

Clean Water Act Section 316(b) Proposal for Information Collection for Harbor Generating Station



**City of Los Angeles Department of Water and Power
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- A Summary of Existing Physical and Biological Information and IM&E Characterization
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- B Velocity Calculations
- C Restoration Measures
- D Proposed Method for Evaluation of Environmental Benefits

Acronyms and Abbreviations

| | |
|---------|---|
| AFS | American Fisheries Society |
| BMP | Best Management Practice |
| BTA | Best Technology Available |
| CCRWQCB | Central Coast Regional Water Quality Control Board |
| CDFG | California Department of Fish and Game |
| CDS | Comprehensive Demonstration Study |
| cfs | Cubic Feet per Second |
| CWIS | Cooling Water Intake Structure |
| CWRP | Corporate Wetlands Restoration Project |
| El. | Elevation |
| ft | Feet |
| ft/s | Feet per Second |
| GDNR | Georgia Department of Natural Resources |
| gpm | Gallons per Minute |
| ILAHC | Inner Los Angeles Harbor Complex |
| IM&E | Impingement Mortality and Entrainment |
| LADWP | City of Los Angeles Department of Water and Power |
| LARWQCB | California Regional Water Quality Control Board, Los Angeles Region |
| MBNEP | Morro Bay National Estuary Program |
| mgd | Million Gallons per Day |
| MLLW | Mean Lower Low Water |
| mm | millimeter |
| MW | Megawatt |
| NGO | Non-Governmental Organization |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| PIC | Proposal for Information Collection |
| PSEG | Public Service Electric & Gas |
| psi | Pounds per Square Inch |
| psig | Pounds per Square Inch (gauge) |
| QA/QC | Quality Assurance/Quality Control |
| rpm | revolutions per minute |
| Rule | Clean Water Act Section 316(b) Phase II Final Rule |
| RUM | Random Utility Model |
| SCE | Southern California Edison |
| SONGS | San Onofre Nuclear Generating Station |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |

1.0 EXECUTIVE SUMMARY

This Proposal for Information Collection (PIC) is submitted in compliance with the Clean Water Act Section 316(b) Phase II Final Rule (Rule) for existing electric generating stations published in the *Federal Register* on July 9, 2004. This PIC is specific to the City of Los Angeles Department of Water and Power's (LADWP's) Harbor Generating Station and provides the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) with LADWP's plans for:

- Providing necessary biological information;
- Evaluating alternative fish protection technologies;
- Evaluating the Rule's Compliance Alternatives and options; and
- Providing information on consultations with fish and wildlife agencies.

The Rule requires facilities that withdraw cooling water greater than 50 million gallons per day (mgd) from waters of the United States and that have a capacity utilization that exceeds 15% to meet both the Rule's impingement mortality and entrainment (IM&E) reduction standards of 80-95% and 60-90%, respectively. Harbor Generating Station is subject to both reduction standards.

LADWP's preferred means to comply with the Rule's entrainment performance standard is use of restoration measures. However, due to some uncertainty regarding use of the restoration alternative as a result of Phase II Rule litigation, technologies and/or operational measures as well as site-specific standards will also be evaluated as discussed in Section 4 of this PIC. LADWP plans to initiate IM&E studies to establish the IM&E characterization baseline in January 2006. This PIC also provides an updated schedule consistent with LADWP's proposed schedule submitted on November 4, 2004, to the LARWQCB.

2.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) signed into regulation new requirements for existing electric power generating facilities for compliance with Section 316(b) of the Clean Water Act on July 9, 2004. These regulations became effective on September 7, 2004, and are based on numeric performance standards¹. The Rule at 125.94(a)(1-5) provides facilities with five Compliance Alternatives as follows:

1. *A facility can demonstrate it has or will reduce cooling water flow commensurate with wet closed-cycle cooling to be in compliance with all applicable performance standards. A facility can also demonstrate it has or will reduce the maximum design through-screen velocity to less than 0.5 ft/s in which case it is in compliance with the impingement mortality (IM) performance standard (the entrainment standard still applies).*
2. *A facility can demonstrate that it already has a combination of technologies, operational measures, and restoration measures in place to meet the applicable performance standards.*
3. *A facility can propose to install a combination of new technologies, operational measures, and restoration measures to meet applicable performance standards.*
4. *A facility can propose to install, operate and maintain an approved design and construction technology.*
5. *A facility can request a site-specific determination of best technology available (BTA) by demonstrating that the cost of installing technologies, operational measures, and restoration measures are either significantly greater than the cost for the facility listed in Appendix A of the Rule or significantly greater than the benefits of complying with the applicable performance standards.*

All facilities that use Compliance Alternatives 2, 3 and 4 are required to demonstrate a minimum reduction in impingement mortality of 80% [125.94(b)(1)]. Facilities with a capacity factor that is greater than 15% that are located on oceans, estuaries or the Great Lakes, or on rivers and have a design intake flow that exceeds more than 5% of the mean annual flow, must also reduce entrainment by a minimum of 60% [125.94(b)(2)].

The Rule further requires that facilities using Compliance Alternatives 2, 3, and 5 prepare a Comprehensive Demonstration Study (CDS) as described at 125.95(b) of the Rule based on each of the seven components of the CDS (as appropriate) for the Compliance Alternative(s) selected. Facilities using Compliance Alternative 1 are not required to submit a CDS, and those using Compliance Alternative 4 are only required to submit the Technology Installation and Operation Plan and Verification Monitoring Plan. All facilities that use Compliance

¹ Performance standards are found at *Federal Register*, Vol. 69, 7/9/04, 125.94(b)

Alternatives 2, 3, and 5 are required to prepare and submit a PIC, the first component of the CDS.

The Rule at 125.95(b)(1) requires that the PIC include:

1. *A description of the proposed and/or implemented technologies, operational measures, and restoration measures to be evaluated.*
2. *A list and description of any historical studies characterizing IM&E, and/or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed Study. If you propose to use existing data, you must demonstrate that the data are representative of current conditions and were collected using appropriate quality assurance/quality control procedures.*
3. *A summary of any past or ongoing consultations with relevant Federal, State, and Tribal fish and wildlife agencies and a copy of written comments received as a result of each consultation.*
4. *A sampling plan for any new studies you plan to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of IM&E at your site. The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods you propose must be appropriate for a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area (including the area of influence of the cooling water intake system [CWIS]), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).*

The preamble to the Rule on *Federal Register* Page 41635 states that the PIC should provide other information, where available, to the National Pollutant Discharge Elimination System (NPDES) permitting authority regarding plans for preparing the CDS such as how the facility plans to conduct a Benefits Valuation Study or gather additional data to support development of a Restoration Plan.

An important feature of the Rule is use of the calculation baseline. The calculation baseline is defined in the rule as follows:

“Calculation baseline means an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody; and the baseline

practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, including flow or velocity reductions, implemented in whole or in part for the purposes of reducing impingement mortality and entrainment. You may also choose to use the current level of impingement mortality and entrainment as the calculation baseline. The calculation baseline may be estimated using: historical impingement mortality and entrainment data from your facility or from another facility with comparable design, operational, and environmental conditions; current biological data collected in the waterbody in the vicinity of your cooling water intake structure; or current impingement mortality and entrainment data collected at your facility. You may request that the calculation baseline be modified to be based on a location of the opening of the cooling water intake structure at a depth other than at or near the surface if you can demonstrate to the Director that the other depth would correspond to a higher baseline level of impingement mortality and/or entrainment.”

This definition provides existing facilities with a variety of study options to take credit for facility features that deviate from the calculation baseline and provide the benefit of fish protection. Facilities can also simply develop the baseline by documenting current IM&E.

This PIC provides a description of Harbor Generating Station including deviations from the calculation baseline and applicable performance standards in Section 3. Section 4 describes the Compliance Alternatives and options to be evaluated including a description of alternative fish protection technologies and operational measures. Section 5 provides a brief description of existing biological information and plans for new studies with a detailed summary of biological information and description of new studies is provided in Appendix A. Section 6 summarizes voluntary and ongoing discussions with fish and wildlife agencies related to Clean Water Act Section 316(b), and Section 7 discusses the schedule for completion of studies.

3.0 DESCRIPTION OF HARBOR GENERATING STATION

3.1 LOCATION AND PHYSICAL DESCRIPTION OF COOLING WATER INTAKE STRUCTURE AND COOLING SYSTEM

Harbor Generating Station is located in the Inner Los Angeles Harbor Complex (ILAHC), in Wilmington, California near Long Beach (Figure 1). Harbor Generating Station has seven natural gas-fired units, which do not require circulating water; and one steam turbine, Unit 5, which requires circulating water from the harbor. Units 1 and 2 are combustion turbines with a heat recovery steam generator (combined-cycle with Unit 5). Two circulating water pumps provide a total of 83.5 cubic feet per second (cfs) [75,000 gallons per minute (gpm)] of cooling water for Unit 5 at full load. Units 10 - 14 are gas turbines equipped with cooling towers. The total plant output is 450 megawatts (MW) with Units 1 and 2 rated at 80 MW each, Unit 5 at 75 MW, and Units 10 - 14 each at 43 MW. For the years 2000 through 2004, Unit 5 had a capacity factor of 29%. Table 1 shows the capacity utilization for Unit 5.

FIGURE 1
LOCATION OF THE HARBOR GENERATING STATION



TABLE 1
CAPACITY UTILIZATION FOR UNIT 5

| | Capacity Utilization (%) | | | | | |
|--------|--------------------------|------|------|------|------|----------------|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 5-Year Average |
| Unit 5 | 46 | 29 | 29 | 24 | 16 | 29 |

3.2 DESCRIPTION OF COOLING WATER INTAKE STRUCTURE

Cooling water for Unit 5 is withdrawn from the ILAHC through an intake structure located in the northwest corner of Slip 5 (Figure 2). The area around the CWIS is lined with riprap and serves as the training ground for the local Ocean Engineering College. The mean water depth in front of the intakes is 35 feet (ft) mean lower low water (MLLW) level.

The Unit 5 CWIS is equipped with six vertical bar racks to deflect large debris (Figures 3 and 4). The bar racks are 3/8-inch by 3-inch bars spaced 4.5 inches on center. Cleaning of the bar racks is done on a weekly basis or as needed. The screenhouse is located onshore, and connected to the intake structure by two 8 ft internal diameter pipes, each 1,095 ft long (Figures 5 and 6). The screenhouse has six screenbays; however, there is no flow in four of the screenbays as they are blocked with stop logs. The two other screenbays are equipped with functioning traveling water screens. Two of the blocked screenbays are equipped with spare traveling water screens.

The screenbays are approximately 7.9 ft wide, with the bottom at elevation² (El.) -16.0 ft (Figures 5 and 6). The top of the intake pipes are at El. -8.0 ft when they enter the screenhouse (Figure 6). The traveling water screen is located about 33.5 ft downstream from where the intake pipes enter the screenhouse. The screens are 6.2 ft wide and extend from the bottom of the screenhouse to the top deck. The mesh size on the screen baskets ranges from 5/8-inch to 3/8-inch. The two operating screens are rotated once for 30 minutes during every 8-hour shift. A backwash system providing up to 800 gpm of cleaning water at 70 pounds per square inch (gauge) (psig) is used to remove debris from the screens. Fish and debris removed from the screens are collected in a rectangular sump for disposal.

Circulating water to Unit 5 is provided by two single-stage vertical mixed-flow pumps (Figure 5). The inlet of these pumps is at El. -14.5 ft. Each of the pumps is rated at 83.5 cfs (37,500 gpm) each. Chlorine is added to the pump suctions to prevent biofouling in the condenser system. After passing through the condensers, warmed cooling water flows through a 1,393 ft long pipe to the discharge structure in Los Angeles Harbor's West Basin. The location and setup of the discharge canal prevents discharged water from re-circulating into the intake.

² All elevations refer to mean sea level.

