

- The governing regulatory/resource agencies should be given the opportunity to consider and approve/reject: the selection process for representative species (mentioned in comments 1 and 23, above); the possible reduction in the number of source water sampling stations (comment 13); and the possible reduced impingement sampling frequency.

  Response: **See responses to comments 1, 13, and 23. Proposals for these, or any other, change to the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by the Regional Board.**

- The temporal aspects of the study questioned in comments 6, 10 and 19 (above) need to explained in more detail.

  Response: **See responses to Comments 6 and 19.**

- The quality control program needs to be described in more detail (see comments 14 and 20), or the QA/QC plan should be cited and/or attached as an appendix.

  Response: **Procedures for the sampling and laboratory processing will be submitted as attachments to the study plan.**

- As mentioned previously, the study plan was obviously developed by qualified and experienced contractors, and we think that their study design is conceptually valid. Most comments listed above represent the need for relatively minor clarifications or additions.

Thank you again for the opportunity to respond to the comments from Tetra Tech. The study being conducted by Tenera Environmental is based on the design used for the entrainment and impingement studies at the Duke Energy South Bay Power Plant in San

Diego Bay. These studies were required for the plant's NPDES permit that was recently approved by the Regional Board. Therefore, we are confident that the study will provide the information necessary for Cabrillo Power I LLC to comply with EPA's recently published Phase II rule for Section 316(b) of the Clean Water Act. We look forward to working with you and the other Regional Board staff on this project and would be available to discuss our responses to these comments at your convenience.

If you have any questions or comments, please contact Mr. Tim Hemig at (760) 268-4037.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig (Cabrillo)
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)

ATTACHMENT 4

UPDATED IMPINGEMENT AND ENTRAINMENT ASSESSMENT

TENERA ENVIRONMENTAL

MAY 2007

TENERA Environmental

CARLSBAD SEAWATER DESALINATION PROJECT

Technical Memorandum

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

Prepared

By Tenera Environmental, Inc.

For

Poseidon Resources Channelside, LLC

May 2007

INTORDUCTION

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

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

ASSESSMENT OF ENTRAINMENT EFFECT AND APF

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

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

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

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

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

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

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

Approximate Wetland Habitat Acreage 330 (11)
Approximate Historic Acreage 695
Habitat Acres Vegetation Source

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

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

IMPINGEMENT ASSESSMENT

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

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

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

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

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

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

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

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

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

ATTACHMENT 5

CARLSBAD DESALINATION PROJECT

SUMMARY OF FISH AND TARGET SHELLFISH LARVAE COLLECTED FOR ENTRAINMENT AND SOURCE WATER STUDIES IN THE VICINITY OF AGUA HEDIONDA LAGOON FROM JUNE 2005 THROUGH MAY 2006

Carlsbad Desalination Facility –
Encina Power Station

Summary of Fish and Target Shellfish Larvae
Collected for Entrainment and Source Water Studies
in the Vicinity of Agua Hedionda Lagoon
from June 2005 through May 2006

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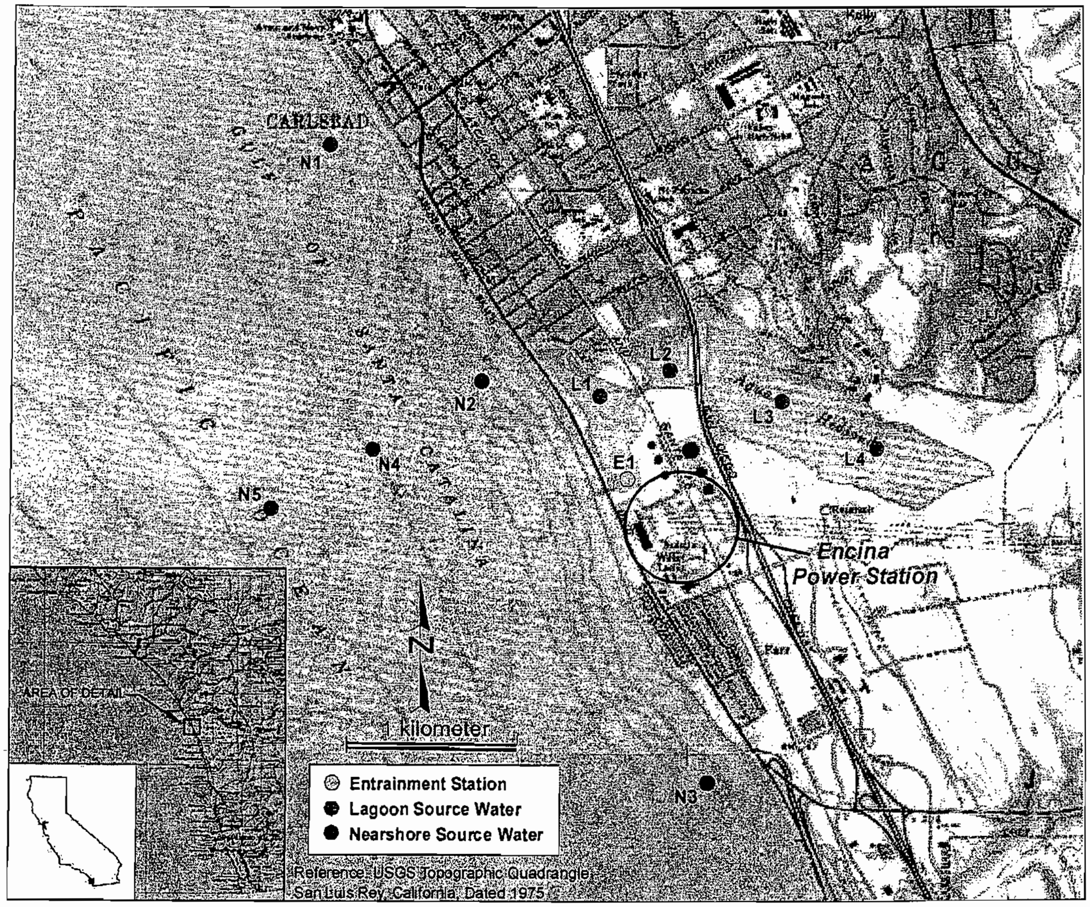

Figure 1. Location of entrainment (E1) and source water (L1–L4; N1–N5) plankton sampling stations.

Table 1. Average concentration and total number collected of larval fishes and target shellfishes in entrainment samples collected in Agua Hedionda Lagoon (Station E1), June 2004–May 2005.

Taxon	Common Name	Average Concentration (# / 1,000 m^3)	Total Count	Percentage of Total	Cumulative Percentage
Gobiidae (CIQ complex)	gobies	2,222.93	12,763	61.95	61.95
Hypsoblennius spp.	blennies	1,107.67	5,838	28.34	90.29
Engraulidae	anchovies	134.29	819	3.98	94.27
Hypsypops rubicundus	garibaldi	40.99	188	0.91	95.18
Typhlogobius californiensis	blind goby	24.65	148	0.72	95.90
Gibbonsia spp.	clinid kelpfishes	22.45	125	0.61	96.51
Labrisomidae.	labrisomid kelpfishes	17.65	81	0.39	96.90
Syngnathidae	pipefishes	16.06	83	0.40	97.30
Acanthogobius flavimanus	yellowfin goby	14.41	87	0.42	97.72
larvae, unid. fish fragment	unid. larval fishes	9.65	56	0.27	98.00
Atherinopsidae	silversides	9.18	54	0.26	98.26
larvae, unid. yolksac	unid. yolksac larvae	8.36	39	0.19	98.45
Roncador stearnsii	spotfin croaker	8.33	42	0.20	98.65
Rimicola spp.	kelp clingfishes	7.92	43	0.21	98.86
Genyonemus lineatus	white croaker	7.04	44	0.21	99.07
Seriphus politus	queenfish	5.50	29	0.14	99.21
Paraclinus integripinnis	reef finspot	4.95	31	0.15	99.36
Paralichthys californicus	California halibut	3.73	21	0.10	99.47
Sardinops sagax	Pacific sardine	2.66	16	0.08	99.54
Citharichthys spp.	sanddabs	2.24	14	0.07	99.61
Gillichthys mirabilis	longjaw mudsucker	2.14	13	0.06	99.67
Sciaenidae	croakers	1.86	11	0.05	99.73
Paralabrax spp.	sea basses	1.86	11	0.05	99.78
Hypsopsetta guttulata	diamond turbot	1.78	10	0.05	99.83
larvae, unid. post-yolksac	larval fishes	1.61	10	0.05	99.88
Pleuronectiformes	flatfishes	0.63	4	0.02	99.90
Heterostichus rostratus	giant kelpfish	0.54	3	0.01	99.91
Clinocottus analis	wooly sculpin	0.51	3	0.01	99.93
Stenobrachius leucopsarus	northern lampfish	0.37	2	0.01	99.94
Cheilotrema saturnum	black croaker	0.35	2	0.01	99.95
Scomber japonicus	Pacific mackerel	0.35	1	<0.01	99.95
Ophidiidae	cusk-eels	0.21	1	<0.01	99.96
Gobiesocidae	clingfishes	0.20	1	<0.01	99.96
Diaphus theta	Calif. headlight fish	0.19	1	<0.01	99.96
Semicossyphus pulcher	California sheephead	0.19	1	<0.01	99.97
Menticirrhus undulatus	California corbina	0.18	1	<0.01	99.97
Haemulidae	grunts	0.18	1	<0.01	99.98
Labridae	wrasses	0.17	1	<0.01	99.98
Myctophidae	lanternfishes	0.16	1	<0.01	99.99
Symbolophorus californiensis	California lanternfish	0.16	1	<0.01	99.99
Oxyjulis californica	señorita	0.14	1	<0.01	100.00
			20,601		
Cancer spp. (megalops)	cancer crabs	0.17	1		0.07

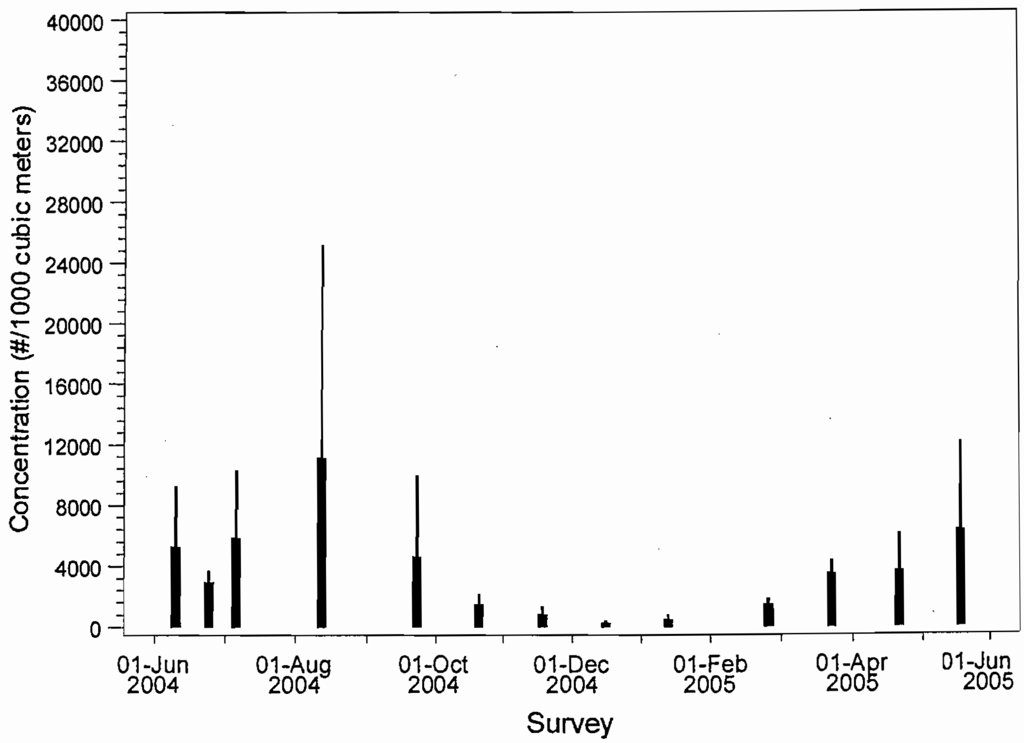

Figure 2. Mean concentration (# / 1,000 m^3 [264,172 gal]) and standard error of all larval fishes collected at entrainment Station E1 during monthly surveys, June 2004–May 2005.

Table 2. Average concentration of larval fishes and target shellfishes in source water samples collected at Agua Hedionda Lagoon and nearshore stations, June 2004–May 2005.

		Nearshore		Lagoon	
Taxon	**Common Name**	**Average Concentration (# / 1,000 m³)**	**Total Count**	**Average Concentration (# / 1,000 m³)**	**Total Count**
Fishes					
Engraulidae	anchovies	525.48	7,631	103.41	1,210
Hypsoblennius spp.	blennies	137.56	1,966	467.32	4,725
Gobiidae (CIQ complex)	gobies	69.12	921	2,718.58	30,270
Genyonemus lineatus	white croaker	64.66	921	4.25	54
larvae, unidentified yolksac	unid. yolksac larvae	45.82	678	3.12	32
Paralichthys californicus	California halibut	42.91	601	1.93	22
Paralabrax spp.	sand basses	24.88	372	0.68	8
Seriphus politus	queenfish	23.79	365	2.40	26
Sciaenidae	croaker	22.55	306	6.56	73
Citharichthys spp.	sanddabs	21.70	334	1.14	15
Roncador stearnsii	spotfin croaker	20.17	286	6.82	74
Gibbonsia spp.	clinid kelpfishes	19.29	277	16.74	182
Labrisomidae	labrisomid kelpfishes	16.36	219	35.30	366
Sardinops sagax	Pacific sardine	13.21	202	0.74	9
larval fish fragment	unid. larval fishes	10.50	145	15.02	174
Haemulidae	grunts	8.80	116	0.17	2
Scomber japonicus	Pacific mackerel	7.07	110	-	-
Hypsypops rubicundus	garibaldi	7.03	110	35.12	352
larval/post-larval fish unid.	larval fishes	6.81	93	1.36	16
Oxyjulis californica	senorita	5.55	79	0.75	8
Paralabrax nebulifer	barred sand bass	5.08	82	-	-
Sphyraena argentea	California barracuda	3.74	59	0.17	2
Xenistius californiensis	salema	3.61	55	0.30	3
Lepidogobius lepidus	bay goby	3.59	56	0.09	1
Stenobrachius leucopsarus	northern lampfish	3.26	51	-	-
Atherinopsidae	silversides	3.09	39	29.73	348
Pleuronichthys verticalis	hornyhead turbot	2.79	43	-	-
Umbrina roncador	yellowfin croaker	2.62	39	0.09	1
Ophidiidae	cusk-eels	2.61	37	0.09	1
Pleuronichthys ritteri	spotted turbot	2.51	34	0.17	2
Pleuronectidae unid.	flounders	2.28	35	0.08	1
Xystreurys liolepis	fantail sole	1.97	27	0.21	2
Hypsopsetta guttulata	diamond turbot	1.97	30	0.55	7
Rimicola spp.	kelp clingfishes	1.79	22	3.28	34
Peprilus simillimus	Pacific butterfish	1.78	28	-	-
Cheilotrema saturnum	black croaker	1.71	24	0.36	4
Semicossyphus pulcher	California sheephead	1.49	21	-	-
Diaphus theta	Calif. headlight fish	1.46	24	-	-
Acanthogobius flavimanus	yellowfin goby	1.46	22	38.98	499
Pleuronectiformes	flatfishes	1.25	21	0.07	1
Menticirrhus undulatus	California corbina	1.21	16	0.47	5
Atractoscion nobilis	white seabass	1.18	18	0.08	1
Sebastes spp.	rockfishes	1.09	18	-	-

(table continued)

Table 2 (continued). Average concentration of larval fishes and target shellfishes in source water samples collected at nearshore stations and Agua Hedionda Lagoon, June 2004-May 2005.

