ATTACHMENT 4

UPDATED IMPINGEMENT AND ENTRAINMENT ASSESSMENT

TENERA ENVIRONEMNTAL, MAY 2007

TENERA Environmental

CARLSBAD SEAWATER DESALINATION PROJECT

Technical Memorandum

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

Prepared

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For

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INTORDUCTION

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

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

ASSESSMENT OF ENTRAINMENT EFFECT AND APF

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

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

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

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

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

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

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

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

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

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

IMPINGEMENT ASSESSMENT

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

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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 of Agua 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**