## Marine Environment

### *Potential Effects of Chemical Additives*

Potential effects from chemical additives during the desalination process will be negligible for the proposed operations at the Carlsbad desalination plant. Chemicals that will be added or impurities that will need to be dealt with include:

| Source | Parameter | Fate |
|---|---|---|
| Source Seawater | Silt, sand, plankton residue & organics | Removed by sand filtration |
| | Ferric Sulfate and Polymer | Removed by sand filtration |
| | Sodium Hypochlorite (Chlorine) | Dechlorination with sodium bisulfite |
| | Sulfuric Acid | Neutralized by seawater |
| Sand Filter Backwash Water | Plankton residue & organics | Solids removed for futher processing and disposal |
| | Ferric Sulfate and Polymers | Clarified backwash water returned to effluent discharge channel<br>Solids removed for further processing and disposal |
| Spent Membrane Cleaning Fluid | Citric Acid<br>Sodium Hydroxide<br>Sodium Tripolyphosphate<br>Sodium Dodecylbenzene<br>Sulfuric Acid | Neutralized prior to discharge into local sewer system for treatment and disposal |

Examination of the fate of the various chemicals added to the source water and its included "impurities" indicates that none of these except the clarified backwash water are returned to the power plant's discharge channel. Consequently, chemical additives are not an issue of concern, and would not result in any of the identified thresholds of significance being exceeded. Therefore, impacts would be less than significant.

### *Potential Effects Related to Impingement and Entrainment*

Impingement impacts upon marine organisms occur as a result of organisms being trapped against screens, filters or other mechanisms associated with a seawater intake system and suffer damage or mortality as a result of pressure exerted from the flow of water. Entrainment effects occur when small planktonic organisms are drawn through the intake system, and suffer damage or mortality as a result of pressure changes, mechanical damage, temperature increases, or turbulence in the water flow.

To determine the potential effects resulting from seawater intake, a study was conducted to characterize the type and concentration of organisms within the source water for the cooling water intake structure and the incremental effects of the proposed desalination plant operations on these organisms. The following discussion is based on the findings of that study, entitled: *Carlsbad Desalination Facility Intake Effects Assessment*, prepared by Tenera Environmental, dated March, 2005 which is included as APPENDIX E to this EIR.

The study was designed to specifically address the following issues:

- What species and in what numbers of fish larvae and what numbers of *Cancer* spp. crabs, and spiny lobster are entrained through the EPS cooling water intake structure and what proportion of these organisms would be susceptible to further entrainment by the desalination plant feedwater withdrawal?

- How might any additional losses of organisms due to desalination plant feedwater entrainment affect the source populations of the entrained species in Aqua Hedionda Lagoon and the southern reaches of the Southern California Bight?

- Are these losses ecologically or economically significant?

The study concluded the following:

**Impingement Effect**

- The desalination plant operation does not require the power plant to increase the quantity of water withdrawn nor does it increase the velocity of the water withdrawn.

- The Carlsbad Desalination Plant will not have a separate direct lagoon or ocean intake and screening facilities, and will only use cooling water that is already screened by the EPS intake.

- Therefore, the Carlsbad Desalination Plant will not cause any additional impingement losses to the marine organisms impinged by the EPS.

**Entrainment Losses**

- Based on in-plant testing, the average observed entrainment mortality of the power plant was 97.6 percent (2.4 percent survival). Living fish larvae entrained by the Carlsbad desalination plant would represent an incremental loss of approximately 0.01 to 0.28 percent of the larvae present in the power plant source water.

