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SUBJECT: COMMENTS ON THE DRAFT STAFF REPORT INCLUDING THE DRAFT SUBSTITUTE ENVIRONMENTAL DOCUMENTATION

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Introduction

Alden was contracted by Poseidon Water to review Section 8.3 (Should the State Water Board identify a preferred method of seawater intake?) of the Draft Staff Report Including the Draft Substitute Environmental Documentation. The overall report describes the State Water Resources Control Board (SWRCB)'s staff rationale and the factors considered in the development and analysis of the Desalination Amendment for the Water Quality Control Plan for Ocean Waters of California (CA Ocean Plan). Alden's review focused primarily on Section 8.3 of the report which provides a summary of the information reviewed on seawater intakes. This Section focuses on the following issues:

- Intake technology considerations for minimizing intake and mortality of marine life
- Surface vs. subsurface seawater intakes

Below are Alden's comments on Section 8.3 of the Draft Staff Report.

Comments

Pg 44, Section 8.3.1 – "*There are instances that occur where surface intakes have to be temporarily shut down because animals (e.g. sea jelly swarms) or other debris clog the intake and prevent source water from entering the facility.*" Though it's true that intakes experience episodic influxes of high debris loads, screens are typically adequate for managing debris. This text may overstate the problem and make intake operators seem passive. In actuality, intake operators continually assess the risk of intake blockages which may result in facility shutdowns and de-rates (each of which has substantial economic impacts and, therefore, incentive for preventing). It is important to understand that there is also a large body of work on the approaches and technologies for forecasting, preparing for, and mitigating anticipated debris events. Some references include:

- Electric Power Research Institute. 2004. Circulating and Service Water Intake Screens and Debris Removal Equipment Maintenance Guide. EPRI, Palo Alto, CA: 2004. 1009672.

- Electric Power Research Institute. 2009. Best Management Practices Manual for Preventing Cooling Water Intake Blockages. EPRI, Palo Alto, CA: 2009. 1020524.
- World Association of Nuclear Operators (WANO). November 2007. Intake Cooling Water Blockage. Significant Operating Experience Report. WANO SOER 2007-2.

Pg 45, Section 8.3.1 – "*The natural filtration process of a subsurface intake eliminates the need for pretreatment requirements. (National Research Council 2008)*" This statement reads too definitively and misrepresents the reference. To be clear, NRC 2008 states, "By taking advantage of the natural filtration provided by sediments, subsurface seawater intakes can reduce (emphasis added) the amount of total organic carbon and total suspended solids, thereby reducing (emphasis added) the pretreatment required for membrane-based desalination systems and lowering the associated operations and maintenance costs."

Pg 45, Section 8.3.1.1.2 – "*Smaller organisms in the water column such as algae, plankton, fish larvae, and eggs, that pass through surface water intake screens are drawn into the facility and will perish when exposed to the high pressure and heat of a cooling water or desalination system.*" A couple of notes regarding this characterization of entrainment:

It is uncommon for algae (micro or macro algae) to be included in the commonly accepted definition of entrainment. The Environmental Protection Agency's (EPA) recently released 316(b) Rule refers to entrainment as "*any life stages of fish and shellfish in the intake water flow entering and passing through a cooling water intake structure and into a cooling water system, including the condenser or heat exchanger.*"

Plankton is a general term which loosely refers to all animal and plant life that floats passively in the water column. As such, plankton includes both zooplankton (early life stages of fish and shellfish) and phytoplankton (plants).

Although it is commonly accepted that entrainment mortality for seawater desalination is 100%, it should be clarified that organisms entrained in water used for dilution purposes (flow augmentation) is not exposed to the same stressors as organisms entrained in the water that undergoes the desalination treatment process. That is, organisms entrained in the dilution flow are not likely to experience 100% mortality.

Pg 46, Section 8.3.1.1.2 – "*Mortality of impinged and entrained organisms is generally assumed to be 100 percent in the absence of site-specific studies. (U.S. EPA 2004; Pankratz 2004)*" Neither the U.S. EPA nor the Pankratz 2004 reference state that impingement mortality is assumed to be 100%. The survival of impinged organisms is commonly accepted and forms the basis of certain compliance alternatives relative to 316(b).