FIGURE 2
GENERAL CONFIGURATION OF HARBOR GENERATING STATION

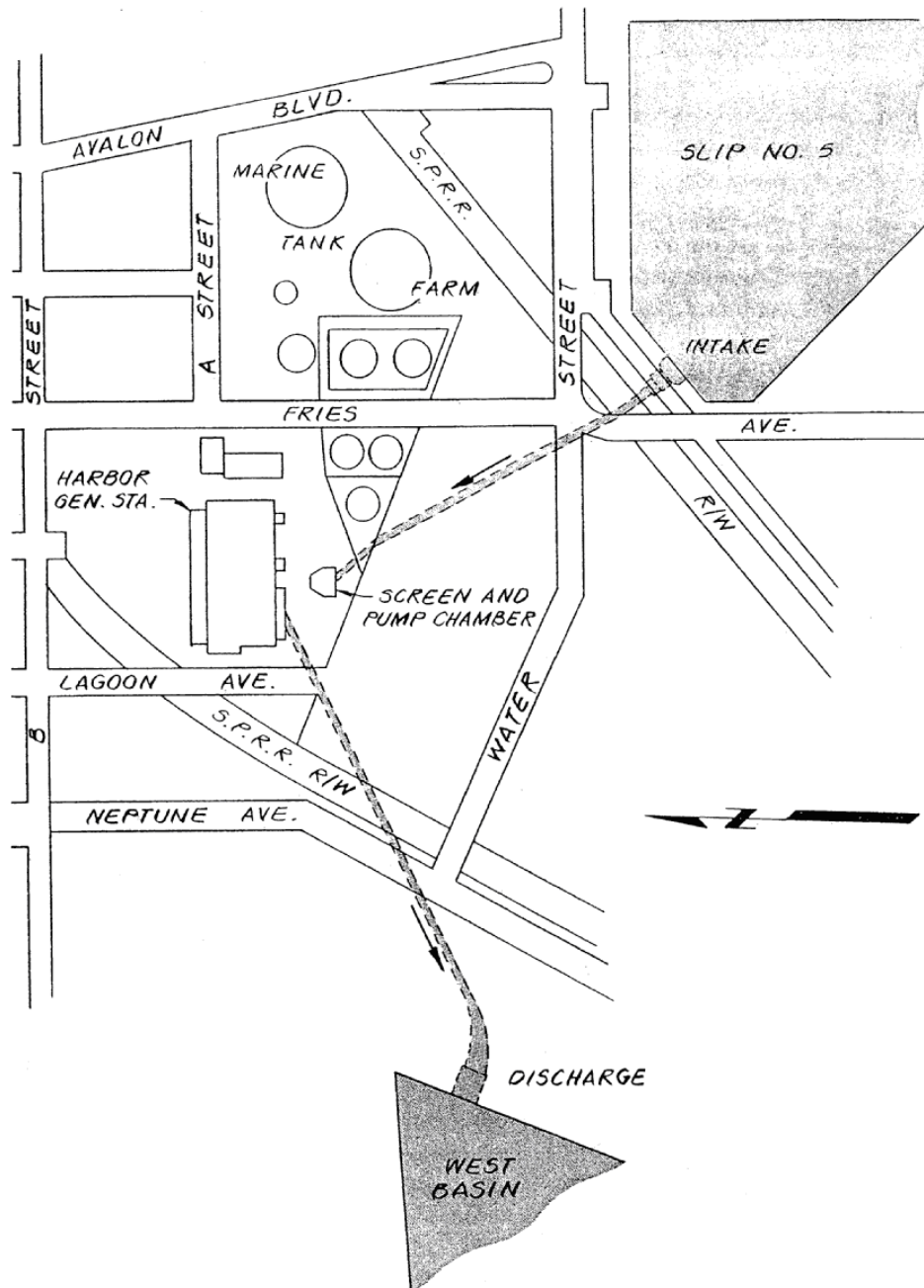


FIGURE 3
DIAGRAM OF INTAKE AT THE ILAHC
FOR HARBOR GENERATING STATION

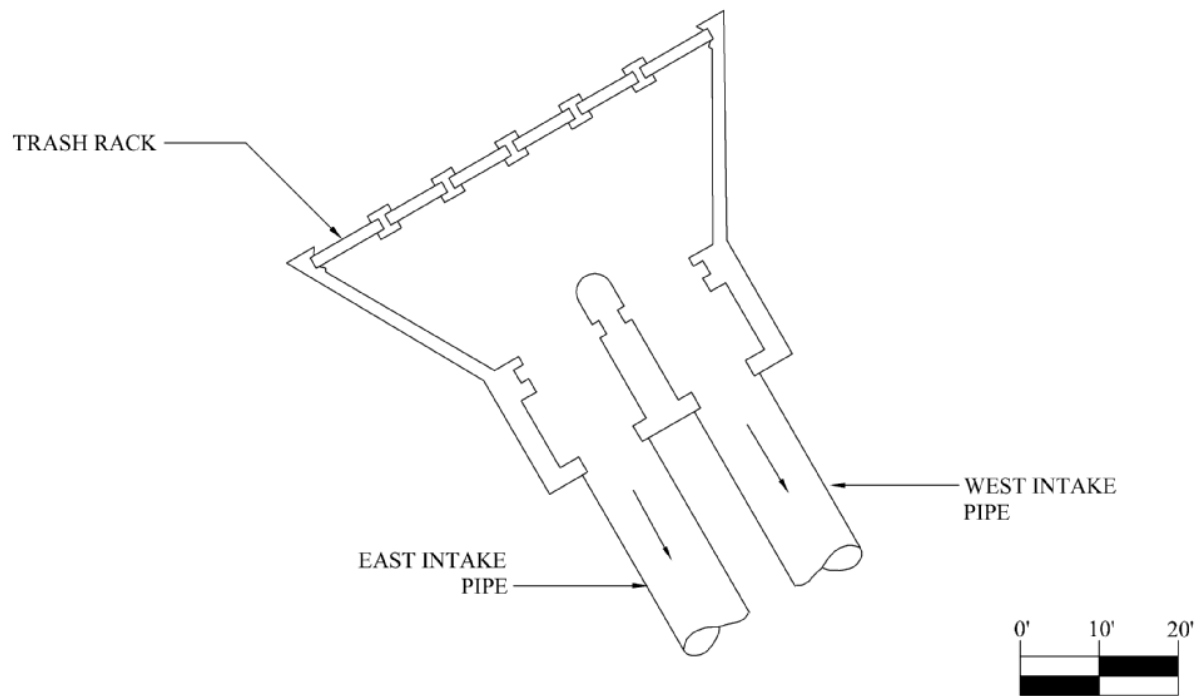


FIGURE 4
SECTIONAL PLAN OF INTAKE AT THE ILAHC
FOR HARBOR GENERATING STATION

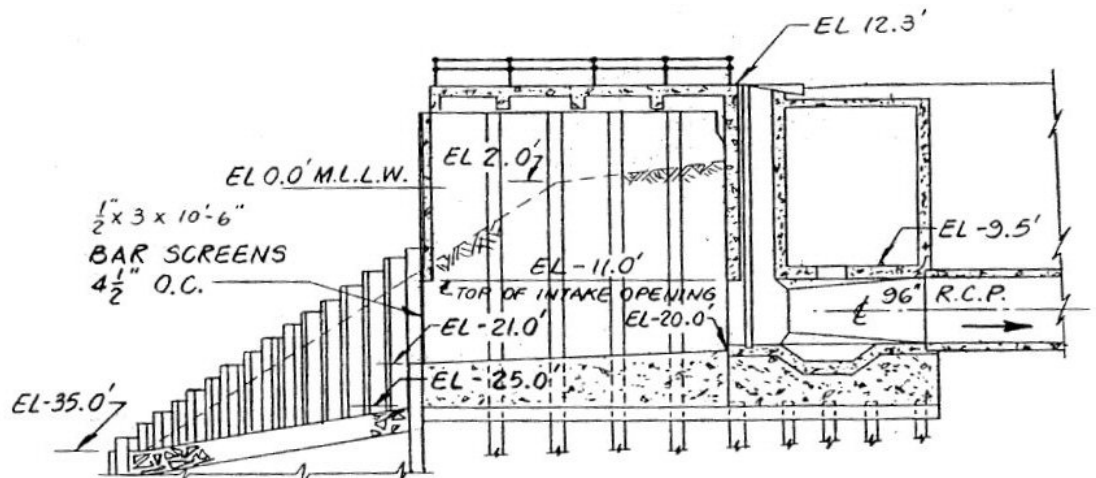
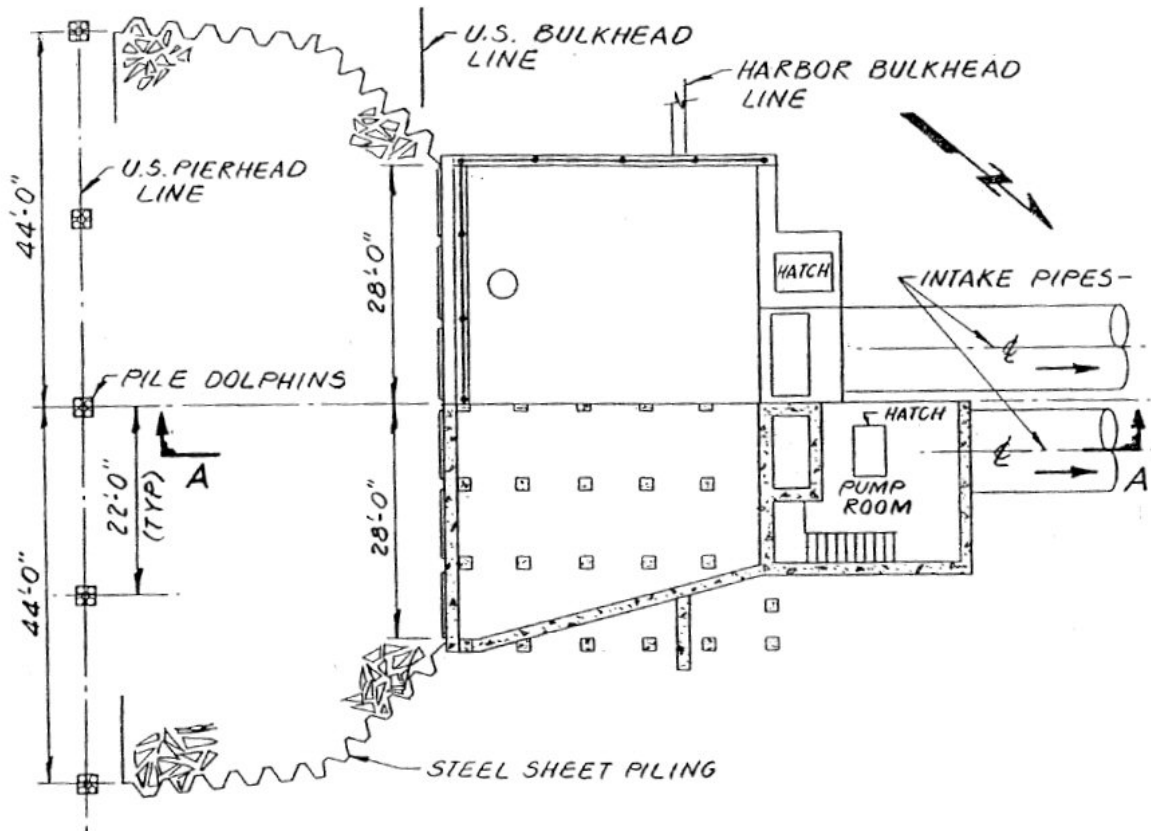