		Nearshore		Lagoon	
Taxon	**Common Name**	**Average Concentration (# / 1,000 m³)**	**Total Count**	**Average Concentration (# / 1,000 m³)**	**Total Count**
Girella nigricans	opaleye	1.06	16	-	-
Syngnathidae	pipefishes	1.02	13	5.31	53
Typhlogobius californiensis	blind goby	0.99	15	9.63	118
Trachurus symmetricus	jack mackerel	0.96	17	-	-
Halichoeres semicinctus	rock wrasse	0.95	15	-	-
Labridae	wrasses	0.83	11	-	-
Paraclinus integripinnis	reef finspot	0.81	14	2.88	31
Symphurus atricaudus	California tonguefish	0.77	11	-	-
Triphoturus mexicanus	Mexican lampfish	0.73	12	0.16	2
Nannobrachium spp.	lanternfishes	0.57	9	-	-
Medialuna californiensis	halfmoon	0.53	7	-	-
Gillichthys mirabilis	longjaw mudsucker	0.51	8	5.17	62
Chilara taylori	spotted cusk-eel	0.50	7	-	-
Heterostichus rostratus	giant kelpfish	0.50	7	-	-
Paralichthyidae	lefteye flounders	0.44	7	-	-
Parophrys vetulus	English sole	0.30	5	-	-
Myctophidae	lanternfishes	0.30	4	-	-
Hippoglossina stomata	bigmouth sole	0.29	5	-	-
Zaniolepis frenata	shortspine combfish	0.25	5	-	-
Ruscarius creaseri	roughcheek sculpin	0.22	3	-	-
Clupeiformes	herrings and anchovies	0.21	3	-	-
Gobiesocidae	clingfishes	0.18	3	0.64	7
Clupeidae	herrings	0.18	3	-	-
Lyopsetta exilis	slender sole	0.16	3	-	-
Pomacentridae	damselfishes	0.14	2	-	-
Rhinogobiops nicholsii	blackeye goby	0.14	2	-	-
Nannobrachium ritteri	broadfin lampfish	0.13	2	-	-
Cyclothone spp.	bristlemouths	0.13	2	-	-
Chromis punctipinnis	blacksmith	0.13	2	-	-
Icelinus spp.	sculpins	0.13	3	-	-
Anisotremus davidsonii	sargo	0.12	2	-	-
Sebastes jordani	shortbelly rockfish	0.10	2	-	-
Blennioidei	blennies	0.08	1	0.36	4
Clinidae	clinid kelpfishes	0.08	1	-	-
Chaenopsidae	tube blennies	0.07	1	-	-
Leptocottus armatus	Pacific staghorn sculpin	0.07	1	0.51	6
Cynoglossidae	tongue soles	0.07	1	-	-
Kyphosidae	sea chubs	0.07	1	-	-
Cyclothone acclinidens	benttooth bristlemouth	0.07	1	-	-
Hexagrammidae	greenlings	0.06	1	-	-
Bathylagus ochotensis	popeye blacksmelt	0.06	1	-	-
Hypsoblennius gentilis	bay blenny	0.05	1	-	-
Rimicola eigenmanni	slender clingfish	-	-	4.13	53
Clinocottus analis	wooly sculpin	-	-	0.31	4
Clinocottus spp.	sculpins	-	-	0.07	1
Semicossyphus pulcher	California sheephead	-	-	0.06	1
			16,763		38,872
Shellfishes					
Cancer spp. (megalops)	cancer crabs	9.29	158	0.17	2
Panulirus interruptus (larval)	California spiny lobster	7.04	98	0.21	2
Cancer gracilis (megalops)	slender crab	2.93	48		

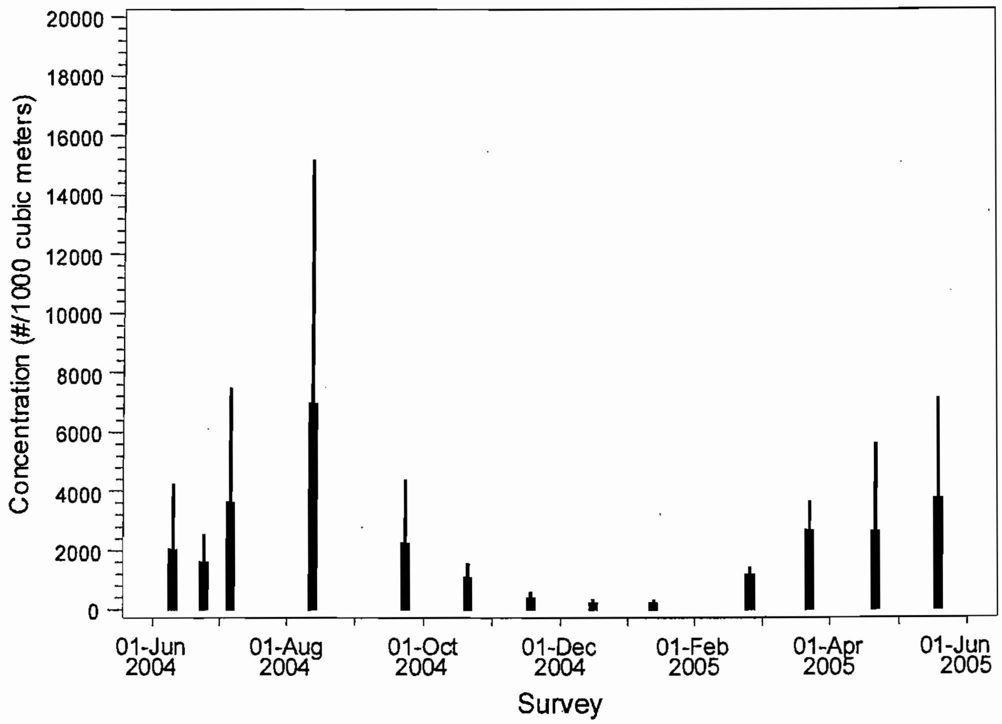

Figure 3. Comparison among surveys of mean concentration (#/1,000 m^3 [264,172 gal]) of CIQ goby complex larvae at entrainment Station E1.

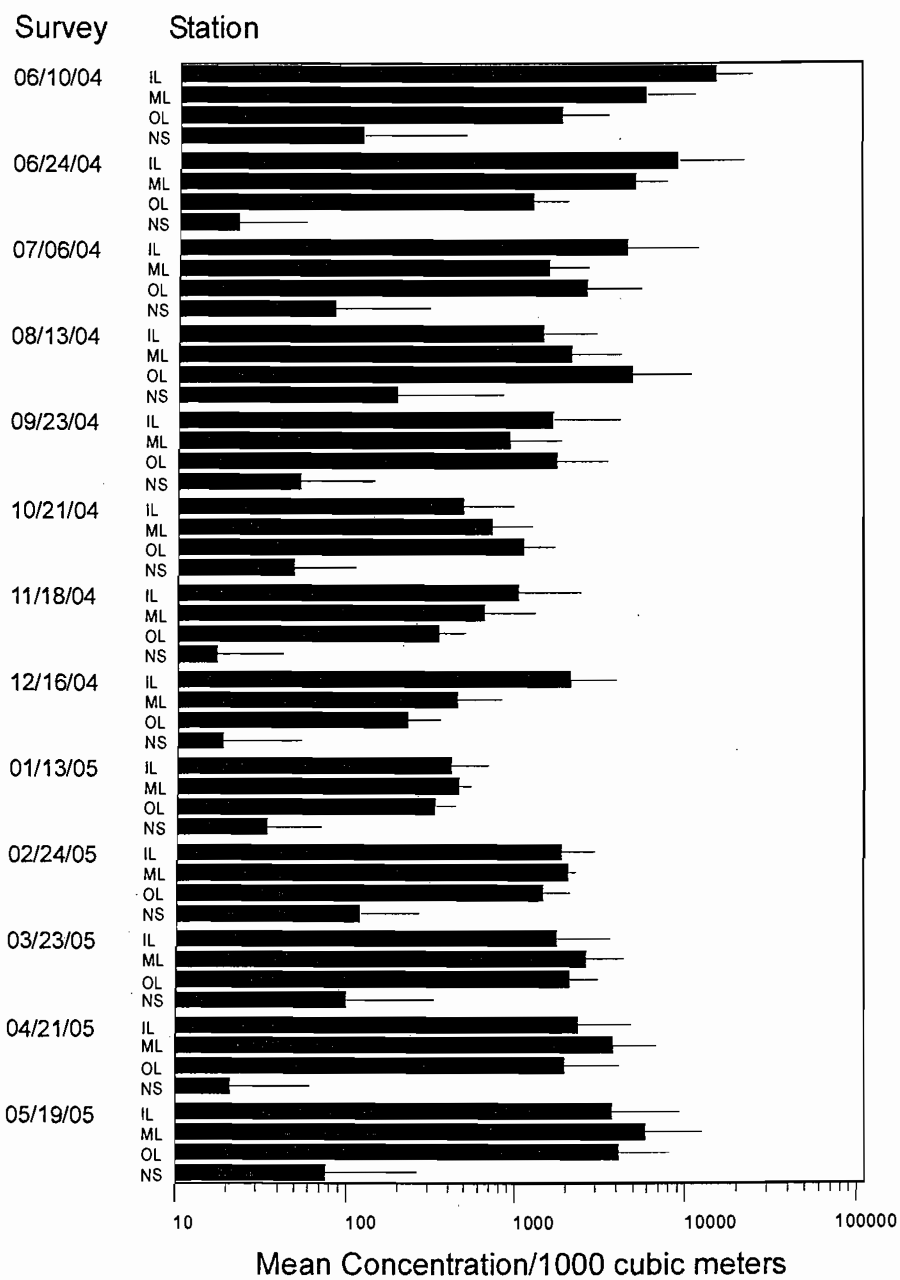

Figure 4. Mean concentration (#/1,000 m^3 [264,172 gal]) and standard error of CIQ goby complex larvae at Agua Hedionda Lagoon (inner, middle, and outer) and nearshore source water stations during the 2004 and 2005 sampling periods. Note logarithmic abundance scale.

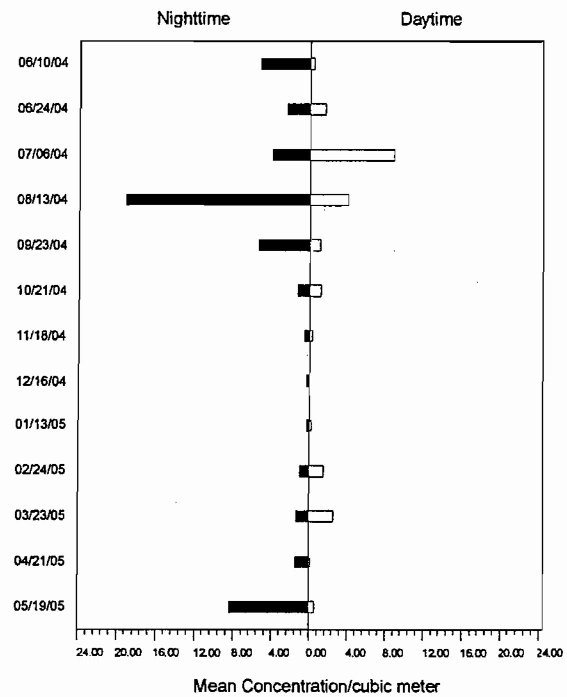

Figure 5. Mean concentration (#/1.0 m^3 [264 gal]) of CIQ goby complex larvae at entrainment Station E1 during night (Cycle 3) and day (Cycle 1) sampling.

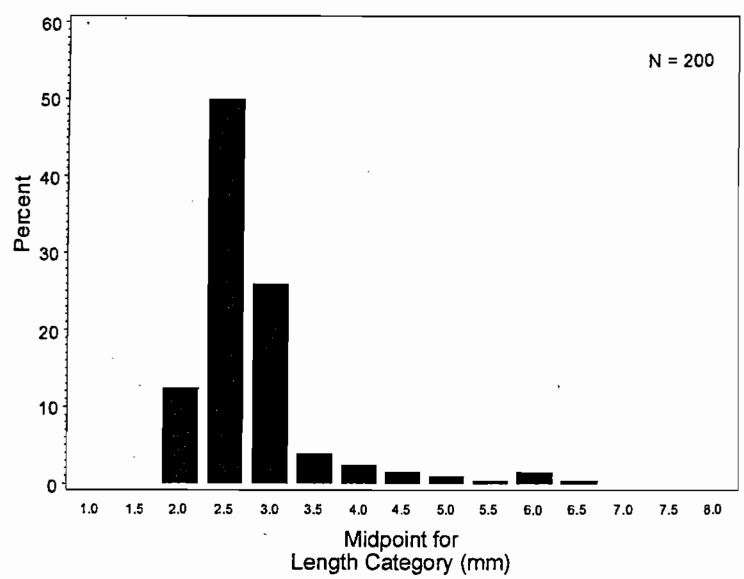

Figure 6. Length frequency of CIQ goby complex larvae at entrainment Station E1. Data from sub-samples of all surveys in 2004–2005.

