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From:	Halter, Amanda (OC)
Sent:	Thursday, March 05, 2009 7:31 PM
To:	'DWoodward@waterboards.ca.gov'; 'CClemente@waterboards.ca.gov'
Cc:	Philip Wyels; 'Catherine Hagan (George)'; Garrett, Christopher (SD); Singarella, Paul (OC); 'dmayer@tenera.com'; 'Peter MacLaggan'
Subject:	Poseidon: Preliminary Draft Supplemental Impingement Statement
Attachments:	Preliminary Draft Supplemental Impingement Statement.pdf

All,

Attached for your review and comment is the preliminary draft supplemental impingement statement evaluating the three approaches to estimating CDP's projected impingement based on the EPS data. As discussed, this was generated in response to the position that no adjustment should be made to EPS's impingement when estimating CDP's, which was expressed to us on Monday. This statement is still being revised and will be submitted in a final form on Monday.

Best regards,
Amanda

Amanda Halter

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Preliminary Draft
Supplemental...

ATTACHMENT

DRAFT SUPPLEMENTAL IMPINGEMENT STATEMENT

The San Diego Regional Water Quality Control Board ("Regional Board") will consider the Flow, Entrainment and Impingement Minimization Plan ("the Plan") for the Carlsbad Desalination Project ("the Project") at its April 8, 2009 meeting. The Plan was required as a Special Provision of the Project's NPDES permit[1] in order to assure compliance with Porter-Cologne Water Quality Control Act, Water Code Section 13142.5(b). As a component of compliance with Section 13142.5(b), Regional Board staff is assessing the projected impingement associated with the Project.

This memorandum evaluates three potential approaches that could be used to estimate the potential for impingement when the Project is operated in stand-alone mode. Based on the relevant facts, data, and literature, the memorandum concludes that a sound and reasonable approach is the flow-proportioned approach. Accordingly, it is our belief that the Regional Board staff reasonably may rely on this approach in reaching conclusions about projected impingement.

I. FACTUAL BACKGROUND

The Project will be co-located with the Encina Power Station ("EPS") and will receive the water necessary for its desalination operations via EPS's seawater intake system, which receives water directly from the Agua Hedionda Lagoon. EPS has historically withdrawn more seawater for its cooling operations than the Project will be required to satisfy the Project's intake needs for its desalination operations.

From June 2004 to June 2005, Tenera Environmental ("Tenera") conducted a field program during which impingement at the EPS intake structure was measured. As the Project's feedwater will come from the EPS's intake system, the Project's projected impingement can be estimated based on the impingement data collected during this program, which was conducted one day each week from June 24, 2004 through June 15, 2005. Table 1 presents the results from the weekly sampling events. It reflects the number and weight of marine organisms collected from the intake screens for each 24-hour sampling event along with the corresponding intake flow.

During the 2004-2005 sampling period, the EPS's flow volume averaged approximately 657 MGD. In contrast, the overall water demand for the Project is 304 MGD. Also, unlike EPS, the Project's intake needs will not vary dramatically throughout the day and will be fairly constant over a 24-hour period. Thus, impingement data from 2004-2005 provides a conservative data set from which to estimate potential impingement from the Project.

II. FACTORS AFFECTING IMPINGEMENT

Impingement is defined as the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal.[2] In its Phase II regulations related to cooling water intake structures, the United States Environmental Protection Agency ("EPA") explains that the impingement of organisms is governed by the combination of three

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[1] Order No. R9-2006-0065, NPDES No. CA0109223, § VI.C.2.e.

[2] National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule, 40 C.F.R. 125(93) et al) and National Pollutant Discharge Elimination System— Subpart I - Requirements Applicable to Cooling Water Intake Structures for New Facilities Under Section 316(b) of the Act; Final Rule, at 40 C.F.R. 125(88) et al).

primary factors—flow, intake velocity, and fish swim speed.[3] Consistent with EPA's guidance, each of these factors is relevant in estimating the Project's projected impingement.

A. Flow

The rate of impingement is directly related to the flow (i.e., volume) of water drawn through an intake structure. As a facility increases its flow by pumping more water from the source water body, the amount of impingement can be expected to increase correspondingly when other factors remain constant. Conversely, as a facility decreases its flow by pumping less water from the source water body, the amount of impingement can be expected to decrease. Accordingly, EPA's Phase I, II and III regulations use flow as a criterion when determining which set of rules will apply to a particular intake system.