FIGURE 5
HARBOR GENERATING STATION SCREENHOUSE – PLAN VIEW

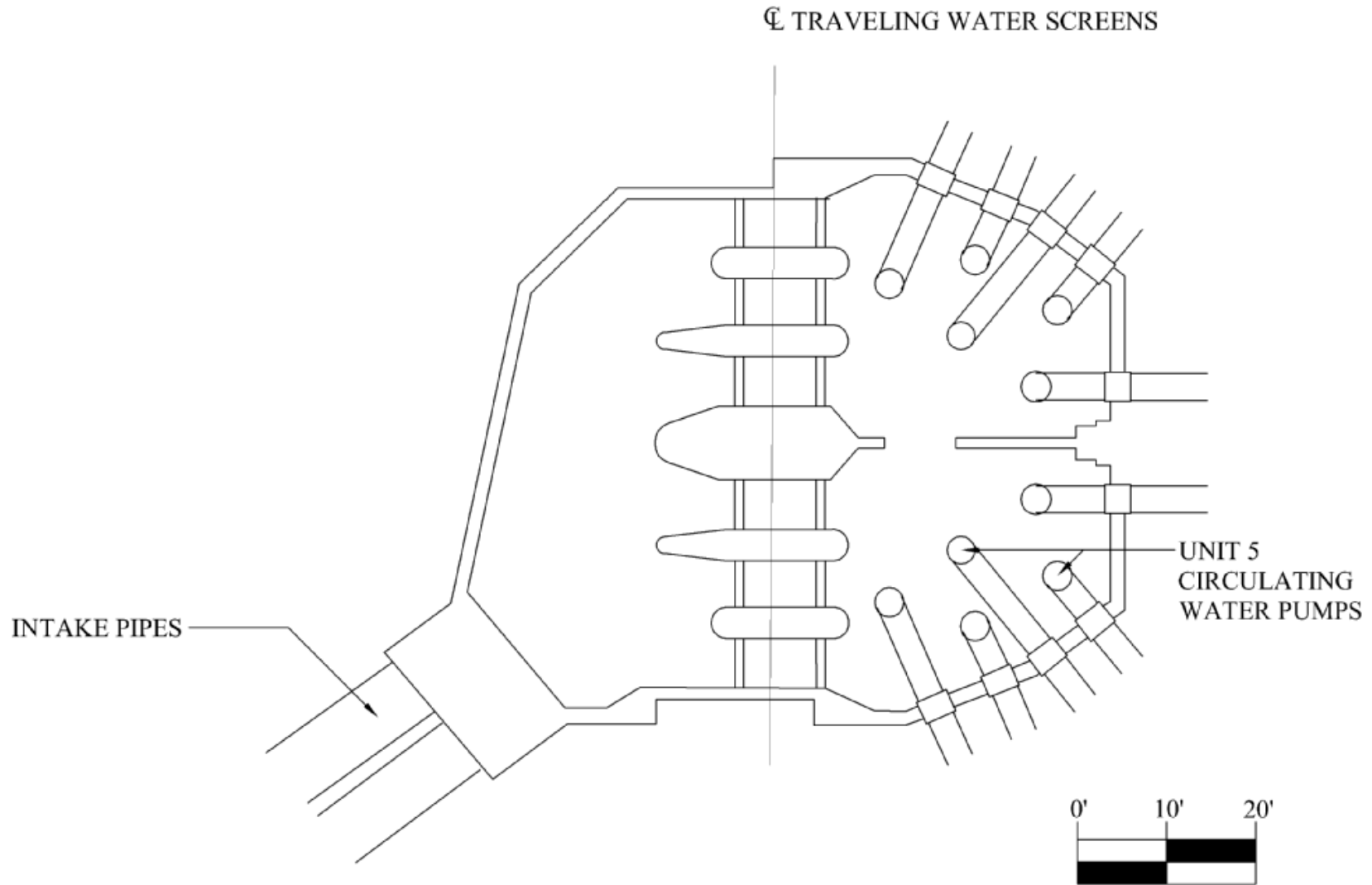
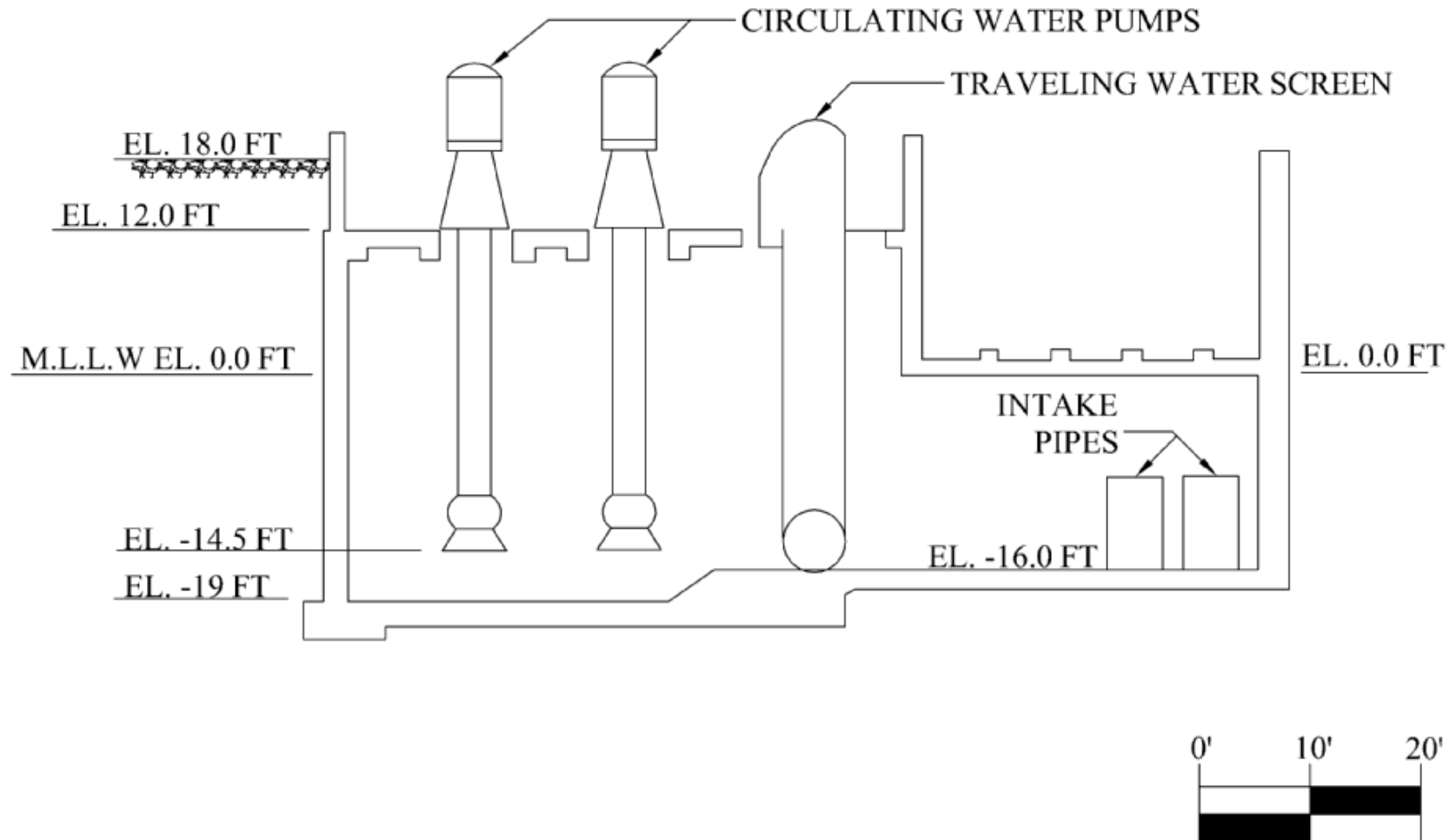


FIGURE 6
HARBOR GENERATING STATION SCREENHOUSE – SECTION VIEW



3.3 EXISTING HYDRAULIC CONDITIONS

The ILAHC is a heavily industrialized area, with the intake and discharge sites entirely surrounded by docks, wharves and container terminals. The bottom of the ILAHC is mainly covered in about 3 ft of silt. Within the ship channels the bottom is regularly dredged to a depth of about 60 ft.

Velocities inside the circulating water system were calculated using the facility design flow of 167 cfs, flow through two screenbays, and the water level at MLLW level (El. 0.0 ft). The water velocity at the trash racks was calculated to be 0.3 feet per second (ft/s), in the intake pipes to be 1.7 ft/s, and at location prior to traveling screens to be 0.4 ft/s. Through-screen velocities were not calculated as the exact open area of the traveling water screens is not known. A conservative estimate of the through-screen velocity would be 0.8 ft/s, or twice the screen approach velocity. Intake structure characteristics, formulas, and velocity calculations for Harbor Generating Station are provided in Appendix B.

3.4 APPLICABLE PERFORMANCE STANDARDS

The Rule requires facilities that withdraw cooling water greater than 50 mgd from waters of the United States and that have a capacity utilization that exceeds 15% to meet both the Rule's IM&E reduction standards of 80-95% and 60-90%, respectively. Since Harbor Generating Station withdraws more than 50 mgd of cooling water and Unit a 5 has 5-year average capacity utilization factor of 29%, it is subject to both the IM&E reduction performance standards.

3.5 CONFORMANCE WITH THE CALCULATION BASELINE

The Harbor Generating Station CWIS does not conform to the Rule's calculation baseline. Significant deviations from the calculation baseline are:

- The intake is submerged rather than at, or near, the surface;
- The traveling screens are located more than 1,000 ft from the shoreline rather than at the shoreline; and
- The closed cycle cooling at Units 10-14 result in flow reduction.

The Rule allows facilities to take credit for deviations from the calculation baseline if it can be demonstrated that these deviations provide the benefit of fish protection to impingeable sized organisms. Opportunities to take a credit are discussed in the next section.

4.0 COMPLIANCE ALTERNATIVES TO BE EVALUATED

LADWP intends to evaluate the full range of Compliance Alternatives and options available in the Rule for potential use in the CDS. However, LADWP also has certain preferences for compliance because some options are considered to be more feasible, cost-effective, and environmentally beneficial than others. This section of the PIC provides a description of specific alternatives and options that will be evaluated for compliance. It also indicates LADWP's preferred Compliance Alternatives and options based on currently available information, as well as, some of the issues currently identified with these alternatives and options.

4.1 TAKING CREDIT FOR EXISTING USE OF FISH PROTECTION TECHNOLOGIES AND OPERATIONAL MEASURES UNDER THE RULE'S CALCULATION BASELINE – COMPLIANCE ALTERNATIVE 2

The Rule specifically entitles facilities to take credit for deviations from the calculation baseline (described in Section 2) that provide the benefit of fish protection. As discussed in Section 3.5, Harbor Generating Station has three facility design and operational deviations from the Rule's calculation baseline that provide the benefit of fish protection. These deviations include a submerged intake and traveling screens that are located more than 1,000 ft from the shoreline. Additionally, the use of closed-cycle cooling for Units 10 - 14 (simple cycle gas turbines) may provide further IM&E reduction credits. In regard to the use of closed-cycle cooling, the Rule states:

Facilities that recirculate a portion of their flow, but do not reduce flow sufficiently to satisfy the compliance option in §125.94(a)(1)(i) (i.e., Compliance Alternative 1) may take into account the reduction in impingement mortality and entrainment associated with the reduction in flow when determining the net reduction associated with existing design and construction technologies and/or operational measures.³

An evaluation of the potential for an IM&E reduction credit for this calculation baseline deviation may be considered.

4.2 USE OF RESTORATION UNDER COMPLIANCE ALTERNATIVE 3

The Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards. The basic philosophy of restoration is mitigation of fish losses at a CWIS by either direct supplementation (stocking) of a "species of concern" potentially impacted by the CWIS, or provision, protection, and restoration of habitat that "produces" fish and thereby, replaces those lost due to IM&E. While the use of

³ *Federal Register* Vol. 69, No. 131, 7/9/04, pg 41688.

restoration is dependent upon the outcome of the Phase II Rule litigation⁴, LADWP views restoration as a preferred method for meeting the entrainment reduction performance standard for a number of reasons. The first reason, as discussed in Section 4.3, is a concern with the feasibility and/or cost of the available technologies and operational measures to meet the entrainment performance standard. The second reason is that LADWP believes the environmental benefits of a restoration project are more directly quantifiable and may be more environmentally beneficial than the use of technologies and/or operational measures. This is due to the fact that a restoration project, such as wetland habitat creation, can provide benefits that go beyond offsetting entrainment losses and can provide those benefits over a longer period than technologies and/or operational measures.

Appendix C provides a summary of the kinds of restoration measures that will be considered. Project examples are listed for the following reasons: (1) their 316(b) application history by other power companies, (2) known interest in the local area based on an internet review of state programs, and (3) because design and implementation information is readily available. The basic categories of considered projects are as follows:

- Habitat Protection or Creation Program
- Fish Stocking
- Waterbody Restoration

Other types of projects may be identified in discussions with appropriate state and federal agencies.

LADWP plans to discuss these ideas and consider other restoration alternatives that may be suggested and will also consider working with other companies with Phase II facilities located in the general proximity of Los Angeles and the Santa Monica Bay to develop joint projects. As part of the requirement for use of restoration, LADWP plans to fully evaluate available technologies and/or operational measures to demonstrate that restoration is more feasible, cost-effective, or environmentally desirable than meeting the performance standards through use of technologies and/or operational measures (see Section 4.3). The analysis of IM&E data described in Appendix A will be used in determining the amount of restoration necessary to provide a minimum benefit equivalent to an 80% impingement mortality reduction and 60% entrainment reduction as required by the Rule.