The cooling water intake structure is part of the EPS existing operations and is presently regulated under Section 316(b). The desalination plant feedwater withdrawal does not include a cooling water intake structure. Therefore, it is not subject to intake regulation under the Federal Clean Water Act (CWA) Section 316(b). However, since the desalination plant will withdraw intake seawater from the EPS discharge flow, the study was conducted consistent with the intent of Section 316(b), which requires that baseline conditions be established. The desalination plant feedwater intake will not increase the volume, nor the velocity of the EPS cooling water intake nor will it increase the number of organisms entrained or impinged by the EPS cooling water intake structure. Therefore, the project would not result in any additional impingement effects of the EPS and therefore, impingement effects are not considered as significant impacts attributable to desalination plant operations.

***Study Methodology:*** The study required an assessment of both the source water for the EPS (lagoon and ocean) and the discharge from the EPS (the desalination plant's feedwater supply). The source water was analyzed to establish population characteristics (relative abundance) for species potentially impacted by the desalination plant. The desalination plant feedwater was characterized to determine the baseline conditions for potential impacts associated with the desalination facility. Specifically, the feedwater characterization examined the type and quantity of organisms that survive entrainment through the EPS cooling water intake structure that could subsequently be impacted by the desalination plant operations.

The EPS source water was partitioned into lagoon and nearshore ocean areas for modeling purposes; ten sampling stations were chosen so that all source water community types would be represented, including five lagoon stations and five nearshore stations. Samples were also collected from EPS's discharge (desalination plant feedwater supply) just before the water flows into the power station's discharge pond.

Laboratory processing for both the feedwater and source water consisted of sorting (removing), identifying, and enumerating all larval fishes, pre-adult larval stages of *Cancer* spp. crabs, and California spiny lobster larvae from the samples. Identification of larval fishes was done to the lowest taxonomic level practicable.

***Source Water Larval Abundance Estimates:*** Data collected from three source water surveys conducted on June 10, June 24, and July 6, 2004, included a total of 27,029 larval fishes, with 4,750 specimens collected from the five nearshore stations and the remaining 22,279 specimens from the lagoon stations. Two taxa comprised 84 percent of the total number of larval fishes collected from all surveys and source water stations combined: three species from the goby family (*Clevelandia ios*, *Ilypnus gilberti*, *Quietula y-cauda*) hereinafter referred to as CIQ gobies comprised 65 percent and combtooth blennies (*Hypsoblennius* spp.) comprised 19 percent. In addition, four species of target invertebrates were collected in the samples from both the lagoon and nearshore sampling stations: California spiny lobster (*Panulirus interruptus*, 93 specimens), yellow rock crab (*Cancer anthonyi*, 31 specimens), brown rock crab (*Cancer antennarius*, 4 specimens), and slender crab (*Cancer gracilis*, 2 specimens).

The mean concentration of CIQ goby larvae from all source water stations and surveys combined was approximately 4,900/1,000 $m^3$ and the mean concentration of combtooth blennies was approximately 1,200/1,000 $m^3$.

***Feedwater (EPS Discharge) Larval Abundance Estimates:*** A total of 1,648 fish larvae was collected during two surveys of the EPS discharge water conducted on June 16 and July 6, 2004 (*Table 4.3-3*). Four taxa comprised 95 percent of all of fish larvae in the EPS discharge flows from which the proposed desalination plant would withdraw its feedwater supply. They were combtooth blennies, CIQ gobies, labrisomid kelpfishes (*Labrisomidae unid.*), and garibaldi (*Hypsypops rubicundus*). Gobies and blennies combined accounted for nearly 72 percent of the larvae identified in the feedwater. No target invertebrate larvae were found in any of the samples from the EPS discharge.