Pg 46, Section 8.3.1.1.2 – "*The entrainment estimate for cooling water intakes provides an example of the scale of entrainment that might occur if desalination efforts expand in California.*" This is hyperbole as the feedwater withdrawn by proposed seawater desalination facilities in CA is substantially less than seawater withdrawn for power plant cooling purposes. According to the 2007 California Energy Commission report "Assessing Power Plant Cooling Water Intake System Entrainment Impacts", the coastal power plants in CA potentially withdraw 17 billion gallons/day. A large seawater desalination facility may draw 100 million gallons/day (if assuming 50% recovery). Since entrainment is proportional to flow, the potential for the scale of entrainment from seawater desalination to reach that of cooling water withdrawals is very unlikely.

Pg 46, Section 8.3.1.2.1 – "*Additional mortality may occur through brine exposure in the mixing process and through predation in conveyance pipes.*" I am not aware of any data on predation in flow conveyance pipes; I would request a reference for this.

Pg 47, Section 8.3.1.2.3 – "*Screened intakes can be placed in areas of high local currents and wave-induced water motion to transport marine debris and organisms off and away from the screens. (Kennedy/Jenks Consultants, 2011)*" Screened intakes are installed everywhere, essentially, with installations onshore, in canals, in bays, in lagoons, etc. This should read "passive screened intakes" as ambient hydrodynamic conditions are key to optimal performance (biological and operational) for these types of screens. The consideration of ambient currents is an issue when considering passive intakes since there is no other means to move debris away from the screen; however, with active screens (e.g., traveling water screens) ambient currents are less of a concern since the screen is designed to collect and remove debris. In addition, Alden co-authored the intake-related portion of the referenced report, specifically the section on the passive screened intake being considered for the $SCWD^2$ project.

Pg 47, Section 8.3.1.2.3 – "*Studies suggest that the type of screen, size of the screen slot opening, and the method of intake are all factors that influence reductions of marine life mortality.*" It's important to note that there are a number of other factors that influence the biological performance of intake screens. These can include intake location, intake velocities (approach and through-screen), ambient currents, predicted debris loads, life stages and species composition present near the intake location, etc.

Pg 47, Section 8.3.1.2.3 – "*Passive intake screens are not self-cleaning and require manual cleaning either by divers or by retrieving the screen for cleaning and maintenance.*" The paragraph beginning with the previous sentence is poorly structured. Essentially all passive screen manufacturers include features to allow cleaning of screens without the regular need for divers to do manual cleaning. Passive wedgewire screens (such as those made by Bilfinger Water Technologies [formerly US Filter/Johnson Screens] and Hendrick Screen Company) are typically equipped with airburst systems to deliver a high pressure burst of compressed air to the screens to clear it of any accumulated debris. Other manufacturers (such as Intake Screens, Inc) offer passive screens with rotating drums and fixed brushes to clean the screens. In cases where the installation location of far offshore, there can be a need for divers and manual cleaning.

Pg 48, Section 8.3.1.2.3 – "*Coarse bar screens, floating booms, and angled coarse screens*" This section is poorly organized. In general, water enters a shoreline intake through a trash rack (also referred to as a bar rack). This first structure in the flow path is typically coarsely-spaced vertical bars designed primarily to exclude debris. The trash rack is equipped with a cleaning mechanism, typically a trash rake, to keep it clean. I'm not aware of any intakes using clear spacing as low as 2 mm as this would constitute a serious risk of becoming overloaded with debris. Though used at some intakes, floating booms are not used commonly enough to warrant discussion in this section "Angled coarse screens" are not the same at trash racks. Angled screens are used, in some cases, to divert organisms to a collection point (within the intake, not "away from the intake" as stated) where they can be returned to the source waterbody.

Pg 48, Section 8.3.1.2.3 – "*Traveling screens have been shown to substantially reduce impingement mortality. (U.S. EPA 2011) Impingement data from Dominion Power's Surry Station was collected during the 1970s.*" It's important to note that only "modified" traveling water screens provide fish-friendly features that can reduce impingement mortality; conventional traveling water screens do not have these features (fish lifting buckets, low pressure spraywash system, fish return trough, etc.) It's unclear why Dominion Station is called out, there is a plethora of data available on impingement survival on modified traveling water screens throughout the U.S.