⁴ The Second Circuit ruled that restoration could not be used for compliance with the Clean Water Act Section 316(b) Phase I Rule. Based on the Phase I litigation decision, USEPA added significant text to the Phase II Rule to support its use in Phase II. LADWP plans to initially limit evaluation of this compliance option in 2005 to discussions with the LARWQCB and appropriate State and Federal fish and wildlife agencies to identify potential projects of interest and methods for scaling and verification monitoring related to projects of interest. It is LADWP's current understanding that the Phase II Rule litigation decision should be rendered sometime in the second quarter of 2006.

4.3 USE OF FISH PROTECTION TECHNOLOGIES AND/OR OPERATIONAL MEASURES UNDER COMPLIANCE ALTERNATIVES 3, 4, AND 5

LADWP plans to evaluate a variety of technologies and operational measures for compliance. Generally, the cost of technologies required for compliance with the entrainment performance standard is significantly more than those required for compliance with the impingement reduction performance standard. Table 2 shows the various technologies and the potential factors preventing implementation. It should also be noted that the entrainment reduction technologies and operational measures proposed for evaluation also provide the benefit of impingement mortality reduction as well. LADWP is using Alden Research Laboratory to assist in evaluating fish protection technologies and operational measures.

**TABLE 2
APPLICABILITY OF OTHER TECHNOLOGIES**

| Concept | Alternatives | Mode of Action | Potential Factors Preventing Implementation | Further Consideration |
|------------------------------|---|--|---|---------------------------------|
| Behavioral Barriers | Sound, infrasound, strobe lights, mercury lights, chemicals, electric screens, air bubble curtain, water jet curtain, visual keys, hybrid barriers | Reduce impingement through behavioral deterrents | Ineffective with the species present in the source waterbody | No |
| Physical Barriers | Fixed-panel screens, traveling water screens, rotary drum screens, barrier net, bar rack barrier, infiltration intakes, porous dike, aquatic filter barrier (Gunderboom), cylindrical wedgewire screens | Reduce impingement by physically excluding fish from entering the intake | Potential interference with navigation, debris, installation spatial requirements (size of installation), water depth | No |
| Collection/ Handling Systems | Modified traveling (Ristroph) screens, fish pumps | Reduce impingement mortality by collecting and/or handling fish and returning them to the source waterbody | Installation spatial requirements, fish and debris transport | Yes. Fine-mesh Ristroph screens |
| Diversion Systems | Louvers and angled bar racks, angled screens (fixed or traveling), angled rotary drum screens, inclined plane screens, Eicher screen, modular inclined screen, submerged traveling water screen | Reduce impingement by diverting fish that enter the intake back to the source waterbody | Spatial requirements, Fish/debris transport | No |

The Rule references three technologies that have the potential to meet the entrainment performance standard and include use of an aquatic filter barrier, passive fine mesh (narrow slot) cylindrical wedgewire screens, and fine mesh Ristroph traveling screens. Currently, the approach flow limits for an aquatic filter barrier installation are 10 gpm/ft². This means that 7,500 ft² of surface area would be required for Harbor Generating Station. Assuming an average depth of 33 ft at low water, the aquatic filter barrier would need to be approximately 225 ft in length. Due to the presence of navigation in Slip 5 including a commercial diving training center located in close proximity to the intake, the use of a barrier of this size would not be feasible. In addition, due to the intake location in the closed end of a channel, there is no sweeping velocity to carry away debris that accumulates on the aquatic filter barrier. The navigation issues and location of the intake at the closed end of Slip 5 would create similar problems for use of cylindrical wedgewire screens. Effectiveness of the screens requires an ambient current velocity that exceeds the through slot velocity of the screens which is normally designed not to exceed 0.5 fps. Since the dominant flow in Slip 5 is due to Harbor Generating Station's cooling water flow, adequate sweeping velocity would not be expected at this location. To obtain adequate velocity would require extending the intake out into the main ILAHC shipping channel which would not be feasible due to the navigational hazards they would present. Therefore use of cylindrical wedgewire screens is also not considered feasible for use at Harbor Generating Station. In the event that use of restoration measures is not available to offset IM&E losses, the following technologies (including fine-mesh Ristroph traveling screens) and operational measures will be evaluated.

4.3.1 Reduce Maximum Through Screen Design Velocity to Less Than 0.5 Feet per Second

Harbor Generating Station's CWIS was originally designed to accommodate once through cooling flow for a number of Units that have since been retired from service. As discussed in Section 1, currently the facility is using only two of the six traveling screens to meet the operational needs of Unit 5. The screen bays of the other four screens have been blocked to reduce the operating and maintenance costs associated with those screens. However, LADWP plans to evaluate opening the other four screen bays in order to increase the surface area and reduce the through screen velocity to below 0.5 fps in order to use Compliance Alternative 1 for impingement. This would eliminate the need to submit CDS documents for meeting the impingement reduction performance standard.

4.3.2 Fine-Mesh Ristroph Traveling Water Screens

LADWP also plans to evaluate replacing the existing 5/8-inch and 3/8-inch traveling water screens utilized for Unit 5 with new 0.5-mm fine-mesh Ristroph screens. This technology is one of the few feasible alternatives with the potential to meet the entrainment performance standard. This fish protection technology is based on first collecting impinged and entrained organisms in a manner to maximize survival and then returning them to the source

waterbody. The technology employs a combination of Ristroph fish buckets attached to the bottom of traveling screen panels (Figure 7) and replacing the 3/8-inch stainless steel mesh with a fine mesh fabric (Figure 8).

A low pressure screenwash spray system [~ 10 pounds per square inch (psi)] is installed to wash impinged fish eggs and larvae gently off the screens into the Ristroph buckets. The Ristroph buckets then discharge the fishes into a fish return system to transport them back to the source waterbody in a location away from the intake to prevent them being drawn back to the CWIS. Fine-mesh screens are typically designed with an approach velocity of less than 0.5 ft/s to help maximize survival of fish eggs and larvae. Currently even with only two traveling screens in operation, Harbor Generating Station meets this criterion.

Ristroph screens differ from standard traveling water screens in that they operate continuously and have additional spray washes. These features prevent debris from building up in front of the screens and reduce debris carryover to the condensers. In addition, the finer mesh provides a smoother surface than conventional woven wire mesh, potentially increasing the effectiveness of the spray washes.

There are several issues that will need to be evaluated relative to this technology. Due to the location of the existing traveling screens, impinged and entrainable organisms collected will have to be transported a considerable distance to a safe release point in the harbor. In addition, fish and shellfish species and their associated life stages tend to vary considerably in terms of their ability to tolerate the collection and handling associated with this option, again emphasizing the need for species and life stage specific testing to verify survival rates. Results of the entrainment study may indicate that a screen mesh size other than 0.5 mm is necessary to meet the entrainment reduction standard. Screen mesh sizes used to prevent entrainment can possibly adversely affect plant operation and reliability. For these reasons it will be important to conduct testing in order to assess the effectiveness of this alternative. However, due to their very high costs, LADWP does not plan to initiate such studies until it is determined that the restoration option is not available.

FIGURE 7
RISTROPH SCREEN BUCKETS ATTACHED TO BOTTOM
OF TRAVELING SCREEN PANELS

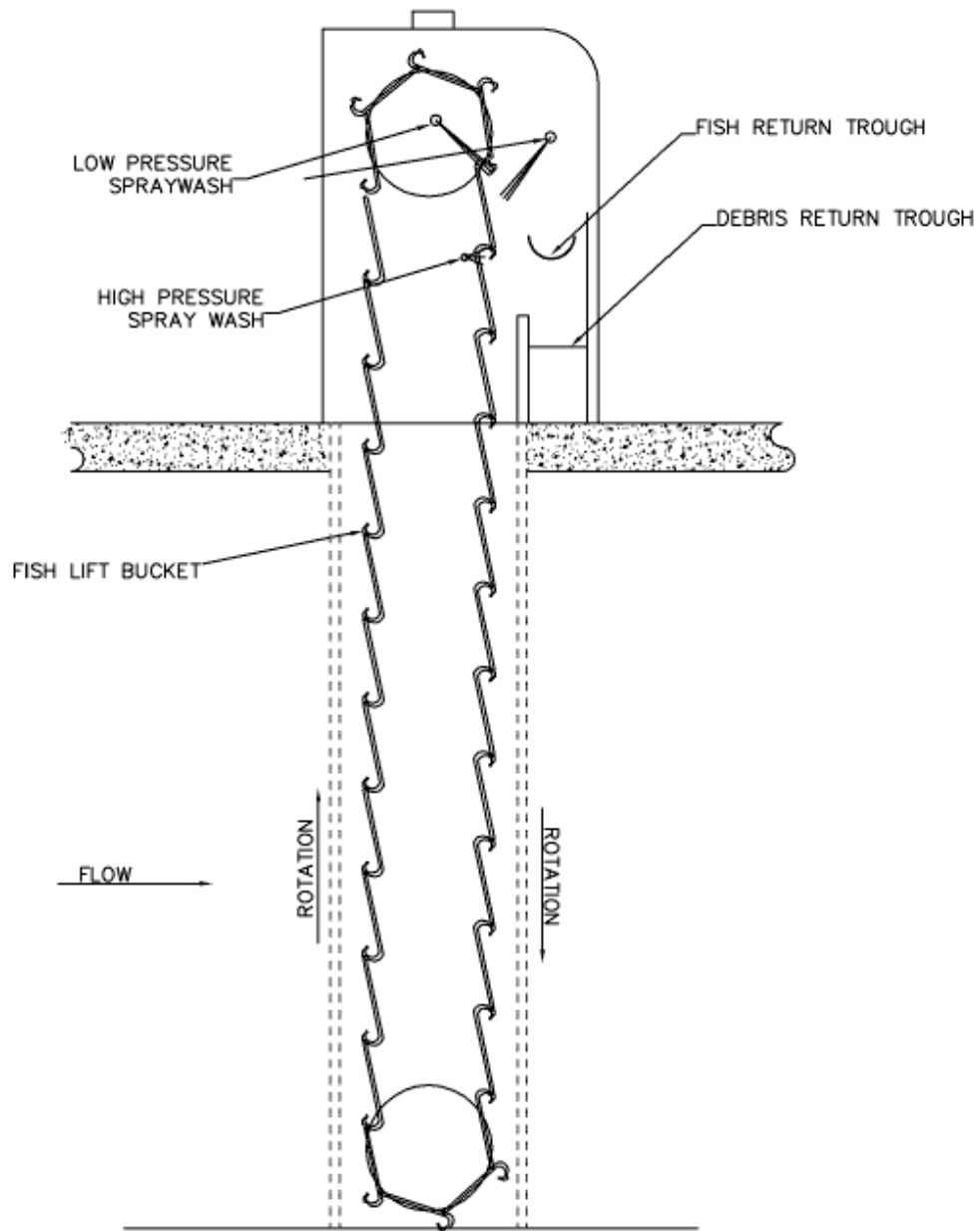
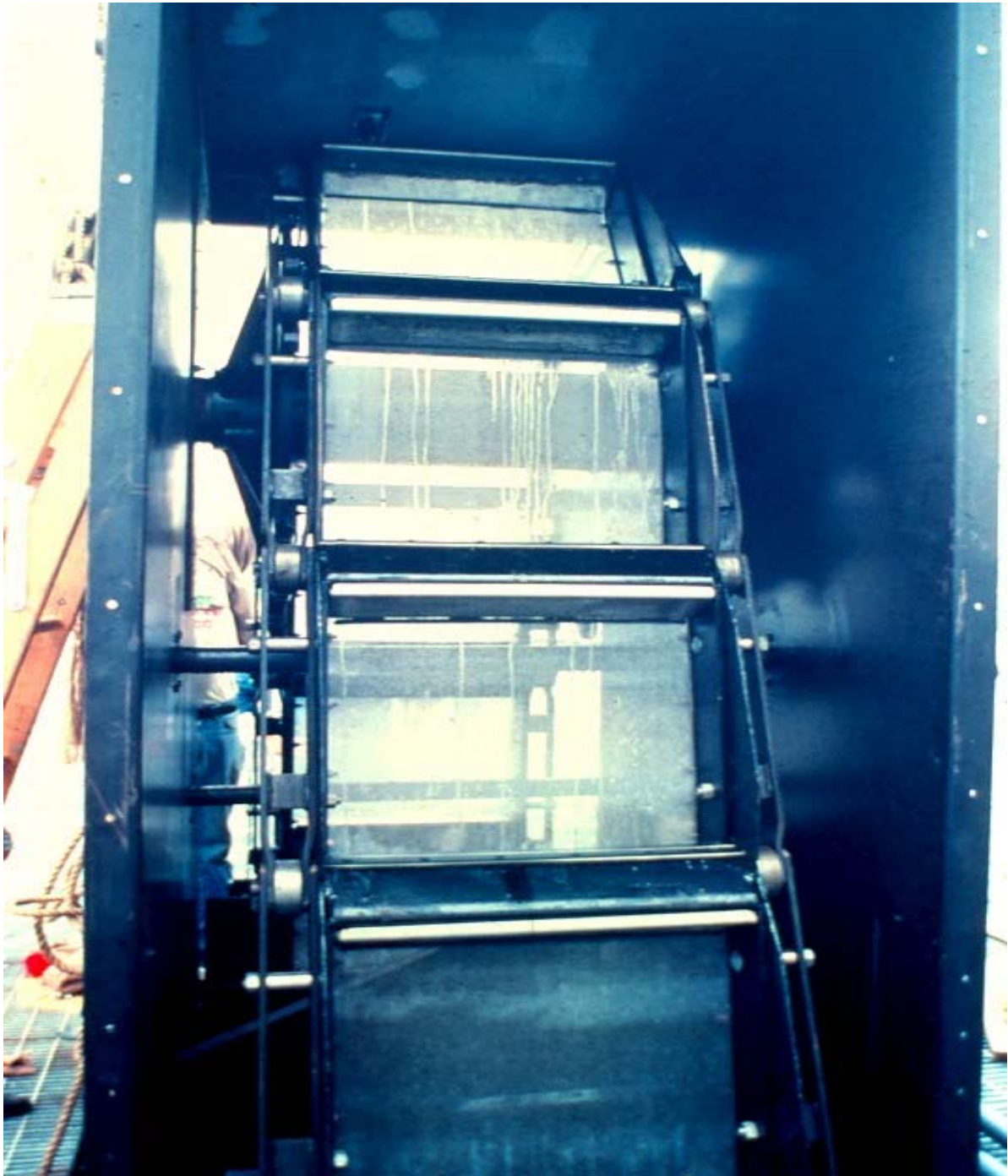