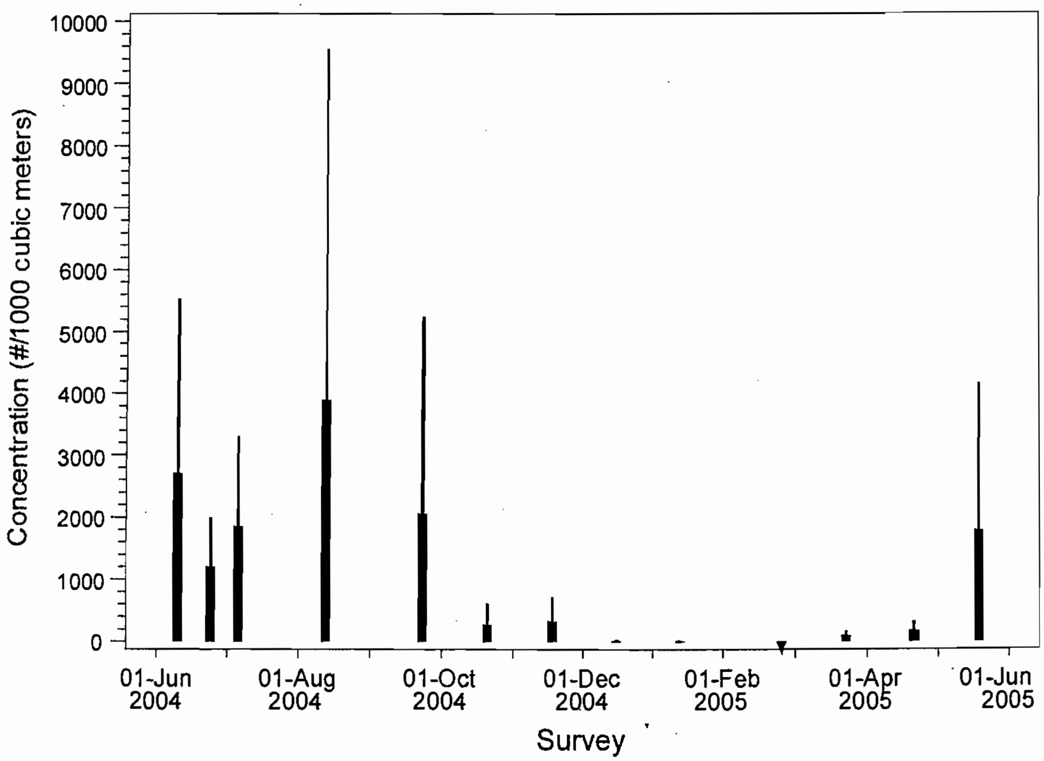

Figure 7. Comparison among surveys of mean concentration (#/1000 m^3 [264,172 gal]) of combtooth blenny larvae at entrainment Station E1. Note: downward pointing triangle indicates survey with no larvae collected.

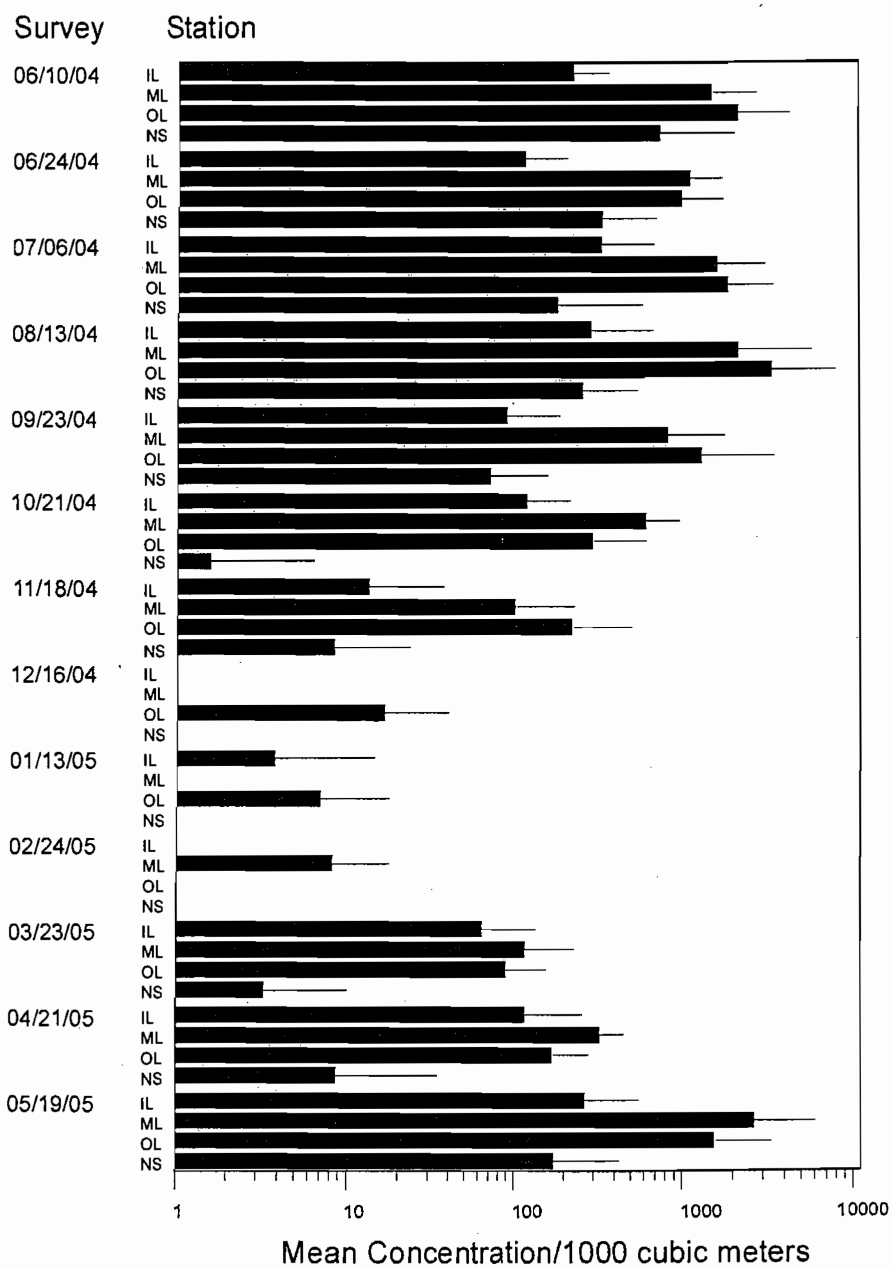

Figure 8. Mean concentration (#/1000 m^3 [264,172 gal]) and standard error of combtooth blenny larvae at Agua Hedionda Lagoon (inner, middle, and outer) and nearshore source water stations during the 2004 and 2005 sampling periods. Note logarithmic scale for mean concentration.

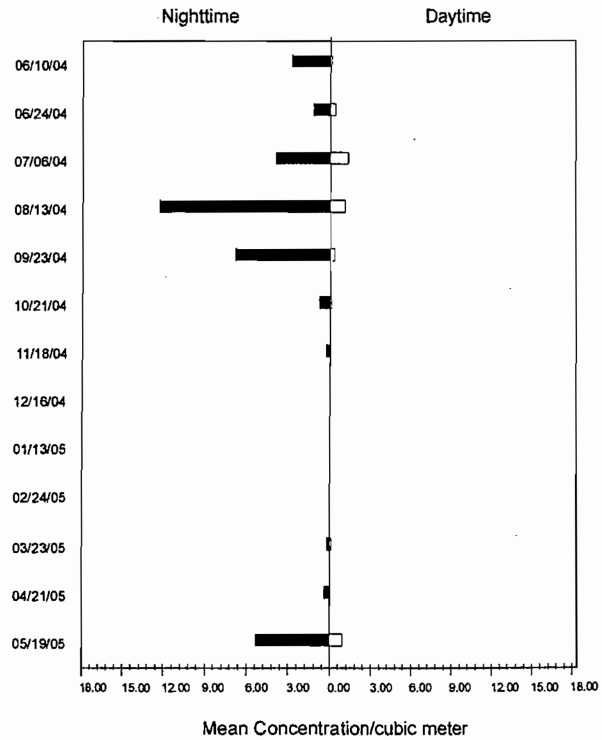

Figure 9. Mean concentration (#/1.0 m^3 [264 gal]) of combtooth blenny larvae at entrainment Station E1 during night (Cycle 3) and day (Cycle 1) sampling.

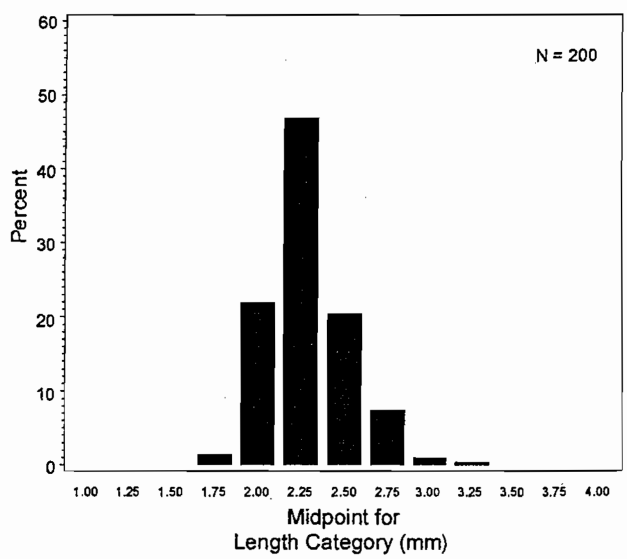

Figure 10. Length frequency of combtooth blenny larvae at entrainment and all source water stations combined. Data from sub-samples of all surveys in 2004–2005.

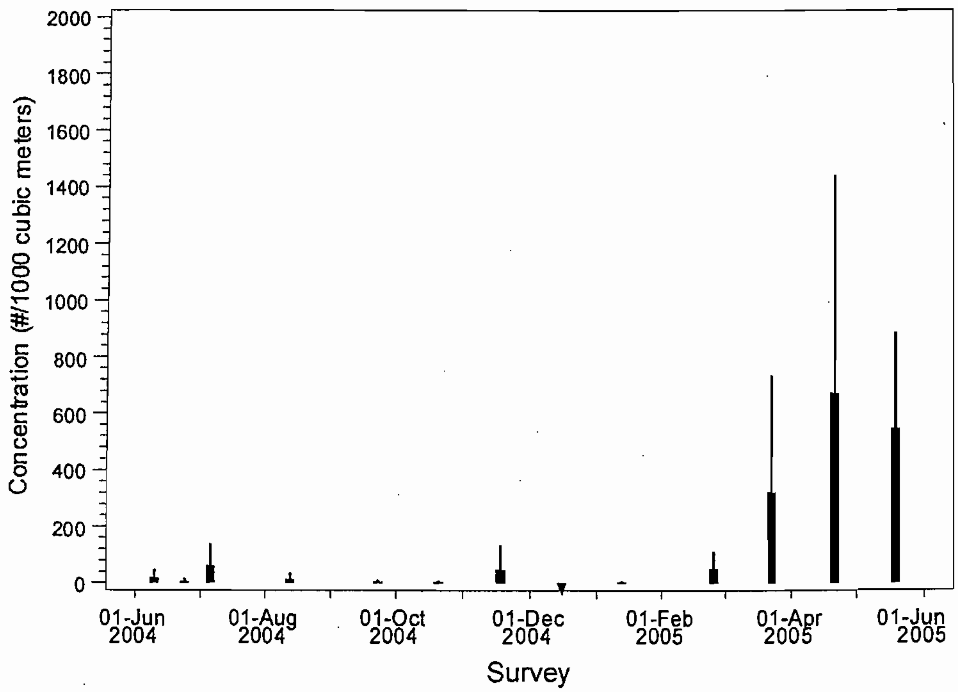

Figure 11. Comparison among surveys of mean concentration (#/1000 m^3 [264,172 gal]) of anchovy larvae at entrainment Station E1. Note: downward pointing triangle indicates survey with no larvae collected.

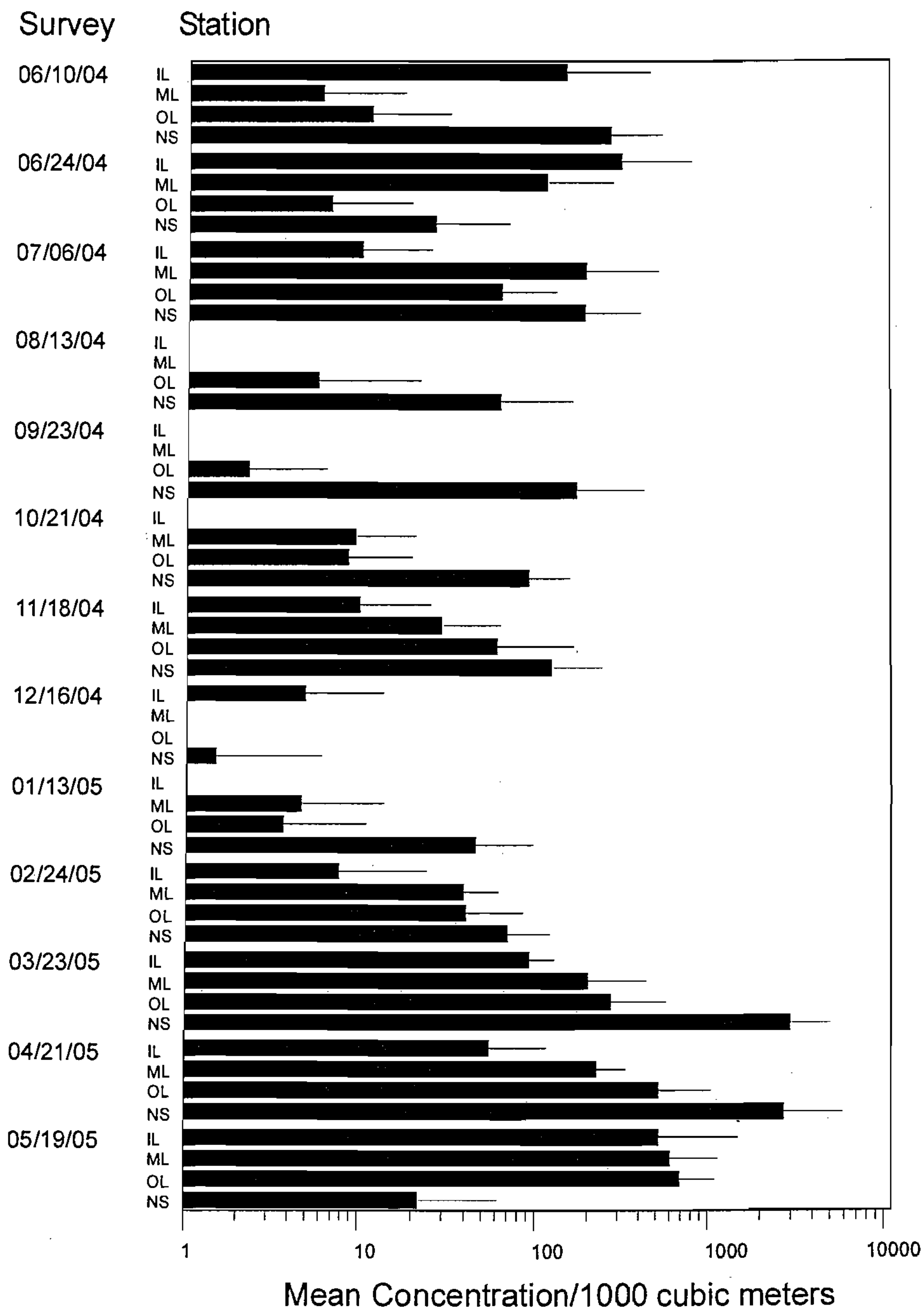

Figure 12. Mean concentration (#/1000 m^3 [264,172 gal]) and standard error of anchovy larvae at Agua Hedionda Lagoon (inner, middle, and outer) and nearshore source water stations during the 2004 and 2005 sampling periods. Note logarithmic abundance scale.