Since the 1970s, EPA has explicitly recognized the relationship between flow and impingement.[4] For example, in the Preamble to its Phase II regulations, EPA explains that it established 50 MGD as the threshold level for applying its regulations, "because the regulation of existing facilities with flows of 50 MGD or greater in Phase II will address those existing power generating facilities with the greatest potential to cause or contribute to adverse environmental impact."[5]

EPA notes that "flow reduction serves the purpose of reducing both impingement and entrainment."[6] According to the EPA, this explains why "[e]nvironmental commentators [have] advocated for flow reduction technologies, such as retrofitting closed-cycle cooling technologies, as the most direct means of reducing fish kills from power plant intakes."[7] Because flow and impingement are directly related, efforts to reduce flow are premised on the common-sense understanding that a facility will reduce impingement as it reduces intake.

Similarly, the State Water Resources Control Board ("SWRCB") recognizes the benefit of reduced flow. In its March 2008 Scoping Document, Water Quality Control Policy on the Use of Coastal and Estuarine Water for Power Plant Cooling, the SWRCB reiterated EPA's conclusion and observed that "[f]low reduction will reliably reduce both impingement and entrainment impacts of OTC [once through cooling]."[8] The EPS intake structure is an OTC intake, although the structure will be used for feedstock water – not cooling – when Poseidon operates in stand-alone mode.

B. Intake Velocity and Fish Swim Speed

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[3] National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule, 69 Fed. Reg. 41612 (July 9, 2004) (to be codified at 40 C.F.R. pt. 9, 122 et al).

[4] Development Document for Best Technology Available for the Location, Design, Construction and Capacity for Cooling Water Intake Structures for Minimizing Adverse Environmental Impact. EPA 440/1-76/015-a. USEPA April 1976. Washington, DC.

[5] Ibid

[6] U.S. Environmental Protection Agency, Phase II, Final Rule Technical Development Document, Chapter 4 (Efficacy of Cooling Water Intake Structure Technologies), Section 1.5, p. 4-4.

[7] 69 Fed. Reg. 41612

[8] SWRCB, Scoping Document: Water Quality Control Policy on the Use of Coastal and Estuarine Waters For Power Plant Cooling (March 2008), p. 45

Intake velocity bears a direct correlation with impingement. As velocity increases when more water is withdrawn from the source water body through the same opening over a fixed time period, the amount of impingement will increase, if all other factors remain constant. Conversely, as a facility decreases velocity by pumping less water from the source water body during a given time period, the amount of impingement will tend to decrease. This phenomenon is explained by the fact that juvenile and adult fish can swim away from the suction force that is exerted by an intake operating at lower velocities.

In the context of establishing the "best technology available" under Section 316(b) of the federal Clean Water Act for new facilities utilizing cooling water intake structures (Phase I Rule), the EPA determined that a maximum intake velocity of 0.5 fps (feet per second) or less minimizes impingement to acceptable levels.[9]

In developing the Phase I Rule, the EPA found that an approach velocity of 0.5 fps to protect fish species from impingement previously was used as guidance in at least three federal agency reports,[10] which were based in part on a study of fish swimming speeds and endurance performed by Sonnichsen et al. (1973).[11] To include an additional layer of conservatism for the Phase I Rule, the EPA prepared an additional analysis that concluded "thresholds should be based on the fishes' swimming speeds (which are related to the length of the fish) and endurance (which varies seasonally and is related to water quality)."[12] This analysis demonstrated that "the species and life stages evaluated could endure a velocity of 1.0 ft/s."[13] However, to "develop a threshold that could be applied nationally and is effective at preventing impingement of most species of fish at their different life stages, EPA applied a safety factor of two to the 1.0 ft/s threshold to derive a threshold of 0.5 ft/s. This safety factor, in part, is meant to ensure protection when screens become partly occluded by debris during operation and velocity increases through portions of the screen that remain open."[14] Further, "EPA compiled the data from three studies[15] on fish swim speeds ...[which] suggest that a 0.5 ft/s velocity would protect 96 percent of the tested fish."