FIGURE 8
EXAMPLE OF FINE MESH SCREEN PANELS USED IN
TEST SETUP AT ALDEN RESEARCH LABORATORY



4.3.3 Use of Pilot Studies

When results of the proposed IM&E sampling are available in early 2007, and if the use of restoration measures is not available, LADWP may decide to comply using one or a combination of technology and/or operational measures. LADWP may propose pilot studies in the 2006/2007 time frame to verify performance. Due to the high cost of pilot studies, they would not be implemented unless use of restoration is not available.

4.3.4 Use of Operational Measures

If use of restoration measures is not available, LADWP will also consider using reduced flow on a diel or seasonal basis. It is important to note that the primary function of Harbor Generating Station is to generate electric power in response to LADWP's generation needs. A reduction in cooling water flow has the potential to affect generation output. However, depending on the results of the proposed entrainment study and the primary periods of diel or seasonal entrainment, LADWP may consider operational measures. Any flow limitation from a permitting standpoint must be limited to a reduction over the term of the permit so as to ensure that, at any specific time, Harbor Generating Station has the flexibility to operate at full load in order to meet LADWP's generation needs.

4.4 USE OF AN APPROVED TECHNOLOGY UNDER COMPLIANCE ALTERNATIVE 4

Currently, use of wedgewire screens in rivers that meet certain criteria is the only USEPA "approved design and construction technology." However, the Rule provides a process that allows additional technologies to become listed as pre-approved technologies. New technologies can be so designated by providing information to demonstrate that if installed in the waterbody type, the technology would have little trouble meeting the performance standard for which they are approved. Now that the Rule is in place, a good deal of interest has been generated in developing new fish protection technologies. LADWP is actively monitoring the development and testing of new technologies for potential use. If other technologies more effective in terms of fish protection efficacy and cost-effectiveness become available, LADWP will contact the LARWQCB to recommend it for public review and comment as required for the addition of new "approved design and construction technologies" (under Compliance Alternative 4), and LADWP will inform the LARWQCB that the new technology may be added to the PIC for evaluation at Harbor Generating Station.

4.5 USE OF SITE-SPECIFIC STANDARDS UNDER COMPLIANCE ALTERNATIVE 5

LADWP plans to evaluate potential use of both the cost-cost and cost-benefit tests under Compliance Alternative 5. Use of this alternative is provided to allow Phase II facilities to not incur costs that would be considered significantly greater than either the costs estimated by USEPA for these facilities or the economic value of the site-specific environmental benefits that will be achieved. Should the evaluation of the current impingement reduction technologies and operational measures determine that the impingement performance standard is not met, or use of restoration for offsetting entrainment losses is not available these tests will be used in conjunction with the evaluation of technologies and operational measures discussed in the previous section of the PIC.

4.5.1 Evaluation of Cost-Cost Test

USEPA, in developing the national cost of implementing the Rule, considered the cost for each Phase II facility to comply. If the actual cost estimated for a facility to meet the performance standard, based on a site-specific analysis, is determined to be significantly greater than the cost estimated by USEPA for the facility to comply, the facility can apply for a site-specific standard under the cost-cost test using Compliance Alternative 5. The site-specific standard would be that achieved by the use of the best performing technology (i.e., achieve the highest level of protection) or operational measure that would pass the cost-cost test. In the Rule, Harbor Generating Station is identified by the USEPA as facility number DUT1138. USEPA, in Appendix A of the Rule, assigned an annualized cost⁵ to Harbor Generating Station of \$62,942/year. However, USEPA's estimate incorrectly assumed that only the impingement mortality reduction standard applied. The Rule's preamble contains an adjustment factor that can be used to adjust the annualized cost in these instances.⁶ Multiplying the \$62,942/year annualized cost from Appendix A of the Rule by the 2.148 adjustment factor yields a corrected annualized cost estimate of \$135,199/year. This is the cost value that LADWP proposes to use in the cost-cost test.

4.5.2 Evaluation of Cost-Benefit Test

The economic value of the environmental benefit of meeting the performance standards will also be evaluated. It will also include evaluation of the costs of meeting the IM&E performance standard after taking any credits as a result of baseline deviations that can be demonstrated to provide the benefit of fish protection. The approach for this analysis is discussed in Appendix D.

⁵ Capital cost amortized over a period of 10 years and discount rate of 7%

⁶ Federal Register Vol. 69, No. 131, 7/9/2004, pg 41647, in 1st paragraph of column 1

5.0 BIOLOGICAL STUDIES

The Rule requires that a summary of historical IM&E and/or physical and biological studies conducted in the vicinity of the CWIS be provided, as well as plans for any new IM&E studies. One year of impingement and entrainment sampling was conducted at Harbor Generating Station from October 1978 through November 1979. The entrainment sampling was conducted biweekly at the intake while impingement samples were collected on approximately a weekly basis. The dominant fish species entrained included gobies (75%), anchovies (14%), and white croaker (8%) with the highest larval concentrations recorded in winter and spring. The dominant juvenile/adult fish species impinged were Pacific pompano (31%), white croaker (29%), queenfish (17%), and shiner perch (11%). Impingement rates varied by species, but peaked between December and February. A detailed summary of the existing IM&E studies and physical information is provided in Appendix A.

Since there are no recent IM&E data that could be used to establish the IM&E baseline characterization, new studies are planned for initiation in 2006. A full year of sampling is proposed at a bi-weekly frequency for entrainment and a weekly frequency for impingement. In addition, a source waterbody study of entrainable life stages is a component of the overall study plan for use in scaling a restoration project to offset the estimated proportional loss of marine life since this is currently the preferred Compliance Alternative. Should the Phase II Rule litigation court decision determine that use of restoration measures not be allowed, the source waterbody study of entrainable life stages may be terminated. Final data analysis decisions will be made as appropriate to support the Compliance Alternative(s) and option(s) selected. A detailed description of the plans for new biological studies and analytical approaches is also provided in Appendix A.

6.0 SUMMARY OF PAST OR ONGOING CONSULTATIONS WITH AGENCIES

The Rule requires that “a summary of any past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to the CDS and a copy of written comments received as a result of such consultations be provided.”

LADWP has had no discussions with state or federal fish and wildlife agencies regarding Clean Water Act Section 316(b) issues relative to Harbor Generating Station.

7.0 SCHEDULE FOR INFORMATION COLLECTION

The Rule allows facilities with NPDES permits that expire within four years of the date of publication of the Rule in the Federal Register (July 9, 2004), up to three years and six months to submit the CDS [125.95(2)(ii)]. LADWP submitted a letter to the LARWQCB on November 4, 2004, requesting approval of a schedule to prepare and submit the PIC, conduct necessary studies, and gather information to prepare and submit the CDS. The letter requested approval to submit the CDS for Harbor Generating Station in January 2008, which is consistent with the final date for submittal in the Rule. This section provides further discussion in support of the rationale for that schedule.

As noted in Section 4, LADWP is planning to initiate new IM&E studies in 2006. Assuming that the LARWQCB provides comments within the 60 day period suggested in the Rule, LADWP will make any necessary changes to modify the PIC within 30 days and provide a revised PIC to the LARWQCB. The first major task will be to complete the IM&E Characterization Study and analyze the data. Completing this analysis is critical in order for LADWP to make a final decision on Compliance Alternatives. It is anticipated this analysis will require approximately 4 months to complete after sampling cessation (second quarter of 2007). Upon PIC approval, LADWP will also initiate work and discussions with appropriate State and Federal Agencies to identify potential restoration projects of interest for use under Compliance Alternatives 3 and/or 5.

It is expected that based on the final litigation schedule that the Court will issue a decision on the on-going Phase II litigation around the end of the second quarter of 2006. This will allow LADWP to reassess available Compliance Alternatives and options based on the Court's decision. If LADWP's preferred use of restoration is not available for IM&E, it is anticipated that a more detailed evaluation of alternative technologies, including pilot studies, may be initiated in the latter part of 2006. Based on completion of analysis of the biological data in 2007, if restoration is available LADWP should be in a position to consider a final compliance decision in mid to late 2007 in terms of project details to be incorporated into the CDS. If restoration is not available, the CDS is anticipated to focus on technologies and/or operational measures under Compliance Alternatives 3 and/or 5.

Preparation of the CDS will depend on the final Compliance Alternative(s) selected as follows:

- **Use of Technologies or Operational Measures** – It is anticipated that it will require approximately six months after results of any pilot studies to review and complete a draft and final CDS based on the technology and compliance assessment information (i.e., Design and Construction Technology Plan and Technology Installation and Operation Plan).
- **Use of Restoration** – If LADWP's preferred approach of using restoration measures is available, work will be initiated to prepare a restoration plan. It is anticipated that

preparation of this plan and providing the information necessary to address the requirements necessary for this plan will also require six months. It is therefore likely that a final CDS based on restoration can be submitted by January 2008.

- **Use of Site-Specific Standards** – Should use of Compliance Alternative 5 be a component of the CDS, it will be necessary to prepare a Comprehensive Cost Evaluation Study and if the Cost-Benefit test is used, a Benefit Valuation Study will be required. In addition, if a technology or operational measure is used as part of Compliance Alternative 5, the technology and compliance assessment information documents will also be required. Thus the full allowable schedule will be necessary. Therefore, the final CDS will be submitted by January 2008.

The Rule recognizes that the CDS studies are an iterative process⁷ and allows facilities to modify the PIC based on new information. LADWP may request LARWQCB approval of an amendment to this PIC, based on new information relative to technologies and operational measures, use of restoration measures, Phase II Rule litigation, or subsequent Agency guidance. Such information may also require modification of the currently proposed schedule.

⁷ See Rule preamble first column pg 41235 of *Federal Register*/Vol. 69, No. 131/Fri 7/9/04.

