

CHAPTER 2. EFFLUENT QUALITY

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I. INTRODUCTION

The goal of the Terminal Island Treatment Plant (TITP) effluent monitoring program is to characterize the physical and chemical properties of treated wastewater discharged from the plant. The effluent data, in conjunction with the receiving water monitoring data, are used to assess the impact of the effluent discharge on the Los Angeles Harbor.

TITP has been a full secondary treatment facility with biosolids handling capability since 1977. The plant was upgraded to include a filtration system, which became operational in December 1996. Since 1997, essentially all TITP effluent discharged to the Harbor has been filtered secondary-treated wastewater. In 2003, TITP discharged an average of 15.3 MGD of filtered secondary-treated wastewater into the outer Los Angeles Harbor at the TITP Outfall (see Figure 1-1). Biosolids produced during wastewater treatment at TITP are anaerobically digested and dewatered. The resultant biosolids are 100% beneficially reused. The plant has also been upgraded to include an Advanced Wastewater Treatment Facility (AWTF) that began operation in 2001. The AWTF treatment process consists of microfiltration, reverse osmosis (RO), lime stabilization, chlorination and dechlorination. The AWTF is designed to generate advanced tertiary effluent that will be used by the City's Harbor Water Recycling Project (HWRP) for nonpotable applications (e.g. industrial, irrigational and recreational purposes), and for ground water recharge in the Dominguez Gap Barrier Project. The HWRP programs are undertaken by the City to comply with the Regional Water Quality Control Board Resolution to ultimately phase out the discharge of wastewater into the Los Angeles Harbor. During 2003, when the AWTF was in operation, about 5 MGD of the AWTF product water was discharged to the harbor.

The plant has a dry weather design capacity of 30 million gallons per day (MGD) and receives wastewater from San Pedro and neighboring cities (CLA, EMD 1994). Approximately 60% of the wastewater is from the industrial and commercial sector, while the remaining 40% is domestic. Domestic sewage sources include the cities of Wilmington, San Pedro, and Harbor City. Major industrial sources include the seafood processing, petroleum, and metal finishing industries. Other non-domestic sources include docking and storage facilities around the Los Angeles Harbor and the United States Coast Guard facility.

This chapter reports the concentrations of the TITP effluent constituents from January 2003 through December 2003 and summarizes trends in effluent quality from 1993 to 2003. Table 2-1 lists the constituents measured in the effluent under the current TITP NPDES effluent monitoring program. The concentrations of major wastewater constituents in the effluent discharged in 2003 were compared with the current NPDES permit limits. The original discharge limits, along with their interim provision, are based on the California Bays and Estuaries Policy discharge criteria and on TITP performance from 1987 to 1991. The current permit has been in effect since March of 1993. Under an order from the Regional Water Quality Control Board, TITP completed a filtration facility for its effluent in mid-December 1996. Since then, more stringent permit limits have been applied to the filtered wastewater effluent.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Representative TITP effluent samples were collected from the effluent pumping plant wet-well. Raw sewage influent to the plant comes from the Fries Avenue, Terminal Way, San Pedro, and Navy forcemains. Representative raw influent samples were collected after a convergence point of the four forcemains. Bi-hourly samples of raw influent and wet-well effluent were collected using automatic samplers and composited by laboratory personnel based on the flow on the sampling date. Grab samples were collected manually by plant operators or laboratory technicians for analysis (see Table 2-1). These samples were taken during the expected peak flow.

Samples for oil and grease and organic analyses were collected in glass bottles. The grab samples for VOCs were collected with no headspace in amber glass vials with Teflon-coated screw caps. All other samples were collected in plastic bottles. Samples were preserved and stored as detailed in Standard Methods (APHA 1998).

B. LABORATORY ANALYSIS

All samples were analyzed according to Environmental Laboratory Accreditation Program (ELAP) approved procedures. Specific methods used for individual analyte measurements are listed in Table 2-1. When the result of an analysis for a constituent was below the Method Detection Limit (MDL) of the constituent, a value of zero was used in the calculation of the average value of the constituent.

To control discharge of toxic chemicals to the environment, the Federal Clean Water Act mandates a national policy that "the discharge of toxic pollutants in toxic amounts be prohibited". The EPA, as authorized by the Clean Water Act, implements this policy through the use of "whole effluent testing" for toxicity using the sensitive life stage of aquatic organisms exposed to wastewater effluent. Acute toxicity tests were performed using fathead minnows (*Pimephales*).