Pg 48, Section 8.3.1.2.3 – "*Fine-meshed screens*" Very few would agree that fine-mesh includes sizes up to 9.5 mm. Screens with 9.5 mm openings are generally considered to be coarse-mesh and have been the industry standard for traveling water screens at cooling water intakes in the power industry. In the recently released final 316(b) Rule (particularly in the discussion of the Comprehensive Technical Feasibility and Cost Evaluation Study [§ 122.21(r)(10)]), EPA states, "*The study must include an evaluation of technical feasibility of closed-cycle cooling and fine-mesh screens with a mesh size of 2 mm or smaller…*" In this sense, fine-mesh as it relates to 316(b) compliance must be 2 mm or smaller.

Pg 48, Section 8.3.1.2.3 – "*While fine-meshed screens can reduce entrainment of adult and juvenile fish, they still allow phytoplankton, zooplankton, eggs, and fish and invertebrate larvae to pass through.*" The life stages of fish that are precluded from entrainment depends wholly upon the screening mesh size and morphometric dimensions of the species present; it is not accurate to state that these screens only reduce entrainment of adult and juvenile fish. Meshes of 0.5, 1.0, and 2.0 mm can reduce entrainment of many fish larvae and eggs.

Pg 48, Section 8.3.1.2.3 – "*Wedgewire screens are passive screening systems that act as a physical barrier to prevent organisms from being entrained. The screen slot size must be sufficiently small to physically block passage of an organism in order for wedgewire screens to effectively prevent entrainment. (EPRI 1999)*" This statement is true – that exclusion technologies, such as cyclindrical wedgewire screens, function on the basis that organisms need to be physically large enough to excluded by the screen. However, recent (and some historical) research has demonstrated that larval exclusion is not solely a physical phenomenon; rather, there are hydrodynamic and behavioral components that increase the biological performance of cylindrical wedgewire screens. Among the studies that have demonstrated that exclusion of early life stages of fishes is not solely based on physical size of the organisms are the following:

- EPRI. 2003. Laboratory Evaluation of Wedgewire Screens for Protecting Early Life Stages of Fish at Cooling Water Intakes, EPRI, Palo Alto, CA: 2003. 1005339.
- Heuer, J. H. and D. A. Tomljanovich. 1978. A Study on the Protection of Fish Larvae at Water Intakes Using Wedge-Wire Screening. TVA Technical Note B26.
- Weisburg, S. B., W. H. Burton, F. Jacobs, and E. A. Ross. 1987. Reductions in Ichthyoplankton Entrainment with Fine-Mesh, Wedge Wire Screens. North American Journal of Fisheries Management 7: 386–393.

- NAI. 2011a. 2010 IPEC Wedgewire Screen Laboratory Study. Prepared for the Indian Point Energy Center, Buchanan, NY.
- NAI. 2011b. 2011 IPEC Wedgewire Screen Laboratory Study. Prepared for the Indian Point Energy Center, Buchanan, NY.

A detailed description of how hydrodynamics and behavior can affect exclusion of early life stages of fishes with cylindrical wedgewire screens is provided beginning on page 23 of the following reference: Barnthouse, L.W., D.G. Heimbuch, M.T. Mattson, and J.R. Young. 2010. Response to Biological Aspects of NYSDEC 401 Certification Letter. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/iprespbioaspect.pdf

Pg 49, Section 8.3.1.2.3 – "The only pilot study that has implemented wedgewire screens on an intake is at West Basin Municipal Water District's (WBMWD) pilot desalination facility." This is incorrect. In CA alone, there have been multiple pilot-scale studies of cylindrical wedgewire screens; they are listed below:

- Marin Municipal Water District – tested a 2.4-mm (3/32-in) cylindrical wedgewire screen
- Santa Cruz and Soquel Creek – tested a 2.0-mm cylindrical wedgewire screen
- West Basin Municipal Water District – currently testing 1.0- and 2.0-mm cylindrical wedgewire screen

In addition to these CA desalination-related pilot-scale studies, the following describes previous pilot-scale studies that have been conducted with cylindrical wedgewire screens:

Weisberg et al. (1987) conducted a field evaluation of cylindrical wedgewire screens (1, 2, and 3 mm) in the Chalk Point Generating Station intake canal in Maryland. The results demonstrated that exclusion was influenced not only by the size of organisms, but also by hydrodynamics, particularly since not all fish small enough to be entrained were always entrained. The biological efficacy of the screens was reported as a reduction in entrainment over an open port. The authors concluded that the entrainment of larger larvae was regularly reduced by 80% over the open port and by 90% over the ambient densities of larvae in the canal. Browne (1997) conducted a field evaluation of cylindrical wedgewire screens (1, 2, and 3 mm) from a floating facility at the Oyster Creek Generating Station on Barnegat Bay in New Jersey. The researchers concluded that the air backwashing feature functioned well in keeping the screens free of debris and that the screens constructed of metals with higher copper contents had the lowest amount of biofouling. Too few organisms were collected in entrainment samples to draw significant conclusions about the biological performance of the screen, though the authors pointed out that fewer fish were entrained through the 1-mm screen than the 2-mm screen or the open port and that those that were entrained through the 1-mm screen were generally smaller. Impingement was negligible. Lifton (1979) conducted a similar evaluation of 1- and 2-mm cylindrical wedgewire screens on the St. John's River in Florida. The data indicated that there was no significant difference in entrainment between the 1- and 2-mm screens. Sixty-five percent of the time, the screened intakes entrained at least 50% fewer organisms. Gulvas and Zeitoun (1979) evaluated entrainment through pilot-scale cylindrical wedgewire screens (2 and 9.5 mm) in Lake Michigan. The results indicated that entrainment densities were much lower than ambient densities of larvae and that no significant differences were seen in entrainment among either screen or the open pipe (control). In addition, no fish were impinged on the screens. EPRI (2005, 2006) completed a comprehensive pilot-scale field evaluation of the exclusion efficiency of 0.5- and 1.0-mm cylindrical wedgewire screens in three different water bodies (ocean, estuarine, and freshwater). The results indicate that 0.5 and 1.0 mm wedgewire screens can effectively exclude eggs and larvae at through-screen velocities of 0.5 and 1.0 ft/sec.

I am also aware of a pilot-scale entrainment study that evaluated biological effectiveness of a 2.0-mm cylindrical wedgewire screen in the Hudson River as part of the evaluation for United Water's Haverstraw Water Supply Project.

The citation for Tenera 2013b is also not germane to WBMWD's desalination pilot facility. It is related to the proposed design of a cylindrical wedgewire intake for the Diablo Canyon Power Plant.

Pg 49, Section 8.3.1.2.3 – "*Another issue in the marine environment is fouling marine organisms. The fouling organisms may impede the structural integrity of the screens or prevent adequate intake flow. Z-alloy screens were found to be the most effective at preventing corrosion or fouling in a one-year study. (Tenera Environmental 2013b)*' This text may understate the magnitude of the O&M risk posed by narrow-slot cylindrical wedgewire screens. There is a much larger volume of work on the topic of wedgewire screens and fouling control. Two relevant studies that address biofouling on narrow-slot wedgewire screens in a marine environment are described below:

- McGroddy, Peter M., Steven Petrich, and Lory Larson. 1981. Fouling and Clogging Evaluation of Fine-Mesh Screens for Offshore Intakes in the Marine Environment. In: Advanced Intake Technology for Power Plant Cooling Water Systems. Proceedings of the Workshop on Advanced Intake Technology. April 22-24, 1981.

A study was conducted at the Redondo Beach Generating Station to assess fouling and clogging of fine-mesh screens (McGroddy et.al. 1981). This study was done in two parts; the first part looked at debris clogging and the second investigated the propensity of different materials to fouling.

The debris study was conducted in a small, test tank using an 18 in diameter wedgewire screen. Based on the flow characteristics of this screen, Alden estimates that it had 1.0 mm slot openings. Flow for this tank was provided from behind the existing traveling screens. To provide a cross current an air circulation bubbler was used. This bubbler provided a cross current of between 6 and 9 cm/sec (0.2 and 0.3 ft/sec). Debris obtained from the intake waters was added and the head-loss measured. The results of this study indicated that the screens are prone to fouling and that multiple air-bursts are needed to completely clean the screens. The cleaning is also most effective when the screen is less than 50% blocked, which could require the screens to be air-burst daily or more frequently during high debris loading periods. Additionally, they note that re-impingement of debris on the screens occurs at low cross-screen velocities.