APPENDIX A

**SUMMARY OF EXISTING PHYSICAL AND BIOLOGICAL INFORMATION
AND IM&E CHARACTERIZATION STUDY SAMPLING PLAN**

APPENDIX B
VELOCITY CALCULATIONS

HARBOR GENERATING STATION VELOCITY CALCULATIONS**DATA:**

Flow (Q): 167 cfs
Water Elevation: El. 0.0 ft
Trash Rack Width: 56 ft
Trash Rack Invert: El. -21.5 ft
Top of Trash Rack: El. -11.0 ft
Intake Pipe Internal Diameter: 8.0 ft
Intake Pipe Area: 50.2 ft²
Number of Intake Pipes: 2
Number of Bays: 2
Screen Width: 6.2 ft
Screenhouse Invert: El. -16.0 ft

FORMULA USED:

$$V(\text{velocity}) = \frac{Q(\text{flow})}{A(\text{area})}$$

CALCULATIONS:

$$V(\text{trashrack}) = \frac{167 \text{ cfs}}{56 * (-11.5 \text{ ft} + 21.5 \text{ ft})} = 0.3 \text{ ft} / \text{sec}$$

$$V(\text{Intakepipes}) = \frac{167 \text{ cfs}}{2 * 50.2 \text{ ft}^2} = 1.7 \text{ ft} / \text{sec}$$

$$V(\text{screens}) = \frac{167 \text{ cfs}}{2 * 6.2 \text{ ft} * (0.0 \text{ ft} + 16.0 \text{ ft})} = 0.8 \text{ ft} / \text{sec}$$

APPENDIX C
RESTORATION MEASURES

Restoration Measures to be Evaluated for 316(b) Compliance at LADWP's Harbor Generating Station

The Phase II Final Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available on a site-specific basis. Specifically, USEPA's Rule states the following requirement relative to the use of the restoration approach:

Facilities that propose to use restoration measures must demonstrate to the permitting authority that they evaluated the use of design and construction technologies and operational measures and determined that the use of restoration measures is appropriate because meeting the applicable performance standards or requirements through the use of other technologies is less feasible, less cost-effective, or [emphasis added] less environmentally desirable than meeting the standards in whole or in part through the use of restoration measures.

Types of Restoration Applicable to §316(b)

The Rule does not specify the types of restoration measures that can be used. This lack of specification provides flexibility in developing/proposing a restoration approach. Restoration measures that have been used at other power stations to meet §316(b) requirements under State regulatory programs include:

- **Wetland restoration** [e.g., Public Service Electric & Gas (PSEG) Delaware Bay wetland restoration program for the Salem Generating Station] (Weinstein et al. 2001).
- **Fish stocking** [e.g., Mirant Mid-Atlantic fish hatchery at the Chalk Point Station] (Bailey et al. 2000); Exelon's (formally Commonwealth Edison) walleye hatchery at Quad Cities Station on upper Mississippi River (LaJeone and Monzingo 2000); and Southern California Edison's (SCE's) white sea bass hatchery.
- **Submerged aquatic vegetation restoration** [e.g., SCE's kelp restoration for the San Onofre Nuclear Generating Station (SONGS)] (Deysher et al. 2002).
- **Provision of fish passage** (e.g., fish ladders or dam removal) at non-hydropower projects (e.g., PSEG fish ladders in Delaware Bay tributaries for the Salem Generating Station).
- **Contribution to, or maintenance of, a restoration fund** for impacts associated with the re-powering of the Moss Landing Station on Elkhorn Slough near Monterey Bay, California — see <http://www.duke-energy.com/businesses/plants/own/us/western/morrobay/reports/>.
- **Water quality improvements** (e.g., riparian area protection or implementation of non-point source best management practices) that minimize sediment/pollutant runoff thereby resulting in fishery habitat improvements, and practices that increase dissolved oxygen content in waterbodies thereby increasing available habitat for fish spawning and survival. While this approach is plausible, there are no known existing examples of such a §316(a) or §316(b) restoration project.

Potential Restoration Measures for LADWP California Facilities

LADWP may wish to consider the following example restoration projects⁸ to attain the IM&E reduction performance standard or as part of a site-specific standard developed by the permit director. These projects are listed because of their known interest to fish and wildlife agencies in California and because design and implementation information is readily available:

- **Fish Stocking.** While forage species (e.g., gobies, anchovies, sardines) are the most common species impacted at California power plants, stocking of these species to compensate for the losses would not be of interest to any of the federal and state fish and wildlife agencies. The objective of a supplementation program would be to identify a “species of concern,” the stocking of which would compensate (“comparable to, or substantially similar to”) for the production foregone as measured by a game fish’s consumption (e.g., X northern anchovy are equivalent in energy or food consumption to Y white sea bass or other recreational or commercial fishes of concern). This is the approach used by Potomac Electric Power Company for estimating annual hatchery production of striped bass to compensate for bay anchovy (a forage species) losses at their Chalk Point Generating Station on the Patuxent River in Maryland.

Fish stocking involves the direct supplementation (stocking) of a fish species of concern to aid restoration efforts for that species. Restoration stocking (as opposed to recreational gamefish stocking) is generally pursued where the species of interest has been completely extirpated or where associated habitat restoration is unlikely to contribute to stock restoration. For example, the Georgia Department of Natural Resources (GDNR), following six years of study, recently initiated a long-term effort to restore lake sturgeon to the Coosa River system in Georgia/Alabama. This species is listed as threatened throughout the U.S. and has disappeared completely from much of its original range, including the Coosa River. Through a collaborative effort between several state and federal agencies, GDNR released 1,100 fingerlings to the Coosa River in December 2002 as the first step towards returning lake sturgeon to a healthy, self-sustained population in the river. See <http://georgiawildlife.dnr.state.ga.us/content/displaycontent.asp?txtDocument=305>).

A similar program may be of interest in California, particularly for the southern steelhead salmon or coastal rockfishes (*Sebastes* spp.), both of which are federal and state listed endangered and threatened species along the California coast. See http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?state=CA).

The California Department of Fish and Game (CDFG) and LARWQCB [and United States Fish and Wildlife Service (USFWS)/National Marine Fisheries Service (NMFS)]

⁸ Projects listed are examples – opportunities for creative restoration projects are unlimited and depend upon corporate interests and negotiations with state and federal resource agencies.

may support LADWP's participation in a program to restore rare, threatened, and endangered fish to native habitat. Mirant Mid-Atlantic Inc. currently raises and stocks Atlantic sturgeon at its Chalk Point Hatchery Facility on the Patuxent River for the State of Maryland, Department of Environmental Protection. American shad restoration to the Susquehanna River basin in Maryland/Pennsylvania has been accomplished in part via stocking of juvenile shad and via provision of fish passage (St. Pierre 2003; Hendricks 1995). Restoration stocking (e.g., for southern steelhead) could also be combined with provision of fish passage (i.e., dam removal or fish ladders). This form of restoration is discussed further below.

Fish stocking program support could be via hatchery operation developed on or off plant property (e.g., SCE funds the operation of a fish hatchery in Carlsbad, California for culturing and stocking white sea bass). Such a hatchery would be operated and maintained under state and federal oversight. Alternatively, LADWP could possibly negotiate a direct annual contribution of funds to a state and federal hatchery supplementation program or a private foundation. For example, the Hubbs/Sea World Research Institute operates the SCE fish hatchery for SONGS mitigation. While hatchery or stock supplementation programs can be controversial due to concerns over protection of natural genetic integrity, California resource agencies, based on their approval and development of SCE's SONGS Mitigation Project, have supported stocking as compensation for fish losses. CDFG and NMFS also have a long-term fish hatchery program to support maintenance and restoration of anadromous salmonids in California coastal rivers (CDFG/NMFS 2001). California resource agencies' experience with hatchery supplementation may mean that they could be receptive to a hatchery program established by LADWP as compensation for impingement and entrainment losses at LADWP power plants in Southern California. For example, when operating at design capacity, the SCE funded hatchery is expected to exceed compensation for the total SONGS fish losses estimated by an expert panel created by the California Coastal Commission. See

http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm).

For approximate cost references, SCE provided \$4.7 million in funding for the white sea bass hatchery, which began operation in late 1996. Similarly, the Potomac Electric Power Company established an aquaculture facility at their Chalk Point Station at a capital cost (1990 dollars) of \$1 million. Annual operating and maintenance has been approximately \$175,000 to \$250,000 depending on the species and number of organisms raised and stocked in Maryland waters.

- **Habitat Protection Program Participation.** The importance of wetlands, in-stream habitat, and riparian areas as aquatic habitat for fish and invertebrates, and as habitat for wildlife is reviewed in EPRI (2003). Wetland restoration or habitat restoration in general, is becoming increasingly popular across the U.S. and there is a growing case history with

use of habitat restoration as a 316(b) mitigation approach (EPRI 2003). In California, over 90% of its historic wetlands and 95% of historic streamside trees, shrubs, and ground vegetation has been lost from urbanization, agricultural conversion, logging, and flood control (USFWS 2001). Habitat restoration, therefore, should be a major interest to federal and state resource agencies and non-governmental organizations (NGOs) in California. The following identifies federal, state, and private restoration programs that provide information which LADWP may consider for establishing their own restoration program or offer opportunities to collaborate on potential restoration projects.

Example programs include:

- **SCE's SONGS Mitigation.** The proximity of SONGS and its ongoing restoration program is a key starting point relative to any restoration project initiated by LADWP for impacts at its Southern California generating stations. The California resource agencies and local NGOs will likely heavily rely on lessons learned during the negotiation and development of the SONGS Program. The SONGS Marine Mitigation Program is a multi-faceted environmental enhancement program intended to mitigate unavoidable impacts to the marine environment resulting from operation of the SONGS Units 2&3 cooling water systems. See http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm)

The program includes:

- ❑ Restoring 150 acres of degraded wetlands at San Dieguito Lagoon to mitigate impacts to marine fish populations caused by estimated mortality to fish eggs and larvae;
- ❑ Improving the in-plant fish protection systems to increase survival of adult fishes which enter the cooling water systems;
- ❑ Constructing an artificial kelp reef to mitigate impacts to the San Onofre Kelp Bed (note this was to offset thermal effects);
- ❑ Co-funding a marine fish hatchery program intended as supplementary mitigation for kelp impacts; and
- ❑ Funding for Coastal Commission staff oversight and monitoring of these mitigation projects.

SCE is managing the overall mitigation program. Through its Conservation Financing Corporation subsidiary, the two largest elements of the mitigation program, the wetlands restoration project at San Dieguito Lagoon and the artificial reef at San Clemente, are being addressed by an equity alliance with CH2MHILL, an environmental management services consulting firm. Conservation Financing Corporation finances and oversees implementation of these two mitigation projects.

SCE is the plant operator and majority owner of SONGS. SONGS is jointly owned by SCE, San Diego Gas and Electric, and the cities of Anaheim and Riverside, which are funding the mitigation work.

SONGS' owners want to keep interested parties informed about this program, which will significantly enhance the region's marine resources. Through meetings, discussions, newsletters, a Web site, and the public hearing process, SCE expects to inform and involve the largest possible number of interested parties in the development and implementation of the mitigation/enhancement plans. Detailed technical progress on implementing and monitoring the SONGS mitigation effort can be found in the Proceedings from the Second Annual Public Workshop for the SONGS Mitigation Project (Reed et al. 2002).

- **Duke Energy's Morro Bay Modernization Project Habitat Enhancement Program.** As part of the station modernization, Duke Energy has volunteered to fund a program that would reduce sedimentation and the other major factors undermining the Bay's productivity. The concerns for Morro Bay and the target of Duke's proposal are the issues identified by the Morro Bay National Estuary Program's (MBNEP) Comprehensive Conservation Management Plan. Those issues include sedimentation, loss of habitat, and nutrient pollution. Duke's proposal is their preferred alternative to California Energy Commission requesting dry cooling operation. The Central Coast Regional Water Quality Control Board (CCRWQCB) staff agrees with Duke's proposal and believes that habitat enhancement would yield greater long-term benefits for the Bay. Duke Energy's proposal would fund habitat enhancement projects authorized by the CCRWQCB and managed through professional groups like the MBNEP, which have plans and programs to reduce sedimentation and other factors undermining the Bay's productivity. The special value of habitat enhancement is that it not only addresses marine biology, but also protects and enhances habitat for birds and other animals and sustains important recreational resources for the community. Documents describing the program in detail can be downloaded from the noted website. Because of recent economic conditions across the U.S., Duke has canceled plans for modernizing the Morro Bay Power Station and, as a result, their habitat enhancement project has not been implemented. See <http://www.duke-energy.com/businesses/plants/own/us/western/morrobay/reports/>).
- **PSEG's Delaware Bay Estuary Enhancement Program.** This is the largest restoration program the U.S. implemented as compensation for impingement and entrainment losses at a power station. Established in 1995, this program was negotiated with New Jersey Department of Environmental Protection as a mitigative action for fish losses at the Salem Nuclear Generating Station in lieu of implementing a closed-cycle cooling system. Principally focused on the restoration of approximately 10,000 acres of former salt hay farms to natural estuarine salt marsh in the lower Delaware Estuary, the program also includes provision of fish passage in combination with some limited fish stocking to

support restoration of anadromous (American shad and river herring) fish stocks. Details of the program can be found in Weinstein et al. (2001). In a following section, the method used by PSEG to scale (i.e., convert fish loss to acres of equivalent wetland habitat) the size of the requisite restoration project is demonstrated. The PSEG incurred costs to date for the ongoing restoration project, including capital, O&M, and monitoring exceed \$100 million or \$9,350/acre (EPRI 2003).