**TABLE 4.3-3**
**Total Counts and Mean Concentrations of Larval Fishes from EPS Discharge**

| Taxon | Common Name | Total Count | Percent | Cum. Percent | Mean Concentration (#/1,000 $m^3$) |
|---|---|---|---|---|---|
| *Hypsoblennius* spp. | combtooth blennies | 766 | 46.48% | 46.48% | 1,119.89 |
| CIQ gobies | CIQ goby complex | 426 | 25.85% | 72.33% | 630.94 |
| Labrisomidae unid. | labrisomid kelpfishes | 205 | 12.44% | 84.77% | 291.66 |
| *Hypsypops rubicundus* | garibaldi | 174 | 10.56% | 95.33% | 230.14 |
| *Rimicola* spp. | kelp clingfishes | 13 | 0.79% | 96.12% | 17.54 |
| *Gibbonsia* spp. | clinid kelpfishes | 12 | 0.73% | 96.84% | 16.38 |
| Engraulidae | anchovies | 12 | 0.73% | 97.57% | 15.83 |
| Gobiesocidae unid. | clingfishes | 8 | 0.49% | 98.06% | 10.15 |
| Sciaenidae | croakers | 8 | 0.49% | 98.54% | 11.38 |
| Blennioidei | Blennies | 7 | 0.42% | 98.97% | 9.21 |
| Atherinopsidae | Silversides | 6 | 0.36% | 99.33% | 7.36 |
| larval/post-larval fish unid. | | 3 | 0.18% | 99.51% | 3.50 |
| *Heterostichus rostratus* | giant kelpfish | 1 | 0.06% | 99.58% | 1.14 |

**TABLE 4.3-3**
**Total Counts and Mean Concentrations of Larval Fishes from EPS Discharge**

| Taxon | Common Name | Total Count | Percent | Cum. Percent | Mean Concentration (#/1,000 m$^3$) |
|---|---|---|---|---|---|
| *Syngnathus* spp. | Pipefishes | 1 | 0.06% | 99.64% | 0.92 |
| *Paralichthys californicus* | California halibut | 1 | 0.06% | 99.70% | 1.28 |
| Chaenopsidae unid. | Clinids | 1 | 0.06% | 99.76% | 0.92 |
| Labridae | Wrasses | 1 | 0.06% | 99.82% | 1.28 |
| larvae, unidentified yolksac | | 1 | 0.06% | 99.88% | 2.45 |
| *Typhlogobius californiensis* | blind goby | 1 | 0.06% | 99.94% | 1.96 |
| *Agonidae unid.* | Poachers | 1 | 0.06% | 100.00% | 2.19 |
| Total | | 1,648 | | | |

***Feedwater Larval Survival Results:*** Eleven surveys to estimate the survival of larval fishes in the EPS discharge flow were conducted from June through November 2004. A total of 1,989 fishes was collected from the eleven surveys (*Table 4.3-4*). Larvae that were alive immediately after collection were placed in separate containers and observed for up to three hours after collection. Approximately half of the larvae continued swimming for up to two hours after collection while the others died between 0.5–1.5 hours after collection. The species of larvae that survived entrainment and sampling were CIQ gobies, combtooth blennies, and unidentified clingfishes. The highest concentration of larval fishes (2,444/1,000 m$^3$) was collected July 6, 2004, and the lowest concentration (93/1,000 m$^3$) was collected on October 21, 2004.

The average survey percent survival ranged from 0 percent (November 2 survey) to 9.2 percent (November 30 survey) (*Table 4.3-4*). The overall average percent survival based on an average of survival data from each sample containing fish (n=223 out of a 291 total surveys) is 2.40 percent with a standard deviation of 11.22. The average percent survival based on each survey's (n=11) average survival data is 2.71 with a standard deviation of 11.24 among survival averages for the 11 surveys. The surviving larvae that enter the desalination plant will be retained on the pretreatment filters, which could be either granular media facilities or membrane filters. The retained organisms will be removed from the pretreatment filters with the filter media backwash.