The second stage of the McGroddy et al. 1981 study compared the rate of biofouling of several potential screening materials. Small material coupons were placed on the intakes for several weeks. The percent covered and head-loss through the material was measured. The materials tested included carbon steel, epoxy-coated steel, copper, and stainless steel. The mesh size of these materials varied from 0.7 mm to 2 mm. Some of these coupons were also subject to a heat treatment to determine the effectiveness of the heat treatment on controlling bio-fouling.

The results showed that stainless steel was the least prone to bio-fouling of all the materials. However, the stainless steel coupons all had larger mesh openings than the other screen types. In addition, there appears to be inconsistencies between the percent covered and headloss through identical meshes. The results of the heat treatment tests indicate that the heat treatment kills attached organisms, but does not remove their shells and that the screens are quickly re-colonized.

- Wiersema, James M., Dorothy Hogg, and Lowell J Eck. 1979. Biofouling Studies in Galveston Bay-Biological Aspects. In: Passive Intake Screen Workshop. December 4-5, 1979. Chicago, IL

The second relevant study was conducted in Galveston Bay, Texas (Wiersema et al. 1979). This study compared the rates of fouling for several small wedgewire screens. All the test screens were 9.5 inches in diameter with 2.0 mm slot openings. The only difference between the screens were their construction materials; one was stainless steel, two were copper-nickel alloys (CDA 706 and CDA 715), and one was a silicon-bronze-manganese alloy (CDA 655). These screens were mounted to a test apparatus that contained pumps and flow meters to measure the flow through each screen during the test period. The total duration of the test was 145 days.

The results indicate that the copper alloys significantly reduce bio-fouling of the screens. At the conclusion of the test period the copper alloy screens remained at least 50% open. The stainless steel screen fouled very quickly and was completely clogged after 2 weeks. In general, the progression of bio-fouling agents was similar for all the screens. First a slime layer formed over the screens which trapped sediments and provided a base for further colonization. After about 4 weeks hydroids began to colonize the screens. The hydroids were the dominant bio-fouling organism until tube-building amphipods appeared. The amphipods were only able to establish themselves on the portions of the screen with significant hydroid cover. This is assumed to be a result of the hydroids providing a buffer between the screens and the amphipods. Throughout the test period there was a small amount of colonization by bryozoans and loosely attached barnacles.

While this study did not include an air backwash, the researchers postulated that an air-burst could be used to break up the slime layer thus retarding the growth of other bio-fouling agents. To date, there have been no studies to determine if an air backwash would effectively remove the slime layer.

In addition to these two studies, the SCWD^2 pilot-scale cylindrical wedgewire study included investigations of biofouling potential of various screen materials (City of Santa Cruz Water Department & Soquel Creek Water District SCWD^2 Desalination Program: Open Ocean Intake Study Effects. ESLO2010-017.1. http://www.scwd2desal.org/documents/Draft_EIR/Appendices/AppendixG.pdf.) It is important to note, however, that this study was limited to the evaluation of screen material coupons and to periodic visual observations of the pilot-scale screen that was intermittently operated for the biological evaluation. It likely does not accurately reflect the magnitude of boifouling that would be expected with a screen through which flow is being continually withdrawn for a full-scale facility.

Pg 49, Section 8.3.1.2.3 – "*It is imperative that the wedgewire screens are maintained so slot-size integrity is maintained, through-screen velocity does not exceed 0.5 ft/s (0.15 m/s), and the facility still has adequate intake flow.*" As a rule of thumb, it is common to assume a degree of blockage in the design a wedgewire screen array. EPA, in the proposed 316(b) Rule, indicated that the 0.5-ft/sec through screen velocity should be under a 15% blocked condition. Therefore, it is common to target approximately 0.43 ft/sec through screen velocity.