III. APPROACHES TO ESTIMATING THE PROJECT'S STAND-ALONE IMPINGEMENT

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[9] *See* 66 Fed. Reg. 65274; *see also* 40 C.F.R. 125.84(b)(2), 125.84(c)(1).

[10] 66 Fed. Reg. 65274 (citing Boreman, J. 1977. Impacts of power plant intake velocities on fish. Power Plant Team, U.S. Fish and Wildlife Service; 33 Christianson, A. G., F. H. Rainwater, M.A. Shirazi, and B.A. Tichenor. 1973. Reviewing environmental impact statements: power plant cooling systems, engineering aspects, U.S. Environmental Protection Agency (EPA), Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon, Technical Series Report EPA–660/2–73–016; King, W. Instructional Memorandum RB–44: Review of NPDES (National Pollutant Discharge Elimination System) permit applications processed by the EPA (Environmental Protection Agency) or by the State with EPA oversight." In: U.S. Fish and Wildlife Service Navigable Waters Handbook.)

[11] Sonnichsen, J.C., Bentley, G.F. Bailey, and R.E. Nakatani. 1973. A review of thermal power plant intake structure designs and related environmental considerations. Hanford Engineering Development Laboratory, Richland, Washington, HEDL–TME 73– 24, UC–12.

[12] 66 Fed. Reg. 65274.

[13] *Id.*

[14] *Id.*

[15] *Id.* (*citing* University of Washington study [Smith, L.S., L.T. Carpenter. Salmonid Fry Swimming Stamina Data for Diversion Screen Criteria. Prepared by Fisheries Research Institute, University of Washington, Seattle, WA for Washington State Department of Fisheries and Washington State Department of Wildlife, 1987], Turnpenny [Turnpenny, A.W. H. The Behavioral Basis of Fish Exclusion from Coastal Power Station Cooling Water Intakes. Central Electricity Generating Board Research Report, RD/L/3301/R88, 1988], and EPRI [EPRI. Technical Evaluation of the Utility of Intake Approach Velocity as an Indicator of Potential Adverse Environmental Impact Under Clean Water Act Section 316(b). Technical Report. 1000731, 2001])

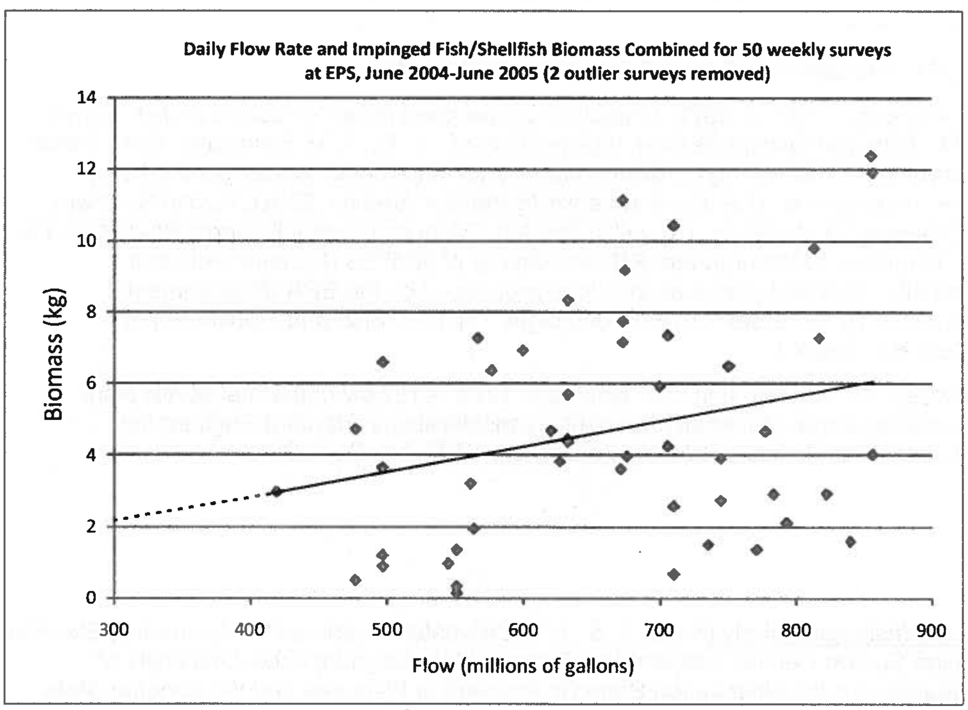
Because the Project will use EPS's intake system, one can estimate the Project's stand-alone impingement from EPS's data by adjusting for the Project's reduced flow and intake velocity. The following analysis begins by identifying three different approaches for estimating the Project's impingement: (1) a regression analysis approach; (2) an equivalence approach; and (3) a flow-proportioned approach. It then evaluates each approach by considering the extent to which it draws upon the well-recognized relationship between flow and velocity and impingement.