**TABLE 4.3-4**
**Summary Of Larval Fish Data Collected During In-Plant Survival Studies From EPS Discharge Flows During June Through November 2004.**

| Date Collected | Number of Samples[1] | Total Volume Filtered ($m^3$) | Average Larval Fish Concentration (#/1,000 $m^3$) per Survey[2] (s.d. in parenthesis) | Total # Larvae Collected | Total # Alive upon Collection | Average % Survival per Survey[3] (s.d. in parenthesis) |
|---|---|---|---|---|---|---|
| 6/16/2004 | 8 | 117 | 1,289.4 (754.2) | 140 | 2 | 1.8 (4.7) |
| 7/06/2004 | 9 | 112 | 2,443.8 (875.0) | 276 | 13 | 4.3 (4.1) |
| 7/20/2004 | 30 | 301 | 1,053.3 (674.6) | 315 | 7 | 1.6 (4.0) |
| 8/13/2004 | 30 | 339 | 564.4 (632.9) | 192 | 2 | 0.005 (0.02) |
| 8/26/2004 | 32 | 284 | 415.4 (350.9) | 112 | 1 | 0.6 (3.2) |
| 9/09/2004 | 31 | 342 | 2,027.5 (2,246.4) | 590 | 4 | 0.5 (1.8) |
| 9/23/2004 | 30 | 344 | 668.8 (1,134.6) | 200 | 2 | 1.2 (5.5) |
| 10/21/2004 | 31 | 347 | 93.0 (123.9) | 31 | 1 | 5.9 (24.3) |
| 11/02/2004 | 30 | 257 | 182.3 (161.9) | 47 | 0 | 0 |
| 11/18/2004 | 30 | 271 | 132.9 (166.7) | 34 | 2 | 4.6 (13.8) |
| 11/30/2004 | 30 | 216 | 264.5 (291.6) | 52 | 4 | 9.2 (24.2) |

1. The number of samples per survey increased beginning July 20, 2004 when the duration of sampling increased to cover 24-hour periods.
2. The average larval fish concentration per survey was calculated by summing the individual sample concentrations and dividing by the number of samples in each survey.
3. The average percent survival per survey was calculated by summing the individual sample survival percentages and dividing by the number of samples containing fish larvae in each survey.

In order to assess any potential effects of the desalination facility feedwater withdrawal on local fishery resources, three taxa were selected: CIQ goby complex, combtooth blennies, and northern anchovy. These taxa were some of the most commonly entrained species in the EPS cooling water intake structure or were species (northern anchovy) that may be of interest to fishery managers. Larvae of species with high value to sport and commercial fisheries such as California halibut were entrained in such low numbers (approximately 0.06 percent of the total number of EPS-entrained larvae) that any effects on source water populations of these species could not be modeled.

***Entrainment Effects Model:*** The Empirical Transport Model (*ETM*) used in the analysis is based on principles used in fishery management. To determine the effects of fishing on a population, a fishery manager needs an estimate of the number of fishes in the population and the number of fishes being *removed* by the fishery. ETM is recommended and approved by the California Energy Commission (CEC), California Coastal Commission (CCC), Regional Water Quality Control Boards and other regulatory and resources agencies for analyzing impacts to fisheries. This assessment assumes 100 percent mortality of all organisms surviving the EPS upon withdrawal into the desalination facility.

The *ETM* first takes the estimate of daily mortality (also known as Proportional Entrainment (*PE*)), and expands the estimate over the number of days the larvae from a single cohort, or batch of larvae, would be exposed to entrainment. The ETM thereby predicts regional effects on appropriate adult populations. Finally, the effects of entrainment are examined in the context of survival data collected from the EPS discharge.

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 average concentration of larvae in the feedwater, as noted in Table 4.3-4, was multiplied by desalination facility's maximum feedwater withdrawal volume of 401,254 $m^3$/day (106 mgd). A total maximum withdrawal volume of 106 mgd (as compared to average withdrawal of 104 mgd) was used as a worst case volume, under a scenario where maximum backwash water volumes would be used during a period of maximum RO production.

Average concentrations of larval fishes from the source water survey data were multiplied by the volume estimates for each of the water body segments (total of three lagoon and nine nearshore areas) and then combined to estimate the average source water population.