Pg 49, Section 8.3.1.2.3 – "*However, other studies have shown that a small screen slot size does not by itself result in significant clogging or cleaning problems. (Taft 2000)*" The referenced paper was written by Alden's former president and inaccurately characterizes the conclusion. The paper states the following about narrow-slot wedgewire screens: "*However, there are major concerns with clogging potential and biogrowth. Since the only two large CWIS to employ wedge-wire screens to date use 6.4 and 10 mm slot openings, the potential for clogging and fouling that would exist with slot sizes as small as 0.5 mm, as would be required for protection of many entrainable life stages, is unknown. In general, consideration of wedge-wire screens with small slot dimensions for CWIS application should include in situ prototype scale studies to determine potential biological effectiveness and identify the ability to control clogging and fouling in a way that does not impact station operation.*"

Pg 49, Section 8.3.1.2.3 – "*Importance of Screen Slot Size.*" The majority of the references cited in this section are secondary sources. It does not appear that the SWRCB staff reviewed the original work for each of the studies and sites that are included in this section.

Pg 49, Section 8.3.1.2.3 – "*Tampa Bay seawater desalination plant*" It is important to note that the co-located desalination plant draws feedwater (approximately 50 MGD) from Big Bend Station's heated effluent (i.e., after it has already been screend and passed through te power plant cooling system). As such, it is the cooling water intake system of the power plant (flow capacity of 1.4 billion gallons/day) that makes use of the 0.5-mm traveling water screens. The 0.5-mm screens are only used seasonally between March 15 and October 15 and only in the intake for Units 3 and 4 (the intake for Units 1 and 2 is equipped with 9.5-mm dual-flow traveling water screens). Low-pressure and high-pressure screen wash pumps provide wash water to the spray nozzle supply headers. Aquatic organisms and debris are rinsed from the fine-mesh screens, collected in a common trough, and routed to a screened sump. The sump incorporates a trash basket to facilitate removal of debris. Three Hidrostal pumps discharge rinsed organisms and debris into one of two 18-inch fiberglass organism return lines. The organism return system is approximately 0.75 miles long and discharges into a natural embayment south of the station discharge canal.

The fine-mesh traveling water screens at Big Bend were considered to be very successful. They were sufficient, in the view of the EPA and the Florida Department of Environmental Regulation, for reducing entrainment at the CWIS for Units 3 and 4. In addition, studies at full-scale installation indicate that the survival of impinged organisms on the fine-mesh screens were comparable to, and in some cases higher than, those achieved during the prototype study. However, the survival of some fragile species/life stages was lower (e.g., bay anchovy).

As part of the evaluation of the fine-mesh screens, an auditing program was established to monitor the conditions of the screens and optimize their screening efficiency. The biggest O&M problem at this site was biofouling (particularly barnacles and mussels). It was found that biweekly manual cleaning of the screens by a two-person crew was effective in preventing damage to the screen mesh and seals. Later studies at Big Bend focused on optimizing the screening.

Pg 49, Section 8.3.1.2.3 – Reference to *Robert Pagano* is outdated (1976); many newer references with better information are available. In addition, "traveling screens" is a general category that includes, among many other designs, the single-entry, double-exit center-flow design at Barney Davis.

Pg 49, Section 8.3.1.2.3 – "*The Tennessee Valley Authority pilot studies showed reductions in striped bass larvae entrainment of up to 99 percent using 0.5 mm screens.*" The TVA studies were conducted in a laboratory with hatchery-reared striped bass; they were not pilot-scale studies as indicated.

Pg 50, Section 8.3.1.2.3 – "*0.5 mm fine mesh screen at the Brunswick seawater cooling Power Plant in North Carolina showed entrainment reductions of 84 percent. Similar results were shown at the Chalk Point Generating Station in Maryland, which also uses seawater for cooling, and the Kintigh Generating Station in New Jersey. (Tetra Tech Inc. 2002)*" Regarding Brunswick, the screens were 1.0-mm mesh and only 3 of the 4 traveling water screens had this mesh size; the fourth screen had standard 9.5-mm mesh. The design of this intake is also fairly unique and likely confers a substantial benefit in terms of managing debris. The intake is comprised of a stationary diversion structure located at the mouth of the intake canal in the river, a traveling water screen structure at the end of the intake canal, and a fish return system. The diversion structure is a stationary, V-shaped screen comprised of 9.4-mm copper-nickel mesh panels. The V-shape was chosen to aid in the sweeping of debris from the screen face during ebb and flood tides. As such, the traveling water screens at the end of the 2.7-mile long intake canal likely experience lighter debris loads than if the screens were adjacent to the estuary.