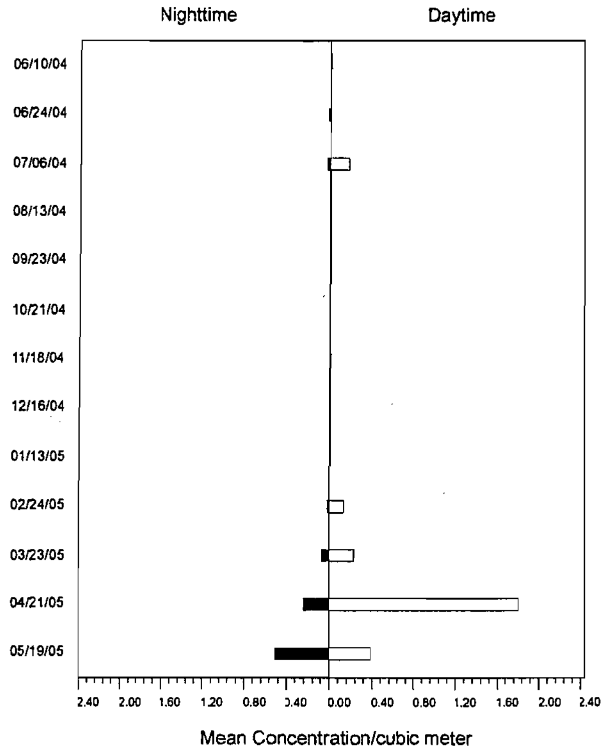

Figure 13. Mean concentration (#/1.0 m^3 [264 gal]) of anchovy larvae at entrainment Station E1 during night (Cycle 3) and day (Cycle 1) sampling.

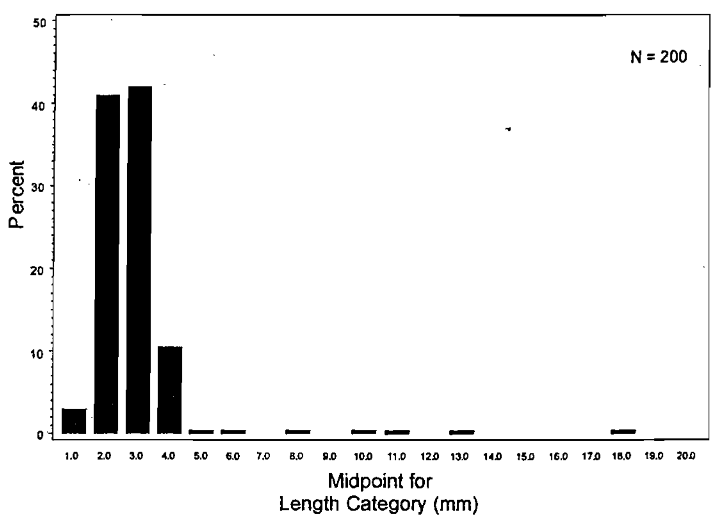

Figure 14. Length frequency of anchovy larvae at entrainment Station E1. Data from sub-samples of all surveys in 2004–2005.

Appendix A

Entrainment and Source Water Sampling Results by Survey

A1 – Entrainment

A2 – Source Water: Agua Hedionda Lagoon

A3 – Source Water: Nearshore

Table A1. Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at entrainment Station E1.

		Survey Number:			1		2	
		Survey Date:			06/10/04		06/24/04	
		Sample Count:			8		8	
	Taxon	Common Name	Total Count	Mean Conc.	Count	Conc.	Count	Conc.
	Fishes							
1	Gobiidae unid.	gobies	12,762	2,222.69	609	2,059.68	576	1,622.60
2	*Hypsoblennius* spp.	combtooth blennies	5,838	1,107.67	784	2,712.14	438	1,197.26
3	*Engraulis mordax*	northern anchovy	505	84.40	6	17.86	-	-
4	Engraulidae unid.	anchovies	314	49.88	-	-	2	5.15
5	*Hypsypops rubicundus*	garibaldi	188	40.99	79	268.68	8	23.41
6	*Typhlogobius californiensis*	blind goby	148	24.65	2	4.80	-	-
7	*Gibbonsia* spp.	clinid kelpfishes	125	22.45	3	11.11	2	5.24
8	Labrisomidae unid.	labrisomid kelpfishes	81	17.65	26	92.41	10	28.36
9	*Acanthogobius flavimanus*	yellowfin goby	87	14.41	-	-	-	-
10	larval fish fragment	larval fishes	56	9.65	8	25.54	-	-
11	larvae, unidentified yolksac	yolksac larvae	39	8.36	5	16.62	6	18.21
12	*Roncador stearnsi*	spotfin croaker	42	8.33	1	2.40	1	2.57
13	*Syngnathus leptorhynchus*	bay pipefish	36	8.20	7	21.36	8	22.75
14	*Atherinopsis californiensis*	jacksmelt	47	7.99	-	-	-	-
15	*Rimicola* spp.	kelp clingfishes	43	7.92	3	9.95	1	2.49
16	*Syngnathus* spp.	pipefishes	47	7.85	2	6.39	-	-
17	*Genyonemus lineatus*	white croaker	44	7.04	-	-	-	-
18	*Seriphus politus*	queenfish	29	5.50	2	6.65	-	-
19	*Paraclinus integripinnis*	reef finspot	31	4.95	-	-	-	-
20	*Paralichthys californicus*	California halibut	21	3.73	1	2.40	-	-
21	*Sardinops sagax*	Pacific sardine	16	2.66	-	-	-	-
22	*Gillichthys mirabilis*	longjaw mudsucker	13	2.14	-	-	-	-
23	Sciaenidae unid.	croaker	11	1.86	-	-	1	2.49
24	*Hypsopsetta guttulata*	diamond turbot	10	1.78	-	-	-	-
25	larval/post-larval fish unid.	larval fishes	10	1.61	1	2.40	-	-
26	*Citharichthys stigmaeus*	speckled sanddab	8	1.33	-	-	-	-
27	*Paralabrax* spp.	sand bass	7	1.15	-	-	-	-
28	Atherinopsidae unid.	silverside	5	0.82	-	-	-	-
29	*Citharichthys sordidus*	Pacific sanddab	5	0.79	-	-	-	-
30	*Paralabrax clathratus*	kelp bass	4	0.71	-	-	-	-
31	Pleuronectiformes unid.	flatfishes	4	0.63	-	-	-	-
32	*Heterostichus rostratus*	giant kelpfish	3	0.54	1	2.40	-	-
33	*Clinocottus analis*	wooly sculpin	3	0.51	-	-	-	-
34	*Stenobrachius leucopsarus*	northern lampfish	2	0.37	-	-	-	-
35	*Atherinops affinis*	topsmelt	2	0.36	-	-	-	-
36	*Cheilotrema saturnum*	black croaker	2	0.35	-	-	-	-
37	*Scomber japonicus*	Pacific mackerel	1	0.35	1	4.51	-	-
38	*Quietula y-cauda*	shadow goby	1	0.25	-	-	-	-
39	Ophidiidae unid.	cusk-eels	1	0.21	-	-	-	-
40	*Gobiesox* spp.	clingfishes	1	0.20	-	-	1	2.66
41	*Diaphus theta*	California headlight fish	1	0.19	-	-	-	-
42	*Semicossyphus pulcher*	California sheephead	1	0.19	-	-	-	-
43	*Menticirrhus undulatus*	California corbina	1	0.18	-	-	-	-
44	Haemulidae unid.	grunts	1	0.18	-	-	-	-
45	Labridae unid.	wrasses	1	0.17	-	-	-	-
46	Myctophidae unid.	lanternfishes	1	0.16	-	-	-	-
47	*Symbolophorus californiensis*	California lanternfish	1	0.16	-	-	-	-
48	*Oxyjulis californica*	senorita	1	0.14	-	-	-	-
49	*Citharichthys* spp.	sanddabs	1	0.13	-	-	-	-
	Invertebrates							
	Cancer anthonyi (megalops)	yellow crab	1	2.21	-	-	-	-
			20,602		1,541		1,054	

Table A1 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at entrainment Station E1.

Survey Number:	3		4		5		6	
Survey Date:	07/06/04		08/13/04		09/23/04		10/21/04	
Sample Count:	8		8		8		8	
Taxon	Count	Conc.	Count	Conc.	Count	Conc.	Count	Conc.
Fishes								
Gobiidae unid.	1,349	3,651.19	3,347	6,989.90	992	2,259.40	454	1,118.40
Hypsoblennius spp.	615	1,857.95	1,843	3,900.14	917	2,056.02	115	275.79
Engraulis mordax	7	19.60	-	-	2	4.55	2	4.43
Engraulidae unid.	17	41.45	6	11.44	-	-	-	-
Hypsypops rubicundus	24	76.54	8	16.58	-	-	-	-
Typhlogobius californiensis	1	3.57	-	-	-	-	-	-
Gibbonsia spp.	-	-	1	1.85	-	-	16	42.17
Labrisomidae unid.	20	52.50	2	4.38	20	45.30	1	2.62
Acanthogobius flavimanus	-	-	-	-	-	-	-	-
larval fish fragment	-	-	3	6.62	4	8.90	8	19.52
larvae, unidentified yolksac	16	46.61	-	-	3	7.57	-	-
Roncador stearnsi	11	34.26	1	2.09	28	67.03	-	-
Syngnathus leptorhynchus	19	57.50	-	-	-	-	1	2.83
Atherinopsis californiensis	-	-	-	-	-	-	-	-
Rimicola spp.	12	29.44	15	31.44	3	6.87	9	22.75
Syngnathus spp.	-	-	32	67.29	13	28.39	-	-
Genyonemus lineatus	-	-	1	1.93	7	16.59	-	-
Seriphus politus	-	-	3	6.38	22	53.74	2	4.77
Paraclinus integripinnis	-	-	31	64.39	-	-	-	-
Paralichthys californicus	-	-	1	2.09	5	13.58	2	5.23
Sardinops sagax	-	-	-	-	-	-	-	-
Gillichthys mirabilis	-	-	-	-	-	-	-	-
Sciaenidae unid.	1	3.20	-	-	3	6.64	1	2.62
Hypsopsetta guttulata	-	-	-	-	3	7.81	-	-
larval/post-larval fish unid.	1	2.39	5	9.76	-	-	-	-
Citharichthys stigmaeus	-	-	-	-	-	-	2	5.54
Paralabrax spp.	-	-	3	5.69	4	9.26	-	-
Atherinopsidae unid.	-	-	-	-	-	-	-	-
Citharichthys sordidus	-	-	-	-	-	-	-	-
Paralabrax clathratus	-	-	-	-	4	9.21	-	-
Pleuronectiformes unid.	-	-	-	-	-	-	-	-
Heterostichus rostratus	-	-	-	-	-	-	-	-
Clinocottus analis	-	-	-	-	-	-	-	-
Stenobrachius leucopsarus	-	-	-	-	-	-	-	-
Atherinops affinis	1	2.50	-	-	-	-	-	-
Cheilotrema saturnum	1	2.50	1	2.02	-	-	-	-
Scomber japonicus	-	-	-	-	-	-	-	-
Quietula y-cauda	1	3.20	-	-	-	-	-	-
Ophidiidae unid.	-	-	-	-	-	-	1	2.71
Gobiesox spp.	-	-	-	-	-	-	-	-
Diaphus theta	-	-	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	-	-	-	-
Menticirrhus undulatus	1	2.39	-	-	-	-	-	-
Haemulidae unid.	-	-	-	-	1	2.29	-	-
Labridae unid.	-	-	-	-	1	2.19	-	-
Myctophidae unid.	-	-	-	-	-	-	-	-
Symbolophorus californiensis	-	-	-	-	-	-	-	-
Oxyjulis californica	-	-	-	-	-	-	-	-
Citharichthys spp.	-	-	-	-	-	-	-	-
Invertebrates								
Cancer anthonyi (megalops)	-	-	-	-	-	-	-	-
	2,097		5,303		2,032		614	

Table A1 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at entrainment Station E1.