The estimated effects of withdrawal for desalination operations on a single cohort of larvae were calculated using the *ETM* as: $P_M = 1-(1-PE)^{duration}$, where $P_m$ is the proportional level of mortality resulting from the water withdrawals by the proposed desalination facility. 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) studies (Tenera 2004).

The results of the analysis are contained in *Table 4.3-5*. Estimates of *PE* ranged from 0.01 percent for northern anchovy to 0.55 percent for CIQ gobies.

**TABLE 4.3-5**
**Estimates of Average Daily Mortality (*PE*)**
**(Standard Error in parentheses)**

| Fish Group | Feedwater Volume – Maximum Flow 401,254 $m^3$/day (106 MGD) |
|---|---|
| CIQ gobies | 0.55% (2.08) |
| Combtooth blennies | 0.36% (0.87) |
| Northern anchovy | 0.01% (0.05) |

Fish larvae entrained by desalination plant represent an incremental loss of the EPS source water supply of larvae. The average observed entrainment mortality of the EPS was 97.6 percent (2.4 percent survival). Since 97.6 percent of the larvae are dead at the point of the desalination plant intake, the incremental entrainment loss on source water populations is the 2.4 percent survival rate times the desalination plant proportional entrainment for each specific species in the EPS discharge. These incremental effects range from 0.01 percent for northern anchovy to 0.28 percent for CIQ gobies (*Table 4.3-6*). The incremental mortality assumes 100 percent mortality of all organisms surviving the EPS upon withdrawal into the desalination facility.

**TABLE 4.3-6**
**Estimates of Proportional Mortality ($P_m$)**

| Fish Group | $P_m$ based on Maximum Length at Entrainment | Estimate When Applying The Overall Average Survival Estimate Of 2.4 Percent[1] |
|---|---|---|
| | Desalination Plant Entrainment from EPS Discharge Flow Maximum flow - 106 MGD (401,254 $m^3$/day) | Incremental Entrainment Loss Due to Desalination Plant Operations Maximum flow - 106 MGD (401,254 $m^3$/day) |
| CIQ gobies | 11.8% | 0.28% |
| Combtooth blennies | 5.7% | 0.14% |
| Northern anchovy | 0.6% | 0.01% |

1. The overall average percent survival (2.4 percent with a standard deviation of 11.22) was based on an average of each sample that contained fish (n=223).

The role of turbulence and temperature and how larvae are affected were not evaluated at the EPS. It is noted that mortality from entrainment through the cooling water intake structure may be primarily due to pressure and turbulence in the water flow, rather than temperature increases resulting from the cooling operation. Since the desalination plant feedwater will be subject to the same turbulence whether or not the EPS is operating, it is reasonable to estimate incremental mortality for the heated and unheated desalination scenarios using the survival data presented in Table 4.3-4 Using those data, and based on typical operation of the EPS, the entrainment loss rate ranges from 0.01 percent to 0.28 percent.

Although combtooth blennies had higher *PE* estimates, CIQ gobies had higher estimates of $P_m$ because their larvae were exposed to entrainment for a longer period of time (either from multiple spawnings of one species or from different species spawning at different times). Adult CIQ gobies and combtooth blennies are very common in Agua Hedionda Lagoon habitats and these levels of mortality would not be expected to result in any population-level effects because these fishes are adapted to estuarine environments where large percentages of their larvae are exported into nearshore areas during tidal flushing. Gobies are abundant in the shallow mudflat and eelgrass habitats that are common in Agua Hedionda middle and inner lagoons. A significant proportion of the CIQ goby larvae in the outer lagoon at the point of entrainment likely originated in the inner and middle lagoon segments and would be exported from the lagoon system on the following tidal cycle. Adult combtooth blennies are common in outer lagoon habitats including rock jetties, docks, pilings, and aquaculture floats, as well as some sandy areas in the lagoon, which explains the large numbers of the larvae found in the EPS discharge flows. The estimates for northern anchovy are much lower than the other two taxa because they are more common in the nearshore areas than the lagoon. In fact, the estimates for northern anchovy are very conservative because these fish are distributed over a large area and therefore the estimate of their source water population would be much larger than the estimate used in the calculation of *PE*.