- **Santa Monica Bay Restoration Commission.** In recognition of the need to restore and protect the Santa Monica Bay and its resources, the State of California and the U.S. Environmental Protection Agency established the Santa Monica Bay Restoration Project as a National Estuary Program in December of 1988. The Project was formed to develop a plan that would ensure the long-term health of the 266 square mile Bay and its 400 square mile watershed, located in the second most populous region in the United States. That plan, known as the Santa Monica Bay Restoration Plan, won State and Federal approval in 1995. Since then, the primary mission has been to facilitate and oversee the implementation of the Plan. See. <http://www.santamonica-bay.org/site/aboutus/layout/index.jsp>.

On January 1, 2003 the Santa Monica Bay Restoration Project formally became an independent state organization and is now known as the Santa Monica Bay Restoration Commission. The Santa Monica Bay Restoration Commission continues the mission of the Bay Restoration Project and the collaborative approach of the National Estuary Program but with a greater ability to accelerate the pace and effectiveness of Bay restoration efforts. Restoration activities are based on a comprehensive plan of action for Bay protection and management, known as the Bay Restoration Plan that was approved by Governor Pete Wilson in December of 1994 and by USEPA Administrator Carol Browner in 1995. The Plan identifies almost 250 actions, including 74 priority actions, that address critical problems such as storm water and urban runoff pollution, habitat loss and degradation, and public health risks associated with seafood consumption and swimming near storm drain outlets. The Plan outlines specific programs to address the environmental problems facing the Bay and identifies implementers, timelines, and funding needs.

Implementation of the Plan is the focus of current efforts. Securing and leveraging funding to put solutions into action, building public-private partnerships, promoting cutting-edge research and technology, facilitating a stakeholder-driven consensus process, and raising public awareness in order to restore and preserve the Bay's many beneficial uses are key objectives of the Santa Monica Bay Restoration Commission.

- **National Oceanic and Atmospheric Administration (NOAA) Community-Based Restoration Program.** This program applies a grass-roots approach to restoration by actively engaging communities in on-the-ground restoration of fishery habitats around the nation. The Community-Based Restoration Program emphasizes partnerships and collaborative strategies built around restoring NOAA trust resources

and improving the environmental quality of local communities. The program is: (1) providing seed money and technical expertise to help communities restore degraded fishery habitats, (2) developing partnerships to accomplish sound coastal restoration projects, and (3) leveraging resources through national, regional, and local partnerships. This program is one of the services of the NOAA Restoration Center. This Center's mission is to enhance living marine resources to benefit the nation's fisheries by restoring their habitat. Working with others, the Center achieves its mission by (1) restoring degraded habitats, (2) advancing the science of coastal habitat restoration, (3) transferring restoration technology to the private sector, the public, and other government agencies, and (4) fostering habitat stewardship and a conservation ethic. Recently, under the community-based program, NOAA awarded \$250,000 to the Gulf of Mexico Foundation for habitat restoration in the five states bordering the Gulf of Mexico. USEPA, under their Gulf of Mexico Program, similarly awarded \$90,000 to the Foundation. These awards launch a major new effort to reclaim essential fish habitats of the Gulf of Mexico by implementing field efforts to restore and improve marine and coastal habitats that have been degraded or lost. See <http://www.nmfs.noaa.gov/habitat/restoration/>.

- **USFWS Partnership for Fish & Wildlife.** This program is supported by funds from federal and state agencies, private landowners, and NGOs (e.g., Ducks Unlimited, CDFG, The Nature Conservancy). The program is a voluntary partnership program with a goal to restore wetlands and other vital habitats on private land with 70% of the current funding coming from private sources. The remaining funds, along with restoration design and technical assistance, are provided by USFWS. State resource agencies, such as CDFG, work with the USFWS to help establish priorities and identify focus areas. The restoration of degraded wetlands, native grasslands, streams, riparian areas, and other habitat to conditions as close as possible to natural is emphasized. The Partnership for Fish and Wildlife Program is important for restoration of critical habitats in California (USFWS 2001). LADWP financial support to the program and potential in-kind service could potentially be negotiated as compensation for impingement mortality and entrainment at their power plants in Southern California. See <http://partners.fws.gov/index.htm>).
- **Coastal America's Corporate Wetlands Restoration Partnership (CWRP).** This program is designed to foster collaboration between the federal government, state agencies, and private corporations. Private corporations that participate in this national program will donate funds for either site-specific wetland or other aquatic habitat restoration projects or provide matching funds to a national or regional effort in support of aquatic ecosystem restoration activities. Projects that will receive funds from the CWRP will all be approved Coastal America projects, while federal agencies will assist in their proper execution. The Coastal America Partnership will coordinate among all of its Regional Implementation Teams to identify the appropriate private foundation or state trust fund that will receive funds from the

CWRP. This organization will not likely accept support in response to regulatory requirements. However, the organization is a source of wetland restoration information and unique partnerships may be arranged. See: <http://www.coastalamerica.gov/text/cwrpoperating.html>.

- **Alternative Restoration Measures.** The above measures have been identified as the most likely restoration approaches that would be receptive to the LARWQCB and other federal and state resource agencies. Other potential approaches include nonpoint source pollutant runoff abatement programs and contaminated sediments restoration. While these types of efforts focus on water quality improvements, the long-term benefit is improved fish and shellfish habitat. Such efforts would have to demonstrate a clear linkage between the two as compensation for impingement mortality and entrainment losses at LADWP's Southern California power stations.

The California Coastal Commission is implementing a statewide Nonpoint Source Program. See <http://www.coastal.ca.gov/nps/npsndx.html>. Elements of the program include management measures for reducing runoff pollution from agriculture, silviculture, urban areas, marinas and recreational boating, and via hydromodification (includes modification of stream and river channels, dams and water impoundments, and streambank/shoreline erosion). The California Coastal Commission, therefore, is a source of information for developing potential nonpoint source runoff abatement program or implementing best management practices (BMPs) to meet the goals of the State's plan in the Los Angeles urban and suburban areas. The LARWQCB may welcome direct support by LADWP toward implementing some of the BMPs as compensation for the impingement (and entrainment losses) at LADWP power plants.

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APPENDIX D

**PROPOSED METHOD FOR EVALUATION
OF ENVIRONMENTAL BENEFITS**

Proposal for Information Collection (PIC): Deriving Economic Benefits of Reduced Impingement and Entrainment at Harbor Generating Station

D.1 BACKGROUND

For use of the Cost-Benefit test under the site-specific standards, LADWP is required to have a Benefits Valuation Study prepared. The Clean Water Act Section 316(b) Phase II Final Rule (herein after referred to as the Rule) requires use of a comprehensive methodology to value fully the impacts of IM&E at Harbor Generating Station. Other requirements for use of the test include:

- A description of the methodology(ies) used to value commercial, recreational, and ecological benefits (including non-use benefits, if applicable).
- Documentation of the basis for any assumptions and quantitative estimates. If the valuation includes use of an entrainment survival rate other than zero, a determination of entrainment survival at the facility based on a study approved by the NPDES permitting authority must be submitted.
- An analysis of the effects of significant sources of uncertainty on the results of the study.
- If requested by the NPDES permitting authority, a peer review of the items submitted in the Benefits Valuation Study. The peer reviewers must be chosen in consultation with the Director who may consult with USEPA and Federal, State, and Tribal fish and wildlife management agencies with responsibility for fish and wildlife potentially affected by the cooling water intake structure. Peer reviewers must have appropriate qualifications depending upon the materials to be reviewed.
- A narrative description of any non-monetized benefits that would be realized at the site if the applicable performance standards were to be met and a qualitative assessment of their magnitude and significance.

All benefits, whether expressed qualitatively or quantitatively, should be addressed in the Benefits Valuation Study and considered by the NPDES permitting authority and in determining whether compliance costs significantly exceed benefits.

The benefits assessment begins with an IM&E study that quantifies both the baseline mortality as well as the expected change from the Rule compliance. Based on the information generated by the IM&E studies, the benefits assessment includes a qualitative and/or quantitative description of the benefits that would be produced by compliance with the applicable performance standards at the facility site. To the extent feasible, dollar estimates of all significant benefits categories would be made using well-established and generally accepted valuation methodologies.

In order to have the appropriate information if the benefit/cost option is chosen, we propose a strategy for the collection and analysis of economic information. It should be noted that one

particular benefit category, benefits accruing to individuals even if they have no plans ever to use resources associated with Harbor Generating Station (non-use benefits), are to be estimated only:

In cases where the impingement or entrainment study identifies **substantial harm** to a threatened or endangered species, to the sustainability of populations of important species of fish, shellfish or wildlife, or to the maintenance of community structure and function in a facility's waterbody or watershed. (Final Rule, *Federal Register* page 41648).

“Substantial harm” is a stringent requirement to necessitate estimation of non-use values, and thus, non-use values usually would not be included in the final analysis. However, because the Final Rule does raise the potential for estimation of non-use values, we do provide some contingency for their estimation.

The overall approach proposed for use at Harbor Generating Station is consistent with the approach that USEPA used in developing the assessment of the national benefits of the Rule as discussed in the Rule's preamble⁹. The USEPA quantified the economic benefit of the Rule based on quantification of recreational and commercial fishing benefits. The recreational economic benefit uses a region specific random utility model (RUM) based on fisherman behavior combined with a benefit function transfer approach. USEPA estimated the commercial fishing benefit using a four-step process as follows:

1. Estimate IM&E losses under current conditions using a linear stock to harvest assumption. The percent harvest is based on historical fishing mortality rate data.
2. Estimating the gross revenue of the lost commercial catch. This was based on use of NOAA 1991-2001 landings and dockside price (\$/lb) data.
3. Estimating the lost economic surplus. USEPA assumed a range of 0-40% of the gross revenue losses estimated in Step 2 as a means of estimating the change in producer surplus.
4. Estimating the increase in surplus as a result of the Rule. Based on Steps 2 and 3, USEPA estimates the percent reduction in IM&E at a regional level.

The major changes to the USEPA approach to be used in the Harbor Generating Station analysis will be to use more current or site-specific information wherever possible.

D.2 DESCRIPTION OF METHODOLOGIES TO DETERMINE BENEFITS

The Rule defines a performance standard that the USEPA has established for all existing power plant facilities to meet. Harbor Generating Station may be subject to the impingement mortality performance standard (requiring a reduction in impingement mortality of 80-95%)

⁹ *Federal Register*, Vol 69, No 131, 7/9/04, pg 41657.

and the entrainment reduction performance standard (requiring a reduction in entrainment of 60-90%). However, the Rule states that facilities do not have to meet the IM&E performance standards if it can be shown that the costs of achieving the performance standards are significantly greater than the benefits. Therefore we are providing a plan to collect information in case it is necessary to determine whether the benefits to be provided by the identified technology are significantly less than costs.

Impingement studies were conducted in 1978-1979 and again in 2003-2004. The early studies indicate that Pacific pompano, white croaker, queenfish, and shiner perch had the most individuals impinged. During the 2003-2004 period, the limited sample prevented drawing conclusions about the effect of current operations. At this point in time it is difficult to say which of the species will be selected as representative for the benefit analysis. The species chosen will be based on the planned IM& E studies. When the impingement and entrainment studies are done, we will know which species are directly or indirectly (through forage fish changes) affected. For now, we consider the typical recreational and commercial species that are caught in and around San Pedro Bay. When better information is available, more specification will be possible and be made. It is possible, although highly unlikely, that non-use values will need to be addressed.

The USEPA examined a technology (closed-cycle cooling) to achieve a national standard for IM&E. In determining benefits at a national level, USEPA used certain economic concepts of benefits associated with using the assets that cooling water adversely affects and the methodologies to estimate the benefits (USEPA, 2004a; USEPA 2004b; USEPA 2004c). In order to make the benefits comparable to costs, they presented benefits in a monetary unit (i.e., dollars). Their benefit estimates reflected the willingness of individuals to pay to go from the current environmental status to one associated with an identified technology.

More specifically, the benefits analysis will seek to provide a unit value per fish caught (\$/fish) for recreational and commercial species affected. With this information, total recreational and commercial benefits can be determined by multiplying the unit value times the expected increase in recreational and commercial catch arising from the identified technology. In addition, some information will be provided with respect to non-use values.