Survey Number:	7		8		9		10	
Survey Date:	11/18/04		12/16/04		01/13/05		02/24/05	
Sample Count:	8		8		8		8	
Taxon	Count	Conc.	Count	Conc.	Count	Conc.	Count	Conc.
Fishes								
Gobiidae unid.	203	411.13	102	233.48	118	263.27	555	1,179.31
Hypsoblennius spp.	151	320.89	5	11.75	4	8.53	-	-
Engraulis mordax	26	48.05	-	-	1	2.22	25	51.06
Engraulidae unid.	-	-	-	-	-	-	-	-
Hypsypops rubicundus	-	-	-	-	-	-	-	-
Typhlogobius californiensis	-	-	-	-	-	-	4	8.61
Gibbonsia spp.	7	13.96	6	13.51	61	141.98	11	22.93
Labrisomidae unid.	1	1.75	-	-	-	-	-	-
Acanthogobius flavimanus	-	-	-	-	19	44.01	63	133.24
larval fish fragment	2	3.95	-	-	1	2.28	4	8.48
larvae, unidentified yolksac	-	-	-	-	-	-	-	-
Roncador stearnsi	-	-	-	-	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-
Atherinopsis californiensis	-	-	2	4.93	13	29.82	22	47.31
Rimicola spp.	-	-	-	-	-	-	-	-
Syngnathus spp.	-	-	-	-	-	-	-	-
Genyonemus lineatus	4	7.92	1	2.47	3	6.50	13	26.67
Seriphus politus	-	-	-	-	-	-	-	-
Paraclinus integripinnis	-	-	-	-	-	-	-	-
Paralichthys californicus	1	1.75	1	2.22	2	4.40	3	5.75
Sardinops sagax	2	3.49	-	-	-	-	5	10.93
Gillichthys mirabilis	3	7.07	1	2.15	1	2.22	5	10.56
Sciaenidae unid.	1	1.85	-	-	-	-	-	-
Hypsopsetta guttulata	2	4.02	1	1.71	4	9.59	-	-
larval/post-larval fish unid.	-	-	-	-	3	6.33	-	-
Citharichthys stigmaeus	4	7.32	-	-	-	-	-	-
Paralabrax spp.	-	-	-	-	-	-	-	-
Atherinopsidae unid.	-	-	-	-	-	-	2	4.61
Citharichthys sordidus	3	5.24	-	-	-	-	-	-
Paralabrax clathratus	-	-	-	-	-	-	-	-
Pleuronectiformes unid.	3	5.70	-	-	-	-	-	-
Heterostichus rostratus	1	2.18	-	-	-	-	1	2.41
Clinocottus analis	-	-	1	2.20	1	2.28	1	2.15
Stenobrachius leucopsarus	-	-	-	-	2	4.82	-	-
Atherinops affinis	-	-	-	-	-	-	-	-
Cheilotrema saturnum	-	-	-	-	-	-	-	-
Scomber japonicus	-	-	-	-	-	-	-	-
Quietula y-cauda	-	-	-	-	-	-	-	-
Ophidiidae unid.	-	-	-	-	-	-	-	-
Gobiesox spp.	-	-	-	-	-	-	-	-
Diaphus theta	-	-	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	-	-	-	-
Menticirrhus undulatus	-	-	-	-	-	-	-	-
Haemulidae unid.	-	-	-	-	-	-	-	-
Labridae unid.	-	-	-	-	-	-	-	-
Myctophidae unid.	-	-	-	-	-	-	-	-
Symbolophorus californiensis	-	-	-	-	-	-	-	-
Oxyjulis californica	-	-	-	-	-	-	-	-
Citharichthys spp.	-	-	-	-	-	-	-	-
Invertebrates								
Cancer anthonyi (megalops)	-	-	1	2.21	-	-	-	-
	414		121		233		714	

Table A1 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at entrainment Station E1

Survey Number:	11		12		13	
Survey Date:	03/23/05		04/21/05		05/19/05	
Sample Count:	8		8		8	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes						
Gobiidae unid.	1,357	2,700.63	1,314	2,649.98	1,786	3,755.99
Hypsoblennius spp.	49	99.47	86	174.14	831	1,785.69
Engraulis mordax	89	182.27	284	642.95	63	124.21
Engraulidae unid.	60	140.57	14	28.03	215	421.84
Hypsypops rubicundus	-	-	15	30.54	54	117.11
Typhlogobius californiensis	110	238.12	17	34.38	14	31.01
Gibbonsia spp.	12	26.60	2	3.96	4	8.59
Labrisomidae unid.	-	-	-	-	1	2.13
Acanthogobius flavimanus	5	10.08	-	-	-	-
larval fish fragment	12	24.32	4	8.17	10	17.70
larvae, unidentified yolksac	1	2.43	3	7.12	5	10.12
Roncador stearnsi	-	-	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	1	2.21
Atherinopsis californiensis	10	21.80	-	-	-	-
Rimicola spp.	-	-	-	-	-	-
Syngnathus spp.	-	-	-	-	-	-
Genyonemus lineatus	5	9.18	10	20.28	-	-
Seriphus politus	-	-	-	-	-	-
Paraclinus integripinnis	-	-	-	-	-	-
Paralichthys californicus	1	1.82	3	7.12	1	2.13
Sardinops sagax	1	1.86	8	18.35	-	-
Gillichthys mirabilis	2	3.89	1	1.88	-	-
Sciaenidae unid.	2	3.67	-	-	2	3.75
Hypsopsetta guttulata	-	-	-	-	-	-
larval/post-larval fish unid.	-	-	-	-	-	-
Citharichthys stigmaeus	-	-	2	4.37	-	-
Paralabrax spp.	-	-	-	-	-	-
Atherinopsidae unid.	-	-	2	3.89	1	2.21
Citharichthys sordidus	-	-	2	4.98	-	-
Paralabrax clathratus	-	-	-	-	-	-
Pleuronectiformes unid.	-	-	1	2.49	-	-
Heterostichus rostratus	-	-	-	-	-	-
Clinocottus analis	-	-	-	-	-	-
Stenobrachius leucopsarus	-	-	-	-	-	-
Atherinops affinis	-	-	-	-	1	2.21
Cheilotrema saturnum	-	-	-	-	-	-
Scomber japonicus	-	-	-	-	-	-
Quietula y-cauda	-	-	-	-	-	-
Ophidiidae unid.	-	-	-	-	-	-
Gobiesox spp.	-	-	-	-	-	-
Diaphus theta	-	-	1	2.49	-	-
Semicossyphus pulcher	-	-	1	2.49	-	-
Menticirrhus undulatus	-	-	-	-	-	-
Haemulidae unid.	-	-	-	-	-	-
Labridae unid.	-	-	-	-	-	-
Myctophidae unid.	-	-	1	2.14	-	-
Symbolophorus californiensis	-	-	1	2.14	-	-
Oxyjulis californica	-	-	-	-	1	1.78
Citharichthys spp.	1	1.72	-	-	-	-
Invertebrates						
Cancer anthonyi (megalops)	-	-	-	-	-	-
	1,717		1,772		2,990	

Table A2. Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations L1-L4 in Agua Hedionda Lagoon.

		Survey Number:			1		2	
		Survey Date:			06/10/04		06/24/04	
		Sample Count:			16		16	
	Taxon	Common Name	Total Count	Mean Conc.	Count	Conc.	Count	Conc.
	Fishes							
1	Gobiidae unid.	gobies	30,229	2,714.74	7,936	9,400.29	4,466	5,925.43
2	*Hypsoblennius* spp.	combtooth blennies	4,725	467.32	614	901.83	398	547.24
3	Engraulidae unid.	anchovies	652	57.90	54	72.86	141	182.94
4	*Engraulis mordax*	northern anchovy	558	45.51	2	2.79	1	1.33
5	*Acanthogobius flavimanus*	yellowfin goby	499	38.98	-	-	-	-
6	Labrisomidae unid.	labrisomid kelpfishes	366	35.30	166	220.73	71	93.10
7	*Hypsypops rubicundus*	garibaldi	352	35.12	94	134.38	53	76.48
8	*Atherinopsis californiensis*	jacksmelt	279	23.93	-	-	-	-
9	*Gibbonsia* spp.	clinid kelpfishes	182	16.74	8	11.54	4	5.44
10	larval fish fragment	unid. larval fishes	174	15.02	17	19.27	21	30.99
11	*Typhlogobius californiensis*	blind goby	118	9.63	2	2.79	-	-
12	*Roncador stearnsi*	spotfin croaker	74	6.82	1	1.29	-	-
13	Sciaenidae unid.	croakers	73	6.56	23	29.17	-	-
14	*Gillichthys mirabilis*	longjaw mudsucker	62	5.17	-	-	-	-
15	*Genyonemus lineatus*	white croaker	54	4.25	2	2.14	-	-
16	*Rimicola eigenmanni*	slender clingfish	53	4.13	-	-	-	-
17	Atherinopsidae unid.	silversides	41	3.40	3	3.43	-	-
18	*Rimicola* spp.	kelp clingfishes	34	3.28	-	-	2	2.98
19	*Syngnathus leptorhynchus*	bay pipefish	33	3.19	12	15.60	9	11.57
20	larvae, unidentified yolksac	unid. yolksac larvae	32	3.12	5	8.47	-	-
21	*Paraclinus integripinnis*	reef finspot	31	2.88	-	-	-	-
22	*Seriphus politus*	queenfish	26	2.40	1	1.64	5	5.51
23	*Atherinops affinis*	topsmelt	28	2.40	5	7.00	4	5.54
24	*Quietula y-cauda*	shadow goby	26	2.38	5	5.45	5	6.68
25	*Syngnathus* spp.	pipefishes	19	2.01	-	-	2	2.99
26	*Paralichthys californicus*	California halibut	22	1.93	2	2.63	-	-
27	larval/post-larval fish unid.	larval fishes	16	1.36	-	-	-	-
28	*Ilypnus gilberti*	cheekspot goby	14	1.35	-	-	-	-
29	*Oxyjulis californica*	senorita	8	0.75	2	2.36	-	-
30	*Sardinops sagax*	Pacific sardine	9	0.74	-	-	-	-
31	*Citharichthys stigmaeus*	speckled sanddab	9	0.73	-	-	-	-
32	*Paralabrax* spp.	sand basses	8	0.68	-	-	-	-
33	*Hypsopsetta guttulata*	diamond turbot	7	0.55	-	-	-	-
34	*Leptocottus armatus*	Pacific staghorn sculpin	6	0.51	-	-	-	-
35	*Gobiesox* spp.	clingfishes	5	0.49	-	-	2	3.29
36	*Menticirrhus undulatus*	California corbina	5	0.47	-	-	-	-
37	*Cheilotrema saturnum*	black croaker	4	0.36	-	-	-	-
38	Blennioidei unid.	blennies	4	0.36	1	1.11	1	1.40
39	*Citharichthys sordidus*	Pacific sanddab	5	0.34	-	-	-	-
40	*Clinocottus analis*	wooly sculpin	4	0.31	-	-	-	-
41	*Xenistius californiensis*	salema	3	0.30	-	-	-	-
42	*Xystreurys liolepis*	fantail sole	2	0.21	-	-	-	-
43	*Pleuronichthys ritteri*	spotted turbot	2	0.17	-	-	-	-
44	Haemulidae unid.	grunts	2	0.17	-	-	-	-
45	*Sphyraena argentea*	California barracuda	2	0.17	-	-	-	-
46	*Triphoturus mexicanus*	Mexican lampfish	2	0.16	-	-	-	-
47	Gobiesocidae unid.	clingfishes	2	0.15	-	-	-	-
48	*Clevelandia ios*	arrow goby	1	0.11	-	-	-	-
49	Syngnathidae unid.	pipefishes	1	0.11	-	-	-	-
50	Ophidiidae unid.	cusk-eels	1	0.09	-	-	-	-
51	*Umbrina roncador*	yellowfin croaker	1	0.09	-	-	-	-
52	*Lepidogobius lepidus*	bay goby	1	0.09	-	-	-	-
53	*Pleuronichthys* spp.	turbots	1	0.08	-	-	-	-
54	*Atractoscion nobilis*	white seabass	1	0.08	-	-	-	-
55	Pleuronectiformes unid.	flatfishes	1	0.07	-	-	-	-
56	*Clinocottus* spp.	sculpins	1	0.07	-	-	-	-
57	*Citharichthys* spp.	sanddabs	1	0.06	-	-	-	-
58	*Semicossyphus pulcher*	California sheephead	1	0.06	1	0.78	-	-
	Invertebrates							
	Panulirus interruptus (larvae)	California spiny lobster	2	0.21	-	-	-	-
	Cancer antennarius (megalops)	brown rock crab	1	0.09	-	-	-	-
	Cancer anthonyi (megalops)	yellow crab	1	0.08	-	-	-	-
		Totals:	38,876		8,958		5,185	

Table A2 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations L1-L4 in Agua Hedionda Lagoon.