Approach #1: Regression Analysis

1. Explanation of the approach. The regression approach employs statistical principles to isolate the impingement associated with the Project's stand-alone intake operations. It draws upon the relationship between flow volume and impingement by plotting each of the 2004/2005 sampling events on a graph (Figure 1) where the X axis represents EPS's flow and the Y axis represents the amount of impingement (in terms of kgs/day). Each point on this graph represents data obtained from one sampling event—i.e., the total weight of fishes impinged and the total flow drawn through EPS's intake structure over a 24-hour period. Figure 1 contains 50 plotted points—one for each of the 52 days of the week minus two outlier samples.

2. Result of the model: 2.13 kgs/day. The regression approach uses the least-squares methods to calculate a line through the data points that conforms to the following equation: y = 7.6195x - 189.45. Based upon the Project's projected flow of 304 MGD, this approach calculates a straight-line extrapolation value of 2.13 kgs/day (i.e., (7.6195x - 189.45) x 304/1000).

Figure 1: Regression Analysis



SUMMARY OUTPUT - ALL BIOMASS; 2 OUTLIER SURVEYS REMOVED

Regression Statistics	
Multiple R	0.282166574
R Square	0.079617976
Adjusted R Square	0.06044335
Standard Error	3.100729066
Observations	50

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	39.92196233	39.92196233	4.15225713	0.047111232
Residual	48	461.4969956	9.614520741		
Total	49	501.4189579			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.189279848	2.528574897	-0.07485633	0.94064013	-5.273320334	4.89476064	-5.273320334	4.894760638
X Variable 1	0.00761929	0.003739146	2.037708795	0.04711123	0.000101234	0.01513735	0.000101234	0.015137346

Flow (MGD)	Predicted Imp (kg)
304	2.126984322

3. Evaluation of the approach. The regression approach is effective to the extent that it accounts for the relationship between flow and impingement. The approach shows that impingement declines as flow decreases, and thereby reflects EPA's understanding that flow is related to impingement

Moreover, the approach is conservative to the extent that it assumes that impingement declines in a linear fashion at progressively reduced flow volumes. This assumption does not fully account for the fact that, when a facility reduces its flows over a given time period, the velocity of said flows declines as well. In so doing, the approach does not fully account for the EPA-recognized principle that when velocities are reduced to 0.5 or less, impingement is minimized to acceptable levels.

A regression approach that would account for the benefit of reduced flow velocities would reflect a significant reduction in impingement below certain flow volumes and would result in a lower estimation of the impingement associated with the Project's stand-alone operations. The facts that the approach does not account for variable flow velocity and that Poseidon has committed to reducing the intake velocity through the bar racks to levels at or below 0.5 fps somewhat increases the conservative nature of the approach.

In this application, the resulting R-square value (0.0796) is rather low and suggests that other factors such as seasonality and biological variability near the intake have introduced noise into the data. Even though the EPS data do establish the existence of a meaningful correlation that is consistent with known principles, it is reasonable to consider approaches that do not rely on statistical correlation to estimate the Project's stand-alone impingement.

B. Approach 2: Assumed Equivalence

1. Explanation of the approach. The second approach assumes that, as a stand-alone desalination facility, the Project's impingement will be equivalent to EPS's impingement. Applying this approach is straightforward: for each discrete sampling event that resulted in the collection of a given number and weight of impinged fishes, the approach assumes that the Project's stand-alone impingement would have been the same. For instance, the data show that on June 24, 2004, EPS withdrew 632 million gallons of seawater, which resulted in the impingement of 287 fish that weighed 0.436 kg in total. The assumed equivalence approach estimates that the Project would impinge the same number and weight of fish (i.e., 287 and 0.436 kg, respectively), even though the Project's projected intake will be much less than 632 MGD.