D.3 VALUATION OF RECREATIONAL ANGLING ECONOMIC BENEFITS

For recreational angling, there are two potential ways to quantify benefits:

1. Benefit Transfer – the application of benefit estimates provided in other studies to Harbor Generating Station.
2. Primary Research – collection and/or assemblage of data on recreational fishing in the Southern California area and use of the data to derive an estimate of the value per fish for the important species.

While the two approaches initially will be discussed independently (i.e., the benefit transfer approach is discussed in Section D.3.1 and the primary research is discussed in Section D.3.2), there is a sound reason to consider them in concert with one another. That is, the benefit transfer information provides a reality check for any values derived in the primary research. Conversely, any primary research effort should contain a thorough literature review, a component that would have information very similar in nature to the benefit transfer analysis. Also, the benefit transfer approach may provide a fallback position if the primary research is unsuccessful in providing benefit estimates. After both have been discussed independently, a strategy that integrates them will be developed and proposed (see Section D.3.3).

D.3.1 Benefit Transfer Approach

The use of benefit transfers requires finding a previous economic study (or studies) that considers a comparable situation to fishing near Harbor Generating Station and contains dollar values per unit fish caught or a value function for dollar values per unit fish caught. Although there are numerous aspects to the benefit transfer valuation, of particular importance is having species similar to the affected species and a population similar to the local fishing population.

In order to identify an appropriate study or studies, it would be essential to visit the site to examine first-hand the type of recreational fishing that is occurring. At the same time, contact with key people in the area will be made to determine if any relevant studies or data do exist (see references for some articles). We would consider it essential that the following sources be contacted or examined:

1. State or federal hearings on previous Harbor Generating Station permit renewals.
2. State or federal hearings on previous power plant facilities in the general Southern California area.
3. Authors of USEPA “in-house” studies associated with the Final Rule. In particular, USEPA’s RUM analysis of the California region (USEPA. 2004d) should be considered.
4. Personnel from CDFG. Drs. Dale Squires, Cynthia Thompson and Sam Herrick are experts in fisheries economics and management.
5. Researchers at universities or other research facilities:
 - a. University of California, San Diego: Dr. Richard Carson (Department of Economics) is an expert in contingent valuation and non-use valuation.
 - b. University of California, Berkeley: Dr. Michael Hanneman (Department of Agricultural and Resource Economics) is an expert in economic valuation and has studied sportfishing in Southern California.

- c. University of California, Los Angeles: Dr. Trudy Cameron is an expert in econometrics and has studied sportfishing in California.
 - d. Local Consulting firms: Jones and Stokes Inc. (particularly Thomas Wegge) of Sacramento completed numerous sportfishing studies in California.
6. Existing bibliography sources available by internet:
- a. National Marine Fisheries Service, Southeast Fisheries Center
 - b. Sportfishing Values Database
 - c. Environmental Valuation Reference Inventory: Canadian based
 - d. Beneficial Use Values Database
 - e. Regulatory Economic Analysis Inventory, which is maintained by the USEPA
 - f. ENVALUE, an environmental value database maintained in Australia
7. Investigation and Valuation of Fish Kills [American Fisheries Society (AFS), 1992] Excerpt: "Chapter 4 ("Monetary and Economic Valuation of Fish Kills") dates back to the Pollution Committee's Monetary Values of Fish booklets of 1970 and 1975, which dealt with southern U.S. species. In 1978, the AFS North Central Division's Monetary Values of Fish Committee published Reimbursement Values for Fish, addressing species in 12 northern states and 2 Canadian provinces. To integrate these and other regional values, a special AFS Monetary Values of Freshwater Fish Committee collected values from 135 federal, state, provincial, and private agencies and hatcheries. These data were published in 1982 as Part I of AFS Special Publication 13. For the present book, the Socioeconomics Section has repeated the earlier survey to update replacement costs for killed fish and summarized procedures for estimating the broader economic losses resulting from a fish kill."

These potential sources will be used to obtain "off-the-shelf" values that could possibly be relevant to the affected species at Harbor Generating Station. In addition, some of these contacts may be useful as researchers, data sources, and/or witnesses for any hearings that may occur. They may also be useful as peer reviewers or as sources to identify peer reviewers.

D.3.2 Primary Research

There are several other methodologies that could be used to estimate economic values for the species considered, but they will require some level of primary research.

Data and programs could be obtained from the USEPA and examined to see if the results reported in USEPA (2004d) are defensible. If they are not, a new RUM model could be estimated with the data. The major changes introduced in the research would be to consider:

- Correcting (if necessary) problems associated with the original analysis;
- Grouping the representative species individually rather than in a general grouping¹⁰; and
- Specifying that the Harbor Generating Station site rather than aggregate sites be used in the USEPA study (Southern California counties were used as sites).

The analysis would also update the angling activity and possibly generalize the RUM model in ways that current research is including.

One of the major problems in San Pedro Bay and Santa Monica Bay is the potential for harvest of contaminated fish. California's Department of Health Services issues seafood consumption warnings and it will be necessary to consider the effect of sportfish and seafood consumption advisories on the value of recreational fish. This was not done in the USEPA study (2004d).

A number of scientific studies and events brought the PCB and DDT contamination of the marine waters around Los Angeles to the attention of the press and subsequently the public. Some of the first news appeared in the 1970s when, on several occasions, the Food and Drug Administration banned the distribution of several species of commercial fish caught in Los Angeles coastal waters because of DDT found in fish tissues (Stull, Dryden and Gregory, 1987). The 1980s produced studies that brought to the public's attention the potential danger from consuming sport caught fish. A 1983 study by Gossett et al. dealt with the contamination of sport fish, specifically white croaker, and focused on the body burden of PCB/DDT in fish. Based on an intercept survey of sports anglers, Puffer et al. (1982) were able to estimate the quantity of certain species of fish consumed by anglers. The Santa Monica Bay Seafood Consumption Study (see MBC Applied Environmental Sciences 1993) provides evidence that newspapers are an important source of information about sport fish consumption health warnings. In a 1991-1992 field survey, 1248 individuals fishing in the Long Beach-Los Angeles Harbor to Paradise Cove area of Los Angeles County were interviewed about their fishing activities. Those interviewed were asked the following question:

“Are you aware of any health warnings about eating fish from Santa Monica Bay?”

Within the questionnaire, Santa Monica Bay is defined as anywhere from Malibu (or Point Dume) to Cabrillo Beach (near Long Beach). Of the 1228 answering this question, 942 people, or 76.7%, responded yes.

¹⁰ For example, white croaker and queenfish are considered in the category “bottomfish” in previous studies. If there were sufficient anglers targeting them, then a category “queenfish and white croaker” could be designated.

More recently, the California Department of Health Services advised California residents to avoid eating shellfish, crabs, sardines and anchovies caught in Morro Bay because these fish and shellfish may be contaminated with domoic acid, a naturally occurring toxin that can cause illness or death. Warnings regarding mercury in fish have been a common occurrence in the California press.

The literature suggests that unit values are smaller when water quality is so low that states must advise anglers against the consumption of sportfish (Jakus, et al. 1997). Additional research suggests that the effects of the advisories vary across different types of anglers [e.g., anglers interested only in catch and release may actually gain from the advisories] (Jakus et al. 1998). Thus, the USEPA model will likely have to be changed to introduce the potential for seafood consumption warnings on species, site, and mode choices.

D.3.3 Strategy To Obtain Recreational Unit Values Per Fish Caught

The initial portion of the benefit evaluation study would be to complete a benefits transfer analysis and determine whether or not the values obtained were reasonable for the purposes of the decisions to be made. That is, if the mitigation strategy returned recreational benefits that were approximately equal to the costs, it may be unwise and inefficient to move onto primary research because, in all likelihood, the estimate of costs would not be “significantly larger” than the benefits. If, however, the benefit transfer method suggested that the benefits were to be small relative to costs, it may or may not be useful to do one of the primary research plans suggested in the previous section. The quality of existing studies would also be a determinant.

Discussions with key informants in the benefit transfer work would determine the availability and reliability of data from the previous studies of recreational fishing. In addition, some notion of the potential improvement in estimates from using new data and a new model would be obtained.

With this information and a better understanding on the costs of doing the primary research studies, decisions regarding what combination of benefit transfer and primary research would be most advantageous. The primary research would in all likelihood provide better estimates of value, but may be more costly. Given the present information, it is likely that the analysis performed by the USEPA in 2004 could be augmented and improved sufficiently to provide reliable unit values.

D.4 VALUATION OF COMMERCIAL FISHING ECONOMIC BENEFITS

The first determination would be whether commercial fishing is affected by reduced mortality to affected species. The CDFG and the NFMS would be consulted regarding species that the IM&E studies identified. Both producers and consumers could gain from increases in commercial catch, but the assessment would likely only estimate the gains to direct producers (i.e., commercial fishermen). This is based on the expectation that relatively

small changes in commercial landings result from reduced IM&E mortalities. This is the approach that USEPA took in the 2004 study.

The approach that USEPA uses for assessing commercial benefits to producers bases the unit value on the ex-vessel price (sometimes referred to as dockside price) of the species under consideration. One could use the ex-vessel price as the unit value and determine benefits as the price times the additional harvest caused by the IM&E reductions. The logic of doing that rests on the assumption that the additional harvest does not induce increases in effort (inputs used in harvesting) after the reductions of entrained and/or impinged organisms. If this were entirely true, then the ex-vessel price times the increase in quantity harvested would represent producer surplus. However, USEPA appreciates that this would not likely be true and that effort and costs would undoubtedly increase in the long run in response to increased commercial profits (i.e., producer surplus). In the absence of property rights to the harvest, one would expect the producer surplus to be eliminated. Recognizing this and allowing for uncertainty in effort response, the USEPA proposes using a range of 0-40% of the ex-vessel price times the increase in harvest as a measure of the increase in producers' surplus.

Additional economic information on coastal pelagic species (e.g., sardine, anchovy, squid and mackerel) and groundfish may be available through the fisheries management groups. For example, anchovy has been managed for some time (Huppert 1981) and more recently a management plan for the small coastal pelagic species has been developed (Bargmann et al. 1998). These plans may contain information that would permit an analysis that is an improvement to the USEPA approach.

In the unlikely event that the change in landings would be relatively large and cause a change in commercial fisheries prices, we would need to collect information on commercial harvests and prices. There is not a good way to use benefit transfer methods for the consumers' surplus although USEPA is exploring one proposed by Bishop and Holt (2003). Presently, this approach does not look promising and it does not appear that the change in commercial landings will be sufficiently large to cause prices changes.

However, if additional information suggests price changes, existing data from CDFG and the NMFS could be sufficient to estimate an inverse, general equilibrium demand curve (see Just, et al. 2004 for a description) for the species in question. With these estimates, the benefits to consumers could be calculated.

D.5 NON-USE BENEFIT VALUATION

Based on current knowledge, it does not appear necessary to estimate non-use values. That is, the criteria USEPA proposed in the final ruling for their estimation does not appear to be met.

But, in the unlikely event that non-use values will have to be estimated, we would look to using a benefit transfer approach or doing primary research for Harbor Generating Station.

However, we do not believe that the magnitude of the non-use values would justify undertaking a primary research study for non-use values associated with Harbor Generating Station.

Thus, if non-use values were needed, we would, in all likelihood, suggest using a benefit transfer method. There have not been any studies of non-use values associated with power plant activities *per se*. People have had to rely on studies associated with other types of activities. For example, USEPA used a benefit transfer approach in their Proposal for the 316(b) regulations and in the NODA. USEPA (Tudor et al., 2003) reviewed numerous studies of use and non-use values that were associated with surface water improvements (their Appendix A). Of those shown, only three address both changes in fish populations and non-use values associated with them (Huang, et al. 1997; Whitehead and Groothuis 1992; Olsen, et al. 1991).

We propose considering these three studies in addition to doing a review of the recent literature. The recent literature may be important because USEPA has placed some emphasis on this ecological valuation recently. For example, a meeting entitled “Improving the Valuation of Ecological Benefits, a STAR Progress Review Workshop” was held in Washington in October, 2004. The papers presented at that workshop are now available on the internet, and one of them is directly related to California.

The results of this activity would likely be the development of a relationship (specifically a ratio) between use values and non-use values. For years, USEPA used the 50% rule, a practice that implied that non-use values were 50% of use values. Our approach, just like some of their 316(b) efforts (Tudor 2003), would be to refine this ratio for situations more similar to the changes associated with power plant operations.

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