Survey Number:	3		4		5		6	
Survey Date:	**07/06/04**		**08/13/04**		**09/23/04**		**10/21/04**	
Sample Count:	**16**		**16**		**20**		**16**	
Taxon	**Conc.**	**Count**	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes								
Gobiidae unid.	3,034.53	30,229	1,498	1,925.13	1,115	1,272.53	550	690.51
Hypsoblennius spp.	1,053.95	4,725	1,004	1,421.30	360	398.18	245	290.58
Engraulidae unid.	57.39	652	-	-	-	-	-	-
Engraulis mordax	12.07	558	-	-	-	-	4	5.58
Acanthogobius flavimanus	-	499	-	-	-	-	-	-
Labrisomidae unid.	44.54	366	23	29.27	68	70.20	-	-
Hypsypops rubicundus	122.15	352	1	1.38	-	-	-	-
Atherinopsis californiensis	1.15	279	-	-	-	-	-	-
Gibbonsia spp.	4.46	182	1	1.38	3	3.04	12	19.17
larval fish fragment	4.41	174	9	10.98	3	3.48	8	9.95
Typhlogobius californiensis	11.38	118	-	-	-	-	-	-
Roncador stearnsi	34.73	74	-	-	48	51.42	-	-
Sciaenidae unid.	10.27	73	4	4.85	17	17.20	-	-
Gillichthys mirabilis	-	62	-	-	-	-	-	-
Genyonemus lineatus	-	54	4	4.85	6	6.58	1	1.81
Rimicola eigenmanni	-	53	-	-	53	53.73	-	-
Atherinopsidae unid.	1.15	41	-	-	-	-	3	3.66
Rimicola spp.	6.03	34	-	-	9	9.96	10	13.61
Syngnathus leptorhynchus	7.04	33	-	-	5	4.97	1	1.33
larvae, unidentified yolksac	12.08	32	6	7.87	2	2.11	-	-
Paraclinus integripinnis	-	31	31	37.45	-	-	-	-
Seriphus politus	6.58	26	1	1.26	8	8.51	6	7.72
Atherinops affinis	1.15	28	-	-	-	-	-	-
Quietula y-cauda	2.29	26	4	5.80	1	1.01	-	-
Syngnathus spp.	-	19	15	20.83	-	-	1	1.09
Paralichthys californicus	1.63	22	1	1.21	7	7.51	2	3.18
larval/post-larval fish unid.	-	16	2	2.42	3	3.03	-	-
Ilypnus gilberti	-	14	3	4.46	-	-	-	-
Oxyjulis californica	-	8	5	6.24	-	-	-	-
Sardinops sagax	-	9	-	-	-	-	-	-
Citharichthys stigmaeus	1.36	9	1	1.20	2	2.12	-	-
Paralabrax spp.	-	8	3	3.63	5	5.24	-	-
Hypsopsetta guttulata	-	7	-	-	2	2.20	-	-
Leptocottus armatus	-	6	-	-	-	-	-	-
Gobiesox spp.	-	5	-	-	-	-	-	-
Menticirrhus undulatus	1.63	5	1	1.21	3	3.33	-	-
Cheilotrema saturnum	1.32	4	1	1.21	2	2.19	-	-
Blennioidei unid.	-	4	-	-	-	-	-	-
Citharichthys sordidus	-	5	-	-	-	-	-	-
Clinocottus analis	-	4	-	-	-	-	-	-
Xenistius californiensis	-	3	-	-	2	2.03	1	1.81
Xystreurys liolepis	2.77	2	-	-	-	-	-	-
Pleuronichthys ritteri	-	2	-	-	2	2.20	-	-
Haemulidae unid.	-	2	1	1.21	1	0.96	-	-
Sphyraena argentea	-	2	1	1.17	1	0.99	-	-
Triphoturus mexicanus	-	2	-	-	1	1.10	-	-
Gobiesocidae unid.	-	2	-	-	-	-	2	2.01
Clevelandia ios	-	1	1	1.45	-	-	-	-
Syngnathidae unid.	-	1	-	-	-	-	1	1.38
Ophidiidae unid.	-	1	1	1.21	-	-	-	-
Umbrina roncador	-	1	-	-	1	1.21	-	-
Lepidogobius lepidus	-	1	-	-	-	-	-	-
Pleuronichthys spp.	-	1	-	-	1	1.10	-	-
Atractoscion nobilis	-	1	-	-	-	-	-	-
Pleuronectiformes unid.	-	1	-	-	-	-	-	-
Clinocottus spp.	-	1	-	-	-	-	-	-
Citharichthys spp.	-	1	-	-	-	-	-	-
Semicossyphus pulcher	-	1	-	-	-	-	-	-
Invertebrates								
Panulirus interruptus	2.73	2	-	-	-	-	-	-
Cancer antennarius (megalops)	-	1	-	-	-	-	-	-
Cancer anthonyi (megalops)	-	1	-	-	1	1.01	-	-
		38,876	**2,622**		**1,732**		**847**	

Table A2 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations L1-L4 in Agua Hedionda Lagoon.

Survey Number:	7		8		9		10	
Survey Date:	11/18/04		12/16/04		01/13/05		02/24/05	
Sample Count:	16		16		16		16	
Total								
Taxon	Count	Conc.	Count	Conc.	Count	Conc.	Count	Conc.
Fishes								
Gobiidae unid.	706	734.73	1,032	1,201.76	368	402.81	1,873	1,867.75
Hypsoblennius spp.	59	61.74	4	5.26	3	3.22	2	2.05
Engraulidae unid.	2	2.12	-	-	2	2.42	-	-
Engraulis mordax	30	28.07	2	2.43	-	-	21	21.19
Acanthogobius flavimanus	-	-	-	-	140	152.20	300	298.81
Labrisomidae unid.	-	-	-	-	-	-	-	-
Hypsypops rubicundus	-	-	-	-	-	-	-	-
Atherinopsis californiensis	5	5.80	16	18.84	52	61.60	167	185.66
Gibbonsia spp.	13	13.30	56	65.83	43	52.02	21	20.79
larval fish fragment	11	11.11	11	12.69	-	-	49	48.54
Typhlogobius californiensis	-	-	2	2.23	-	-	8	8.22
Roncador stearnsi	-	-	-	-	-	-	-	-
Sciaenidae unid.	-	-	-	-	3	3.65	-	-
Gillichthys mirabilis	4	4.25	21	24.94	14	14.54	15	15.16
Genyonemus lineatus	1	0.95	-	-	2	2.27	23	21.56
Rimicola eigenmanni	-	-	-	-	-	-	-	-
Atherinopsidae unid.	4	4.47	-	-	-	-	12	11.64
Rimicola spp.	1	1.14	5	5.82	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	-	-	1	0.94
larvae, unidentified yolksac	-	-	1	1.31	-	-	-	-
Paraclinus integripinnis	-	-	-	-	-	-	-	-
Seriphus politus	-	-	-	-	-	-	-	-
Atherinops affinis	-	-	-	-	-	-	12	12.21
Quietula y-cauda	2	2.24	4	4.22	-	-	3	3.18
Syngnathus spp.	1	1.28	-	-	-	-	-	-
Paralichthys californicus	2	1.67	-	-	2	2.31	2	1.80
larval/post-larval fish unid.	-	-	-	-	10	11.33	1	0.89
Ilypnus gilberti	1	0.86	5	5.99	5	6.28	-	-
Oxyjulis californica	1	1.12	-	-	-	-	-	-
Sardinops sagax	-	-	-	-	1	1.23	4	4.40
Citharichthys stigmaeus	1	0.81	-	-	-	-	-	-
Paralabrax spp.	-	-	-	-	-	-	-	-
Hypsopsetta guttulata	2	1.68	-	-	1	1.34	1	1.01
Leptocottus armatus	-	-	-	-	5	6.63	-	-
Gobiesox spp.	-	-	-	-	-	-	3	3.04
Menticirrhus undulatus	-	-	-	-	-	-	-	-
Cheilotrema saturnum	-	-	-	-	-	-	-	-
Blennioidei unid.	-	-	1	1.24	-	-	1	0.94
Citharichthys sordidus	4	3.66	-	-	-	-	1	0.77
Clinocottus analis	-	-	2	2.27	-	-	2	1.74
Xenistius californiensis	-	-	-	-	-	-	-	-
Xystreurys liolepis	-	-	-	-	-	-	-	-
Pleuronichthys ritteri	-	-	-	-	-	-	-	-
Haemulidae unid.	-	-	-	-	-	-	-	-
Sphyraena argentea	-	-	-	-	-	-	-	-
Triphoturus mexicanus	1	0.95	-	-	-	-	-	-
Gobiesocidae unid.	-	-	-	-	-	-	-	-
Clevelandia ios	-	-	-	-	-	-	-	-
Syngnathidae unid.	-	-	-	-	-	-	-	-
Ophidiidae unid.	-	-	-	-	-	-	-	-
Umbrina roncador	-	-	-	-	-	-	-	-
Lepidogobius lepidus	-	-	-	-	1	1.18	-	-
Pleuronichthys spp.	-	-	-	-	-	-	-	-
Atractoscion nobilis	-	-	-	-	-	-	-	-
Pleuronectiformes unid.	-	-	-	-	-	-	-	-
Clinocottus spp.	-	-	1	0.93	-	-	-	-
Citharichthys spp.	1	0.81	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	-	-	-	-
Invertebrates								
Panulirus interruptus	-	-	-	-	-	-	-	-
Cancer antennarius (megalops)	-	-	1	1.22	-	-	-	-
Cancer anthonyi (megalops)	-	-	-	-	-	-	-	-
	852		**1,164**		**653**		**2,522**	

Table A2 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations L1-L4 in Agua Hedionda Lagoon.

Survey Number:	11		12		13	
Survey Date:	03/23/05		04/21/05		05/19/05	
Sample Count:	16		16		16	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes						
Gobiidae unid.	1,923	1,908.93	2,314	2,455.55	3,980	4,471.69
Hypsoblennius spp.	81	80.32	175	181.27	1,013	1,128.18
Engraulidae unid.	57	55.27	22	22.80	331	356.88
Engraulis mordax	104	98.45	151	155.03	235	264.72
Acanthogobius flavimanus	54	50.65	3	2.95	2	2.12
Labrisomidae unid.	-	-	-	-	1	1.06
Hypsypops rubicundus	-	-	62	63.71	48	58.49
Atherinopsis californiensis	38	37.99	-	-	-	-
Gibbonsia spp.	4	4.30	4	4.07	10	12.22
larval fish fragment	16	15.83	14	14.73	12	13.31
Typhlogobius californiensis	85	84.34	10	10.82	4	5.36
Roncador stearnsi	-	-	1	1.18	-	-
Sciaenidae unid.	7	6.96	6	5.27	6	6.88
Gillichthys mirabilis	5	5.20	3	3.16	-	-
Genyonemus lineatus	2	1.95	12	12.02	1	1.12
Rimicola eigenmanni	-	-	-	-	-	-
Atherinopsidae unid.	6	7.09	7	7.50	5	5.29
Rimicola spp.	-	-	-	-	3	3.09
Syngnathus leptorhynchus	-	-	-	-	-	-
larvae, unidentified yolksac	5	4.69	-	-	4	4.10
Paraclinus integripinnis	-	-	-	-	-	-
Seriphus politus	-	-	-	-	-	-
Atherinops affinis	1	0.81	2	2.23	2	2.27
Quietula y-cauda	-	-	-	-	-	-
Syngnathus spp.	-	-	-	-	-	-
Paralichthys californicus	2	1.92	1	1.18	-	-
larval/post-larval fish unid.	-	-	-	-	-	-
Ilypnus gilberti	-	-	-	-	-	-
Oxyjulis californica	-	-	-	-	-	-
Sardinops sagax	-	-	4	3.93	-	-
Citharichthys stigmaeus	1	1.05	3	2.97	-	-
Paralabrax spp.	-	-	-	-	-	-
Hypsopsetta guttulata	1	0.89	-	-	-	-
Leptocottus armatus	-	-	-	-	-	-
Gobiesox spp.	-	-	-	-	-	-
Menticirrhus undulatus	-	-	-	-	-	-
Cheilotrema saturnum	-	-	-	-	-	-
Blennioidei unid.	-	-	-	-	-	-
Citharichthys sordidus	-	-	-	-	-	-
Clinocottus analis	-	-	-	-	-	-
Xenistius californiensis	-	-	-	-	-	-
Xystreurys liolepis	-	-	-	-	-	-
Pleuronichthys ritteri	-	-	-	-	-	-
Haemulidae unid.	-	-	-	-	-	-
Sphyraena argentea	-	-	-	-	-	-
Triphoturus mexicanus	-	-	-	-	-	-
Gobiesocidae unid.	-	-	-	-	-	-
Clevelandia ios	-	-	-	-	-	-
Syngnathidae unid.	-	-	-	-	-	-
Ophidiidae unid.	-	-	-	-	-	-
Umbrina roncador	-	-	-	-	-	-
Lepidogobius lepidus	-	-	-	-	-	-
Pleuronichthys spp.	-	-	-	-	-	-
Atractoscion nobilis	-	-	1	0.99	-	-
Pleuronectiformes unid.	-	-	1	0.93	-	-
Clinocottus spp.	-	-	-	-	-	-
Citharichthys spp.	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	-	-
Invertebrates						
Panulirus interruptus	-	-	-	-	-	-
Cancer antennarius (megalops)	-	-	-	-	-	-
Cancer anthonyi (megalops)	-	-	-	-	-	-
	2,392		2,796		5,657	

Table A3. Monthly abundance and mean concentration (#/1,000 m³) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

		Survey Number:			1		2	
		Survey Date:			06/10/04		06/24/04	
		Sample Count:			20		19	
	Taxon	Common Name	Total Count	Mean Conc.	Count	Conc.	Count	Conc.
	Fishes							
1	*Engraulis mordax*	northern anchovy	6,318	423.31	285	211.27	27	24.69
2	*Hypsoblennius* spp.	combtooth blennies	1,959	137.11	936	747.96	325	335.32
3	Engraulidae unid.	anchovies	1,313	102.17	80	54.22	2	1.74
4	Gobiidae unid.	gobies	920	69.06	150	118.83	22	22.51
5	*Genyonemus lineatus*	white croaker	921	64.66	-	-	3	2.82
6	larvae, unidentified yolksac	unid. yolksac larvae	678	45.82	86	68.17	45	40.04
7	*Paralichthys californicus*	California halibut	601	42.91	39	28.28	45	40.90
8	*Seriphus politus*	queenfish	365	23.79	81	59.98	126	109.01
9	Sciaenidae unid.	croaker	306	22.55	52	36.56	17	15.94
10	*Roncador stearnsi*	spotfin croaker	286	20.17	105	84.11	66	63.55
11	*Citharichthys stigmaeus*	speckled sanddab	309	20.01	7	5.17	11	10.03
12	*Gibbonsia* spp.	clinid kelpfishes	277	19.29	36	29.62	5	6.93
13	Labrisomidae unid.	labrisomid kelpfishes	219	16.36	87	73.38	47	48.08
14	*Paralabrax clathratus*	kelp bass	213	14.12	29	20.88	43	36.99
15	*Sardinops sagax*	Pacific sardine	202	13.21	3	1.99	-	-
16	*Paralabrax* spp.	sand bass	159	10.76	12	9.46	8	7.03
17	larval fish fragment	unid. larval fishes	145	10.50	13	9.98	11	9.51
18	Haemulidae unid.	grunts	116	8.80	10	6.71	4	3.34
19	*Scomber japonicus*	Pacific mackerel	110	7.07	32	25.62	9	7.39
20	*Hypsypops rubicundus*	garibaldi	110	7.03	84	66.63	6	5.73
21	larval/post-larval fish unid.	larval fishes	93	6.81	8	5.67	5	4.57
22	*Oxyjulis californica*	senorita	79	5.55	12	8.05	2	1.98
23	*Paralabrax nebulifer*	barred sand bass	82	5.08	-	-	2	1.67
24	*Sphyraena argentea*	California barracuda	59	3.74	8	6.51	8	6.60
25	*Xenistius californiensis*	salema	55	3.61	-	-	31	25.82
26	*Lepidogobius lepidus*	bay goby	56	3.59	-	-	-	-
27	*Stenobrachius leucopsarus*	northern lampfish	51	3.26	-	-	-	-
28	*Pleuronichthys verticalis*	hornyhead turbot	43	2.79	-	-	3	2.56
29	*Atherinopsis californiensis*	jacksmelt	35	2.78	-	-	-	-
30	*Umbrina roncador*	yellowfin croaker	39	2.62	1	0.71	24	21.89
31	*Pleuronichthys ritteri*	spotted turbot	34	2.51	-	-	-	-
32	*Xystreurys liolepis*	fantail sole	27	1.97	-	-	-	-
33	*Hypsopsetta guttulata*	diamond turbot	30	1.97	-	-	-	-
34	*Rimicola* spp.	kelp clingfishes	22	1.79	-	-	-	-
35	*Peprilus simillimus*	Pacific butterfish	28	1.78	-	-	15	12.77
36	*Cheilotrema saturnum*	black croaker	24	1.71	6	4.76	4	3.79
37	*Semicossyphus pulcher*	California sheephead	21	1.49	6	4.23	-	-
38	*Ophidion scrippsae*	basketweave cusk-eel	22	1.48	-	-	-	-
39	*Diaphus theta*	California headlight fish	24	1.46	1	0.76	1	0.83
40	*Acanthogobius flavimanus*	yellowfin goby	22	1.46	-	-	-	-
41	*Pleuronichthys* spp.	turbots	19	1.30	-	-	1	0.83
42	Pleuronectiformes unid.	flatfishes	21	1.25	-	-	-	-
43	*Menticirrhus undulatus*	California corbina	16	1.21	4	3.04	4	4.05
44	*Atractoscion nobilis*	white seabass	18	1.18	2	1.48	9	8.43
45	Ophidiidae unid.	cusk-eels	15	1.14	-	-	-	-
46	*Sebastes* spp.	rockfishes	18	1.09	-	-	-	-
47	*Girella nigricans*	opaleye	16	1.06	2	1.36	1	0.80
48	*Typhlogobius californiensis*	blind goby	15	0.99	4	3.24	1	0.81
49	*Citharichthys sordidus*	Pacific sanddab	16	0.99	-	-	1	0.83
50	Pleuronectidae unid.	flounders	16	0.98	-	-	-	-
51	*Trachurus symmetricus*	jack mackerel	17	0.96	13	9.40	-	-
52	*Halichoeres semicinctus*	rock wrasse	15	0.95	-	-	-	-
53	*Syngnathus* spp.	pipefishes	10	0.84	-	-	1	0.81
54	Labridae	wrasses	11	0.83	-	-	-	-