***Significance of Entrainment Losses:*** The small proportion of marine organisms lost to entrainment as a result of the desalination plant would not have a substantial effect on the species' ability to sustain their populations because of their widespread distribution and high reproductive potential. The most frequently entrained species are very abundant in the area of EPS intake, Agua Hedionda Lagoon, and the Southern California Bight, and therefore, the actual ecological effects due to any additional entrainment from the desalination plant are less than significant. California Department of Fish and Game (2002) in their Nearshore Fishery Management Plan provides for sustainable populations with harvests of up to 60 percent of unfished adult stocks. The incremental entrainment (or "harvest") effect of larval fishes from the desalination plant operations between 0.01 and 0.28 percent. Species of direct recreational and commercial value constitute less than 1 percent of the entrained organisms, and considering the fact that in general, less than one percent of all fish larvae become reproductive adults, the operation of the desalination plant would not result in significant impacts on those species.

### Potential Effects from Elevated Salinity

#### *Dispersion and Dilution Modeling of Discharge*

Jenkins and Wasyl (2001, 2005) applied the U.S. Navy Coastal Water Clarity Model to analyze the dispersal and dilution of the combined Power Plant and RO discharge for the project (APPENDIX E). The objective was to predict how differences in discharge characteristics (salinity-density, temperature, and volume) interact with variations in ocean mixing processes. Maps showing these effects on the discharge plume's salinity and temperature profiles in the nearshore environment enable estimates of the magnitude of the changes and duration of the exposure periods that the organisms might experience. The accuracy of these models has been verified by independent analysis (Grant, 2003) and by findings in agreement with previous works: 1) indicating a less than 1% probability that any of the EPS discharge would drift north and enter the Aqua Hedionda lagoon (EA Engineering, Science, and Technology, 1997) and, 2) suggesting that, because of a greater density, the saltier combined RO and seawater discharge would sink (CA Coastal Commission, 1993). Additional detail regarding the methodology and results of the study is provided in *Section 4.7, Hydrology and Water Quality*.

Jenkins and Wasyl (2001) used time-series data for five coastal oceanographic conditions [most from a continuous 20.5 year (1980-2000) record] to estimate "historical average day" and "month" coastal oceanographic conditions affecting discharge seawater dispersal. The five conditions are, average ocean mixed layer temperature (˚C) and salinity (parts per thousand - “ppt”), average wave height (meters), average wind speed (knots) and maximum tidal current velocity (cm/second). These factors influence discharge dispersal by affecting vertical mixing and longshore flow. Not only do the factors interact with one another, they are further affected by wind and by ocean temperature and salinity (Jenkins and Wasyl, 2001). The combined data were also used to designate periods when the ocean's dispersal capacity would be low: both an actual "historical extreme day" and "month" were identified in the time series and modeled together with the corresponding EPS flow rate for that time.

As detailed in Jenkins and Wasyl (2001, 2005) these oceanographic and weather-related controlling factors were combined using a joint probability analysis based on their separate occurrence frequencies over the 20.5-year period. The corresponding values for flow and for the temperature difference between the discharge and the ocean (the delta T value = 5.5˚C and the delta T value = 0˚C) were also factored in, as was the assumption of a Reverse Osmosis (RO) discharge of 50 mgd with a total dissolved solids (TDS) concentration (salt) that is twice that of ambient seawater for the entire period.

Jenkins and Wasyl (2001, 2005) modeled a diversity of power plant operations and coastal oceanographic variables in order to encompass the range of potential discharge scenarios for the combined RO and heated EPS discharge. This ranges from "historical average day" and "month"