2. Result of the approach. Same result as EPS for each sampling event.

3. Evaluation of the approach. The assumed equivalence approach is easy to apply, but may be overly conservative in that it does not account at all for the relationships between flow, velocity and impingement. As these relationships are well-recognized in the scientific literature, ignoring them makes the predictive value of the assumed equivalence approach suspect

a. Flow. As discussed above, the EPA recognizes the common sense notion that impingement is directly related to flow. All other things being equal, flow increases result in impingement increases; as flow declines, so too does impingement. The assumed equivalence approach ignores this phenomenon; it assumes that the Project's impingement will always be the same as EPS's was during the sampling period despite the reality that the Project's design flow is substantially different.

Inspection of the graph of the EPS data shows that reduced flows result in lower impingement. Although there are data showing lower impingement at high flow rates, the range of impingement rates for each flow value show that there are generally higher losses at the higher flow rates and lower losses at the lower flow rates.

Two hypothetical scenarios illustrate the model's inherent limitations. In the first scenario, assume the Project withdrew 10 billion gallons of water on June 24, 2004—an amount that is thousands of times larger than the 632 million gallons that EPS withdrew on the same day. The assumed equivalence approach would ignore the extreme flow differential and assume that the Project's operations result in the impingement of only 287 fish. In the second scenario, assume the Project withdrew 1 gallon of water on June 24, 2004—an amount that is 632 million times smaller than the volume of water withdrawn by EPS on the same day. Once again the assumed equivalence approach would ignore the extreme flow differential (not to mention common sense) and assume that the Project's operations would result in the impingement of 287 fish.

b. Velocity. The assumed equivalence approach does not account for variable flow velocity or the fact that Poseidon has committed to reducing the intake velocity through the bar racks to levels at or below 0.5 fps.

By ignoring the accepted relationships between flow and velocity and impingement, the assumed equivalence approach calculates an impingement potential that does not seem reasonable and which relies without any adjustment on data collected when average flows were more than twice as large as the Project's. As such, the assumed equivalence approach is not the best of the available alternatives.

C. Approach 3: Proportional Model

1. Explanation of the approach. The third approach assumes that the Project's stand-alone impingement will be directly related to EPS's impingement based on its proportional flow. The approach estimates the Project's impingement by discounting EPS's impingement by its reduced flow percentage. For instance, on June 24, 2004, the Project's flow volume would have been 48.1% that of EPS (304/632). The proportional approach would discount the impingement resulting from EPS's operations on that day by 48.1%. This calculation estimates that the Project's stand-alone operations would result in the impingement of 138 fish (48.1% x 287) weighing 0.209 kg (48% of 0.436 kg).

2. Result of the approach. 188 fish weighing 3.74 kg/day

3. Evaluation of the approach. The proportional approach is effective to the extent that it accounts for the relationship between flow and impingement. The approach shows that impingement declines as flow decreases and thereby reflects EPA-recognized principle that flow is related to impingement.

Moreover, the approach is conservative and similar to the others to the extent that it does not fully account for the impingement reductions that will arise when the Project reduces flow velocities. As discussed above, Poseidon has committed to reducing the intake velocity through the bar racks to levels at or below 0.5 fps.

On the other hand, the proportional approach is limited somewhat by the fact that it assumes that the relationship between flow and impingement is always directly proportional. We cannot be certain that a 50% reduction in flow will necessarily result in an exactly proportional reduction in impingement. Nevertheless, the proportional approach reasonably approximates the potential for impingement from the Project by accounting for the important relationship between flow and impingement. Its reasonableness is supported by the conservative manner by which it discounts the benefits of reduced flow velocities.

IV. CONCLUSION

The relevant facts, data, and scientific principles and literature indicate that a flow-proportioned approach provides a reasonable estimate of the potential for impingement from the Project. By accounting for the relationship between flow and impingement while conservatively discounting the fact that the intake flow velocities during stand-alone operations will be lower than the velocities which occurred during the sampling period, the proportional approach provides a reasonable basis for estimating that impingement during such operations will be about 3.74 kgs/day of fish biomass. Grounded in calculations that are consistent with generally accepted scientific principles, this method provides the Regional Board a rational basis upon which to complete its Section 13142.5 analysis.