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

			Survey Number:		1		2	
			Survey Date:		06/10/04		06/24/04	
			Sample Count:		20		19	
	Taxon	Common Name	Total Count	Mean Conc.	Count	Conc.	Count	Conc.
	Fishes							
55	*Paraclinus integripinnis*	reef finspot	14	0.81	7	4.25	-	-
56	*Symphurus atricauda*	California tonguefish	11	0.77	-	-	-	-
57	*Triphoturus mexicanus*	Mexican lampfish	12	0.73	-	-	1	0.83
58	*Citharichthys* spp.	sanddabs	9	0.70	-	-	1	0.83
59	*Nannobrachium* spp.	lanternfishes	9	0.57	-	-	-	-
60	*Medialuna californiensis*	halfmoon	7	0.53	2	1.69	-	-
61	*Gillichthys mirabilis*	longjaw mudsucker	8	0.51	-	-	-	-
62	*Chilara taylori*	spotted cusk-eel	7	0.50	-	-	-	-
63	*Heterostichus rostratus*	giant kelpfish	7	0.50	1	1.00	1	1.39
64	*Hypsoblennius jenkinsi*	mussel blenny	7	0.46	-	-	-	-
65	Paralichthyidae unid.	lefteye flounders & sandd	7	0.44	-	-	-	-
66	Atherinopsidae	silverside	4	0.31	-	-	-	-
67	*Parophrys vetulus*	English sole	5	0.30	-	-	-	-
68	Myctophidae unid.	lanternfishes	4	0.30	-	-	-	-
69	*Hippoglossina stomata*	bigmouth sole	5	0.29	-	-	-	-
70	*Zaniolepis frenata*	shortspine combfish	5	0.25	-	-	-	-
71	*Ruscarius creaseri*	rouchcheek sculpin	3	0.22	-	-	-	-
72	Clupeiformes	herrings and anchovies	3	0.21	2	1.92	-	-
73	*Syngnathus leptorhynchus*	bay pipefish	3	0.18	3	2.37	-	-
74	Clupeidae unid.	herrings	3	0.18	-	-	-	-
75	*Lyopsetta exilis*	slender sole	3	0.16	-	-	-	-
76	Pomacentridae	damselfishes	2	0.14	-	-	-	-
77	*Rhinogobiops nicholsi*	blackeye goby	2	0.14	-	-	-	-
78	*Nannobrachium ritteri*	broadfin lampfish	2	0.13	-	-	-	-
79	*Cyclothone* spp.	bristlemouths	2	0.13	-	-	-	-
80	*Chromis punctipinnis*	blacksmith	2	0.13	-	-	-	-
81	*Icelinus* spp.	sculpins	3	0.13	-	-	-	-
82	Gobiesocidae unid.	clingfishes	2	0.12	1	0.88	-	-
83	*Anisotremus davidsonii*	sargo	2	0.12	-	-	-	-
84	*Sebastes jordani*	shortbelly rockfish	2	0.10	-	-	-	-
85	Blennioidei	blennies	1	0.08	-	-	-	-
86	Clinidae unid.	clinid kelpfishes	1	0.08	1	1.00	-	-
87	Chaenopsidae unid.	tube blennies	1	0.07	-	-	-	-
88	*Leptocottus armatus*	Pacific staghorn sculpin	1	0.07	-	-	-	-
89	Cynoglossidae	tongue soles	1	0.07	-	-	-	-
90	Kyphosidae	sea chubs	1	0.07	-	-	-	-
91	*Cyclothone acclinidens*	bent tooth bristlemouth	1	0.07	-	-	-	-
92	*Ilypnus gilberti*	cheekspot goby	1	0.06	-	-	-	-
93	*Gobiesox* spp.	clingfishes	1	0.06	-	-	-	-
94	Hexagrammidae unid.	greenlings	1	0.06	-	-	-	-
95	*Bathylagus ochotensis*	popeye blacksmelt	1	0.06	-	-	-	-
96	*Hypsoblennius gentilis*	bay blenny	1	0.05	1	0.64	-	-
	Invertebrates							
	Panulirus interruptus (larvae)	California spiny lobster	98	7.04	1	0.82	71	64.80
	Cancer anthonyi (megalops)	yellow crab	80	4.74	-	-	2	2.38
	Cancer antennarius (megalops)	brown rock crab	71	4.11	-	-	3	3.15
	Cancer gracilis (megalops)	slender crab	48	2.93	2	1.35	-	-
	Cancer spp. (megalops)	cancer crabs	4	0.23	-	-	-	-
	Cancer productus (megalops)	red rock crab	3	0.22	-	-	-	-
		Totals:	17,067		40,384		39,197	

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	3		4		5		6	
	07/06/04		08/13/04		09/23/04		10/21/04	
	20		20		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes								
Engraulis mordax	214	168.35	73	62.19	204	167.31	94	81.59
Hypsoblennius spp.	183	181.20	234	255.74	64	66.94	1	0.90
Engraulidae unid.	24	19.48	-	-	3	2.95	8	9.23
Gobiidae unid.	86	82.38	154	190.83	48	52.35	44	48.00
Genyonemus lineatus	13	10.58	12	14.77	300	280.83	33	25.28
larvae, unidentified yolksac	347	291.29	72	75.56	60	58.18	16	15.29
Paralichthys californicus	194	173.39	37	38.97	170	171.01	32	30.06
Seriphus politus	50	42.17	8	6.62	97	88.33	2	1.94
Sciaenidae unid.	102	99.70	25	28.73	39	38.37	6	4.90
Roncador stearnsi	52	47.53	10	10.18	53	56.79	-	-
Citharichthys stigmaeus	16	14.03	5	4.29	158	124.03	93	85.55
Gibbonsia spp.	4	4.35	3	3.96	2	2.46	11	11.57
Labrisomidae unid.	46	46.77	22	27.32	15	15.46	1	0.90
Paralabrax clathratus	34	27.63	2	1.75	105	96.31	-	-
Sardinops sagax	9	8.07	5	4.93	25	22.04	3	2.47
Paralabrax spp.	50	40.52	31	29.86	55	50.38	2	1.92
larval fish fragment	41	35.90	16	19.10	29	30.59	6	5.77
Haemulidae unid.	5	4.12	4	2.79	91	95.77	2	1.68
Scomber japonicus	39	30.95	-	-	29	27.04	1	0.89
Hypsypops rubicundus	13	11.43	1	1.32	-	-	-	-
larval/post-larval fish unid.	39	34.86	14	17.27	16	16.26	6	5.81
Oxyjulis californica	17	15.21	16	16.22	17	17.56	9	7.70
Paralabrax nebulifer	-	-	-	-	80	64.38	-	-
Sphyraena argentea	27	20.12	9	8.12	7	7.31	-	-
Xenistius californiensis	-	-	2	1.90	22	19.24	-	-
Lepidogobius lepidus	-	-	1	1.18	3	2.32	-	-
Stenobrachius leucopsarus	-	-	-	-	-	-	-	-
Pleuronichthys verticalis	10	7.29	3	3.18	18	15.33	2	1.69
Atherinopsis californiensis	-	-	-	-	-	-	-	-
Umbrina roncador	14	11.41	-	-	-	-	-	-
Pleuronichthys ritteri	4	3.41	5	5.87	15	14.28	6	5.25
Xystreurys liolepis	12	11.12	1	1.14	9	9.07	3	2.82
Hypsopsetta guttulata	-	-	2	1.93	8	7.31	6	4.26
Rimicola spp.	2	1.96	-	-	12	13.28	3	3.20
Peprilus simillimus	6	4.66	-	-	4	3.42	-	-
Cheilotrema saturnum	10	9.25	1	0.80	3	3.60	-	-
Semicossyphus pulcher	1	1.05	3	2.95	8	8.18	2	2.27
Ophidion scrippsae	-	-	6	6.04	11	8.98	4	3.21
Diaphus theta	1	0.81	-	-	3	2.41	1	0.89
Acanthogobius flavimanus	-	-	-	-	-	-	-	-
Pleuronichthys spp.	1	0.52	1	1.14	11	9.76	3	3.18
Pleuronectiformes unid.	-	-	-	-	1	0.78	5	3.67
Menticirrhus undulatus	-	-	2	2.14	6	6.54	-	-
Atractoscion nobilis	5	3.58	-	-	-	-	-	-
Ophidiidae unid.	-	-	1	0.93	5	5.38	8	7.74
Sebastes spp.	-	-	1	1.14	2	1.85	-	-
Girella nigricans	-	-	-	-	3	2.62	6	5.49
Typhlogobius californiensis	-	-	1	0.60	-	-	-	-
Citharichthys sordidus	-	-	-	-	2	1.53	2	1.89
Pleuronectidae unid.	-	-	-	-	1	0.76	-	-
Trachurus symmetricus	-	-	-	-	-	-	2	1.76
Halichoeres semicinctus	1	0.81	-	-	10	8.07	4	3.52
Syngnathus spp.	-	-	6	7.95	1	0.78	-	-
Labridae	7	6.83	1	1.34	-	-	1	0.68

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	3		4		5		6	
	07/06/04		08/13/04		09/23/04		10/21/04	
	20		20		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes								
Paraclinus integripinnis	-	-	7	6.28	-	-	-	-
Symphurus atricauda	-	-	-	-	10	8.81	1	1.23
Triphoturus mexicanus	-	-	1	0.60	6	5.23	2	1.30
Citharichthys spp.	-	-	1	1.14	-	-	3	3.36
Nannobrachium spp.	-	-	-	-	-	-	-	-
Medialuna californiensis	-	-	4	4.48	-	-	1	0.68
Gillichthys mirabilis	-	-	-	-	-	-	-	-
Chilara taylori	-	-	-	-	-	-	6	5.72
Heterostichus rostratus	-	-	-	-	-	-	-	-
Hypsoblennius jenkinsi	-	-	1	0.70	5	4.55	1	0.68
Paralichthyidae unid.	2	1.04	-	-	1	1.11	-	-
Atherinopsidae	-	-	-	-	-	-	-	-
Parophrys vetulus	-	-	-	-	-	-	-	-
Myctophidae unid.	1	1.21	-	-	1	0.75	-	-
Hippoglossina stomata	-	-	1	0.78	2	1.52	-	-
Zaniolepis frenata	-	-	-	-	-	-	-	-
Ruscarius creaseri	-	-	-	-	-	-	-	-
Clupeiformes	-	-	-	-	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-
Clupeidae unid.	1	0.71	-	-	-	-	1	0.89
Lyopsetta exilis	-	-	-	-	-	-	-	-
Pomacentridae	-	-	1	0.97	-	-	1	0.90
Rhinogobiops nicholsi	-	-	-	-	1	1.01	-	-
Nannobrachium ritteri	-	-	-	-	-	-	-	-
Cyclothone spp.	-	-	-	-	1	0.77	-	-
Chromis punctipinnis	-	-	-	-	-	-	1	0.83
Icelinus spp.	-	-	-	-	-	-	-	-
Gobiesocidae unid.	-	-	-	-	-	-	-	-
Anisotremus davidsonii	1	0.67	-	-	1	0.90	-	-
Sebastes jordani	-	-	-	-	-	-	-	-
Blennioidei	1	1.05	-	-	-	-	-	-
Clinidae unid.	-	-	-	-	-	-	-	-
Chaenopsidae unid.	-	-	-	-	-	-	-	-
Leptocottus armatus	-	-	-	-	-	-	-	-
Cynoglossidae	-	-	-	-	-	-	1	0.89
Kyphosidae	-	-	-	-	-	-	1	0.89
Cyclothone acclinidens	-	-	-	-	-	-	-	-
Ilypnus gilberti	-	-	-	-	-	-	-	-
Gobiesox spp.	-	-	-	-	-	-	-	-
Hexagrammidae unid.	-	-	-	-	1	0.75	-	-
Bathylagus ochotensis	-	-	-	-	-	-	-	-
Hypsoblennius gentilis	-	-	-	-	-	-	-	-
Invertebrates								
Panulirus interruptus	19	18.79	5	5.56	2	1.49	-	-
Cancer anthonyi (megalops)	29	22.66	17	11.75	16	12.25	1	0.63
Cancer antennarius (megalops)	1	0.67	50	35.14	4	3.35	2	2.08
Cancer gracilis (megalops)	-	-	33	26.49	6	4.92	-	-
Cancer spp. (megalops)	-	-	4	2.93	-	-	-	-
Cancer productus (megalops)	-	-	1	1.32	-	-	-	-
	39,931		39,152	959	40,160		38,757	