Regarding Chalk Point, this intake does not have 0.5-mm traveling water screens. They use a double barrier net at the head of an intake canal. The outside mesh is 1.5 in and the inside mesh is 0.75 inch. The traveling water screens at the terminus of the intake canal use 9.5-mm mesh screening. I assume SWRCB staff is referring to the pilot-scale study done in the Chalk Point intake canal with 1.0, 2.0, and 3.0-mm wedgewire screens (Weisburg, S. B., W. H. Burton, F. Jacobs, and E. A. Ross. 1987. Reductions in Ichthyoplankton Entrainment with Fine-Mesh, Wedge Wire Screens. North American Journal of Fisheries Management 7: 386–393.).

Regarding Kintigh, this facility is located on Lake Ontario not in New Jersey. It too, uses 1.0-mm mesh, not 0.5-mm.

Pg 50, Section 8.3.1.2.3 – "*Bestgen et al. 2001*" The referenced study is a laboratory evaluation of a Coanda-effect screen. I am not aware of any seawater intakes using this type of screen; it is typically applied at hydroelectric projects, stormwater outfalls, agricultural diversions, etc.. It is essentially a high velocity inclined profile-wire screen and has a fundamentally different hydraulic design. The following description is from the peer-reviewed paper describing the lab study: "*High velocity profile-bar fish screens differ from traditional positive barrier configurations. Most barrier screen designs couple low approach velocities(velocity through the screen) with high sweeping velocities (across screen) to effect screening….. In contrast, inclined profile-bar screens have water delivered to the top of the screen via an overflow weir, which then flows over the screen face at a high 2–3-m/s velocity….. Thus, unlike* *traditional screens, fish behavior and swimming performance and approach and sweeping velocities are not design considerations for high-velocity inclined profile-bar screens.*" Including a review of this intake type is immaterial as it is an inappropriate technology for a seawater intake.

Pg 50, Section 8.3.1.2.3 – "*Laterally compressed fish like anchovies and flatfish typically will have higher entrainment rates than fish like sculpins or rockfishes of the same length because the anchovies and flatfish have smaller head capsule dimensions.*" Flatfish are not laterally compressed, they are dorsoventrally compressed.

Pg 50, Section 8.3.1.2.3 – "*Another study performed at the facility demonstrated that almost 100 percent of larvae over 10 mm were excluded from entrainment by a 1 mm wedgewire screen (EPRI 2003)*" The EPRI 2003 study was conducted in a laboratory flume at Alden, not in the Chalk Point intake canal in Maryland where the Weisberg et al. study was done.

Pg 50, Section 8.3.1.2.3 – "*Screens with 1 mm slot size reduced entrainment of larvae with large head capsules, but did not reduce entrainment of eggs smaller than 2.3 mm in diameter. (EPRI 2005).*" This is incorrectly cited. The SWRCB staff should have cited Hanson 1979 which was a lab, not a field, study.

Pg 50-51, Section 8.3.1.2.3 – "*Entrainment and impingement were evaluated for 1 mm and 2 mm wedgewire screens on intakes at the Seminole Generating Station in Florida. The study showed there was virtually no impingement of organisms after screens were installed, and that larvae entrainment was reduced by 99 and 62 percent for the 1 mm and 2 mm screens, respectively, when compared to larger (9.5 mm) screen systems. (EPRI 1999)*" This is incorrectly cited. The paper that should be referenced for this study is: Lifton, W. 1979. Biological Aspects of Screen Testing on the St. Johns River, Palatka, Florida. Prepared for Passive Intake Screen Workshop, Chicago, IL, December, 1979. Furthermore, the results described here differ from those in the paper. Namely, Lifton concluded that "*the 1-mm and 2-mm screens offered reductions of 66 and 62 percent of the unscreened (open pipe) intake entrainments, respectively. ….. there was no statistically significant differences between the 1- and 2-mm screens in terms of densities of fish entrained…… Nine (or 75 percent) of the entrainment collections through the 1- and 2-mm screens represented reductions of at least 50 percent over entrainments through the unscreened intake, and 10 (or 83. 3 percent) of the 12 collections showed reductions of more than 30 percent.*"