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	7		8		9		10	
	11/18/04		12/16/04		01/13/05		02/24/05	
	20		20		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes								
Engraulis mordax	153	122.98	2	1.47	43	35.34	82	68.40
Hypsoblennius spp.	10	8.40	1	0.76	-	-	-	-
Engraulidae unid.	-	-	-	-	11	10.07	2	1.62
Gobiidae unid.	22	17.02	21	17.62	38	33.74	125	118.27
Genyonemus lineatus	78	63.14	8	6.99	46	38.44	143	124.31
larvae, unidentified yolksac	1	0.76	-	-	8	6.08	11	9.22
Paralichthys californicus	11	8.76	3	2.80	5	4.30	20	17.53
Seriphus politus	-	-	-	-	-	-	-	-
Sciaenidae unid.	1	0.67	-	-	6	5.75	3	3.04
Roncador stearnsi	-	-	-	-	-	-	-	-
Citharichthys stigmaeus	12	10.73	2	1.75	-	-	1	0.67
Gibbonsia spp.	6	5.19	40	32.33	61	57.65	52	48.45
Labrisomidae unid.	-	-	-	-	-	-	-	-
Paralabrax clathratus	-	-	-	-	-	-	-	-
Sardinops sagax	5	4.12	-	-	-	-	34	26.67
Paralabrax spp.	-	-	-	-	-	-	-	-
larval fish fragment	7	6.37	1	0.89	2	1.69	4	3.60
Haemulidae unid.	-	-	-	-	-	-	-	-
Scomber japonicus	-	-	-	-	-	-	-	-
Hypsypops rubicundus	-	-	-	-	-	-	-	-
larval/post-larval fish unid.	-	-	-	-	2	1.90	-	-
Oxyjulis californica	-	-	-	-	1	0.81	-	-
Paralabrax nebulifer	-	-	-	-	-	-	-	-
Sphyraena argentea	-	-	-	-	-	-	-	-
Xenistius californiensis	-	-	-	-	-	-	-	-
Lepidogobius lepidus	13	9.84	4	4.20	20	16.88	4	3.75
Stenobrachius leucopsarus	-	-	-	-	41	34.59	-	-
Pleuronichthys verticalis	1	1.08	-	-	-	-	-	-
Atherinopsis californiensis	-	-	3	2.10	10	9.29	7	6.78
Umbrina roncador	-	-	-	-	-	-	-	-
Pleuronichthys ritteri	-	-	-	-	2	1.77	-	-
Xystreurys liolepis	1	0.77	-	-	-	-	-	-
Hypsopsetta guttulata	2	1.51	1	1.05	8	6.75	2	1.60
Rimicola spp.	-	-	1	1.05	3	2.59	1	1.15
Peprilus simillimus	-	-	-	-	-	-	-	-
Cheilotrema saturnum	-	-	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	-	-	-	-
Ophidion scrippsae	1	0.95	-	-	-	-	-	-
Diaphus theta	-	-	-	-	-	-	-	-
Acanthogobius flavimanus	-	-	-	-	11	8.45	8	8.00
Pleuronichthys spp.	-	-	-	-	-	-	-	-
Pleuronectiformes unid.	10	7.45	-	-	-	-	-	-
Menticirrhus undulatus	-	-	-	-	-	-	-	-
Atractoscion nobilis	-	-	-	-	-	-	-	-
Ophidiidae unid.	1	0.76	-	-	-	-	-	-
Sebastes spp.	7	5.29	6	4.35	-	-	-	-
Girella nigricans	4	3.47	-	-	-	-	-	-
Typhlogobius californiensis	-	-	-	-	-	-	2	1.80
Citharichthys sordidus	9	7.31	-	-	-	-	-	-
Pleuronectidae unid.	1	0.88	-	-	-	-	-	-
Trachurus symmetricus	-	-	-	-	-	-	-	-
Halichoeres semicinctus	-	-	-	-	-	-	-	-
Syngnathus spp.	-	-	1	0.74	1	0.66	-	-
Labridae	-	-	-	-	-	-	-	-

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	7		8		9		10	
	11/18/04		12/16/04		01/13/05		02/24/05	
	20		20		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes								
Paraclinus integripinnis	-	-	-	-	-	-	-	-
Symphurus atricauda	-	-	-	-	-	-	-	-
Triphoturus mexicanus	2	1.54	-	-	-	-	-	-
Citharichthys spp.	-	-	1	0.89	2	1.60	-	-
Nannobrachium spp.	1	0.76	1	0.84	4	3.51	1	0.90
Medialuna californiensis	-	-	-	-	-	-	-	-
Gillichthys mirabilis	-	-	1	0.72	4	3.37	3	2.59
Chilara taylori	1	0.81	-	-	-	-	-	-
Heterostichus rostratus	2	1.83	1	0.88	2	1.35	-	-
Hypsoblennius jenkinsi	-	-	-	-	-	-	-	-
Paralichthyidae unid.	2	1.95	-	-	1	1.01	1	0.61
Atherinopsidae	1	0.84	-	-	-	-	-	-
Parophrys vetulus	-	-	-	-	-	-	-	-
Myctophidae unid.	-	-	-	-	1	0.96	-	-
Hippoglossina stomata	2	1.49	-	-	-	-	-	-
Zaniolepis frenata	-	-	1	0.64	2	1.33	1	0.70
Ruscarius creaseri	-	-	-	-	1	0.68	-	-
Clupeiformes	-	-	-	-	-	-	1	0.78
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-
Clupeidae unid.	-	-	-	-	-	-	1	0.67
Lyopsetta exilis	-	-	-	-	-	-	-	-
Pomacentridae	-	-	-	-	-	-	-	-
Rhinogobiops nicholsi	1	0.85	-	-	-	-	-	-
Nannobrachium ritteri	2	1.75	-	-	-	-	-	-
Cyclothone spp.	-	-	-	-	-	-	1	0.90
Chromis punctipinnis	1	0.82	-	-	-	-	-	-
Icelinus spp.	-	-	-	-	-	-	-	-
Gobiesocidae unid.	-	-	1	0.72	-	-	-	-
Anisotremus davidsonil	-	-	-	-	-	-	-	-
Sebastes jordani	-	-	-	-	2	1.33	-	-
Blennioidei	-	-	-	-	-	-	-	-
Clinidae unid.	-	-	-	-	-	-	-	-
Chaenopsidae unid.	-	-	-	-	-	-	1	0.97
Leptocottus armatus	-	-	-	-	-	-	1	0.90
Cynoglossidae	-	-	-	-	-	-	-	-
Kyphosidae	-	-	-	-	-	-	-	-
Cyclothone acclinidens	1	0.85	-	-	-	-	-	-
Ilypnus gilberti	-	-	1	0.84	-	-	-	-
Gobiesox spp.	-	-	-	-	-	-	-	-
Hexagrammidae unid.	-	-	-	-	-	-	-	-
Bathylagus ochotensis	-	-	-	-	-	-	-	-
Hypsoblennius gentilis	-	-	-	-	-	-	-	-
Invertebrates								
Panulirus interruptus	-	-	-	-	-	-	-	-
Cancer anthonyi (megalops)	8	5.93	2	1.26	3	2.96	1	1.01
Cancer antennarius (megalops)	4	2.91	1	1.12	-	-	-	-
Cancer gracilis (megalops)	2	1.44	2	1.73	1	1.05	-	-
Cancer spp. (megalops)	-	-	-	-	-	-	-	-
Cancer productus (megalops)	-	-	-	-	-	-	-	-
	38,722		**38,471**		**38,736**		**38,950**	

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	11		12		13	
	03/23/05		04/21/05		05/19/05	
	15		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes						
Engraulis mordax	1,767	1,805.85	3,356	2,740.48	18	13.11
Hypsoblennius spp.	3	3.31	11	8.69	191	173.15
Engraulidae unid.	1,163	1,211.29	10	8.62	10	8.93
Gobiidae unid.	98	99.04	21	20.98	91	76.18
Genyonemus lineatus	234	235.43	45	33.43	6	4.54
larvae, unidentified yolksac	19	20.47	2	1.58	11	9.07
Paralichthys californicus	28	27.91	11	9.12	6	4.78
Seriphus politus	-	-	1	1.22	-	-
Sciaenidae unid.	38	44.51	6	5.95	11	9.01
Roncador stearnsi	-	-	-	-	-	-
Citharichthys stigmaeus	2	1.93	2	2.00	-	-
Gibbonsia spp.	15	15.39	2	2.29	40	30.54
Labrisomidae unid.	-	-	1	0.74	-	-
Paralabrax clathratus	-	-	-	-	-	-
Sardinops sagax	-	-	118	101.46	-	-
Paralabrax spp.	-	-	1	0.69	-	-
larval fish fragment	5	5.02	8	6.78	2	1.32
Haemulidae unid.	-	-	-	-	-	-
Scomber japonicus	-	-	-	-	-	-
Hypsypops rubicundus	-	-	1	0.94	5	5.36
larval/post-larval fish unid.	-	-	2	1.69	1	0.55
Oxyjulis californica	1	1.20	4	3.35	-	-
Paralabrax nebulifer	-	-	-	-	-	-
Sphyraena argentea	-	-	-	-	-	-
Xenistius californiensis	-	-	-	-	-	-
Lepidogobius lepidus	3	2.73	2	1.99	6	3.84
Stenobrachius leucopsarus	-	-	10	7.78	-	-
Pleuronichthys verticalis	4	3.45	2	1.74	-	-
Atherinopsis californiensis	15	17.97	-	-	-	-
Umbrina roncador	-	-	-	-	-	-
Pleuronichthys ritteri	1	1.34	1	0.74	-	-
Xystreurys liolepis	-	-	-	-	1	0.75
Hypsopsetta guttulata	1	1.20	-	-	-	-
Rimicola spp.	-	-	-	-	-	-
Peprilus simillimus	-	-	3	2.33	-	-
Cheilotrema saturnum	-	-	-	-	-	-
Semicossyphus pulcher	-	-	-	-	1	0.75
Ophidion scrippsae	-	-	-	-	-	-
Diaphus theta	-	-	13	10.38	4	2.94
Acanthogobius flavimanus	3	2.58	-	-	-	-
Pleuronichthys spp.	-	-	1	0.74	1	0.75
Pleuronectiformes unid.	-	-	3	1.94	2	2.42
Menticirrhus undulatus	-	-	-	-	-	-
Atractoscion nobilis	-	-	2	1.91	-	-
Ophidiidae unid.	-	-	-	-	-	-
Sebastes spp.	-	-	1	0.77	1	0.75
Girella nigricans	-	-	-	-	-	-
Typhlogobius californiensis	2	1.94	2	2.17	3	2.30
Citharichthys sordidus	-	-	2	1.29	-	-
Pleuronectidae unid.	1	0.93	13	10.21	-	-
Trachurus symmetricus	-	-	2	1.38	-	-
Halichoeres semicinctus	-	-	-	-	-	-
Syngnathus spp.	-	-	-	-	-	-
Labridae	-	-	2	1.88	-	-

Table A3 (continued). Monthly abundance and mean concentration (#/1,000 m^3) of larval fishes and target invertebrates at source water Stations N1-N5 in nearshore area.

	11		12		13	
	03/23/05		04/21/05		05/19/05	
	15		20		20	
Taxon	**Count**	**Conc.**	**Count**	**Conc.**	**Count**	**Conc.**
Fishes						
Paraclinus integripinnis	-	-	-	-	-	-
Symphurus atricauda	-	-	-	-	-	-
Triphoturus mexicanus	-	-	-	-	-	-
Citharichthys spp.	-	-	-	-	1	1.24
Nannobrachium spp.	-	-	1	0.65	1	0.75
Medialuna californiensis	-	-	-	-	-	-
Gillichthys mirabilis	-	-	-	-	-	-
Chilara taylori	-	-	-	-	-	-
Heterostichus rostratus	-	-	-	-	-	-
Hypsoblennius jenkinsi	-	-	-	-	-	-
Paralichthyidae unid.	-	-	-	-	-	-
Atherinopsidae	3	3.21	-	-	-	-
Parophrys vetulus	-	-	5	3.93	-	-
Myctophidae unid.	-	-	1	0.94	-	-
Hippoglossina stomata	-	-	-	-	-	-
Zaniolepis frenata	-	-	-	-	1	0.55
Ruscarius creaseri	2	2.15	-	-	-	-
Clupeiformes	-	-	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	-	-
Clupeidae unid.	-	-	-	-	-	-
Lyopsetta exilis	-	-	3	2.04	-	-
Pomacentridae	-	-	-	-	-	-
Rhinogobiops nicholsi	-	-	-	-	-	-
Nannobrachium ritteri	-	-	-	-	-	-
Cyclothone spp.	-	-	-	-	-	-
Chromis punctipinnis	-	-	-	-	-	-
Icelinus spp.	-	-	-	-	3	1.65
Gobiesocidae unid.	-	-	-	-	-	-
Anisotremus davidsonii	-	-	-	-	-	-
Sebastes jordani	-	-	-	-	-	-
Blennioidei	-	-	-	-	-	-
Clinidae unid.	-	-	-	-	-	-
Chaenopsidae unid.	-	-	-	-	-	-
Leptocottus armatus	-	-	-	-	-	-
Cynoglossidae	-	-	-	-	-	-
Kyphosidae	-	-	-	-	-	-
Cyclothone acclinidens	-	-	-	-	-	-
Ilypnus gilberti	-	-	-	-	-	-
Gobiesox spp.	-	-	-	-	1	0.75
Hexagrammidae unid.	-	-	-	-	-	-
Bathylagus ochotensis	-	-	1	0.75	-	-
Hypsoblennius gentilis	-	-	-	-	-	-
Invertebrates						
Panulirus interruptus	-	-	-	-	-	-
Cancer anthonyi (megalops)	-	-	-	-	1	0.77
Cancer antennarius (megalops)	-	-	-	-	6	4.99
Cancer gracilis (megalops)	-	-	-	-	2	1.10
Cancer spp. (megalops)	-	-	-	-	-	-
Cancer productus (megalops)	-	-	-	-	2	1.54
	41,868		**42,167**		**38,953**	