Pg 51, Section 8.3.1.2.3 – "*Tenera 2013a*" Relative to this reference, it is important to note that the theoretical reductions in entrainment calculated are based solely on physical dimensions of larvae and do not incorporate any benefits conferred by hydrodynamics and fish behavior (e.g., many later larval stages possess the ability to swim – something not accounted for in these estimates of exclusion). As such, the predictions are conservative and, in the field, a wedgewire screen will likely provide greater protection than that which can be estimated based on physical dimensions.

Pg 52, Section 8.3.1.2.3 – "*The general estimates for slot size……*" This paragraph states the very well accepted concept that entrainment is site- and species-specific. Given that the SWRCB staff recognizes this in the Draft Staff Report, it should follow that a one-size-fits all prescription for a certain screen mesh size for all intakes may not be appropriate.

Pg 52, Section 8.3.1.2.3 – "*Additionally, even though wedgewire screens can reduce impingement mortality and entrainment loss of juvenile and adult fish, intake-related mortality will be site and species-specific.*" It is commonly accepted that impingement is essentially eliminated by a wedgewire screen designed for 0.5 ft/sec. The statement of impingement mortality being reduced is immaterial if it has been determined that impingement is essentially eliminated.

Pg 52, Section 8.3.1.2.3 – "*scwd2 2010* and *Tenera Environmental 2012*" I cannot find the full citation for either of these references.

Pg 52, Section 8.3.1.2.3 – "*The portion of organisms that are not entrained because of the wedgewire screen is relatively small compared to the number of organisms in the water. (Foster et al. 2012) Consequently, there is only an approximate one percent reduction in entrainment mortality between screened and unscreened intakes. (Foster et al. 2013)*" It is important to note that although there are smaller organisms in the water column, designing screening systems to keep them out is impractical – mesh sizes can only get so small before head losses are so high as to render any intake infeasible from a design perspective. Raising the question of which species should be included in "entrainment" may be valid; though, being able to calculate the value of these species will be difficult. This is the first I've heard of other components of the plankton being included with "entrainables". Furthermore, if Foster et al (2013) concludes that a 1% reduction in entrainment is the maximum that can be expected for wedgewire intakes, it requires some explanation about which organisms are being included and which mesh size is being used.

Pg 52, Section 8.3.1.2.3 –"*Other passive and active screens*" Regarding the active intake screens – all of the types mentioned are considered modified traveling water screens, they simply represent different vendor-specific designs.

Pg 53, Section 8.3.1.2.4 – "*Velocity Caps*" The description of how a velocity cap is designed to function is wrong. Intake velocities created at the entrance to the velocity cap need to be high enough for fish to sense and avoid; 0.5 ft/sec is not high enough to elicit an avoidance response. Velocity caps in southern California were originally designed with entrance velocities between 2 and 3.5 ft/sec (Weight, R.H. 1958. Ocean Cooling Water System for 800 MW Power Station. Journal of the Power Division of the American Society of Civil Engineers. Paper 1888.). Often, a velocity cap is designed with a series of coarse bars arranged in a vertical orientation around the opening of the cap. These bars act as a very coarse mesh trash rack in addition to providing stability to the cap itself. In southern California, the new OTC policy requires bars spaced at no greater than 9 inches to prevent entrapment of large organisms (e.g., seals, sea lions, and sea turtles). EPA provided a recent clarification regarding velocity caps in Federal Register/Vol. 77, No. 112, Monday, June 11, 2012/Proposed Rules, page 34320: "*EPA is aware that low intake velocity is sometimes confused with velocity cap technologies, and EPA would like to clarify that these concepts are not the same. Most velocity caps do not operate as a fish diversion technology at low velocities, and in fact are often designed for an intake velocity exceeding one foot per second. Thus a velocity cap will not typically meet the low intake velocity impingement mortality limitation. The velocity cap is located offshore and under the water's surface, and uses the intake velocity to create variations in horizontal flow which are recognizable by fish. The change in flow pattern created by the velocity cap triggers an avoidance response mechanism in fish, thereby avoiding impingement.*"