Chronic toxicity tests were conducted using the most sensitive species, which is determined by annual screening tests of three species: sporophytes of the giant kelp (*Macrocystis*), larvae of the red abalone (*Haliotis*), and larvae of the silverside (*Menidia*). The most sensitive species determined for TITP in 2002 was the red abalone (*Haliotis*). The annual screening in April 2003 resulted in the continued use of the red abalone larvae for the remainder of the year.

Table 2-1. Constituents measured in the 2003 effluent monitoring program.

| Constituent | Units of Analysis | Frequency of Analysis | Sample Type | Method |
|------------------------|-------------------|-----------------------|--------------------|-----------------|
| Total Waste Flow | MGD | continuous | recorder/totalizer | |
| Total chlorine residue | mg/L | continuous | -- | |
| Turbidity | NTU | continuous | -- | |
| pH | pH units | weekly | grab | SM 4600-H+ B |
| Temperature | °F | weekly | grab | |
| Settleable solids | ml/L | weekly | grab | SM 2540F |
| Suspended solids | mg/L | weekly | 24-hr composite | SM 2540D |
| BOD ₅ @20°C | mg/L | weekly | 24-hr composite | SM 5210B |
| Oil & Grease | mg/L | weekly | grab | EPA 1664 |
| Toxicity (acute) | TU _a | monthly | grab | * |
| Toxicity (chronic) | TU _c | monthly | 24-hr composite | * |
| Ammonia-Nitrogen | mg/L | monthly | 24-hr composite | SM 4500-NH3 E |
| Cyanide | µg/L | monthly | grab | EPA 335.2 |
| Arsenic | µg/L | monthly | 24-hour composite | SM 3030G, 3114B |
| Cadmium | µg/L | quarterly | 24-hour composite | SM 3030H, 3120B |
| Chlordane | pg/L | quarterly | 24-hour composite | EPA 608 |
| Chloroform | µg/L | quarterly | 24-hour composite | EPA 624 |
| Chromium (hexavalent) | µg/L | quarterly | 24-hour composite | SM 3500-Cr D |
| Copper | µg/L | quarterly | 24-hour composite | SM 3030H, 3120B |
| Lead | µg/L | quarterly | 24-hour composite | SM 3030H, 3113B |
| Mercury | ng/L | quarterly | 24-hour composite | SM 3030G, 3112B |
| Nickel | µg/L | quarterly | 24-hour composite | SM 3030H, 3120B |
| Selenium | µg/L | quarterly | 24-hour composite | SM 3030G, 3114B |
| Silver | µg/L | quarterly | 24-hour composite | SM 3030H, 3113B |
| Zinc | µg/L | quarterly | 24-hour composite | SM 3030H, 3120B |
| Aldrin | pg/L | quarterly | 24-hour composite | EPA 608 |
| Benzene | µg/L | quarterly | 24-hour composite | EPA 625 |
| DDT's | pg/L | quarterly | 24-hour composite | EPA 608 |
| 1,2-dichlorobenzene | mg/L | quarterly | 24-hour composite | EPA 625 |
| 1,3-dichlorobenzene | µg/L | quarterly | 24-hour composite | EPA 625 |
| 1,4-dichlorobenzene | µg/L | quarterly | 24-hour composite | EPA 625 |
| Dichloromethane | µg/L | quarterly | 24-hour composite | EPA 625 |
| Dieldrin | pg/L | quarterly | 24-hour composite | EPA 608 |
| Endosulfan | ng/L | quarterly | 24-hour composite | EPA 608 |
| Endrin | ng/L | quarterly | 24-hour composite | EPA 608 |
| Fluoranthene | µg/L | quarterly | 24-hour composite | EPA 625 |
| Halomethanes | µg/L | quarterly | 24-hour composite | EPA 625 |
| Heptachlor | ng/L | quarterly | 24-hour composite | EPA 608 |
| Heptachlor epoxide | ng/L | quarterly | 24-hour composite | EPA 608 |
| Hexachlorobenzene | pg/L | quarterly | 24-hour composite | EPA 625 |
| HCH - Alpha | pg/L | quarterly | 24-hour composite | EPA 608 |
| HCH - Beta | ng/L | quarterly | 24-hour composite | EPA 608 |
| HCH - Gamma | ng/L | quarterly | 24-hour composite | EPA 608 |
| PAH's | pg/L | quarterly | 24-hour composite | EPA 625 |
| PCB's | g/L | quarterly | 24-hour composite | EPA 608 |
| Pentachlorophenol | g/L | quarterly | 24-hour composite | EPA 625 |
| TCDD equivalents | ng/L | quarterly | 24-hour composite | EPA 625 |
| Toluene | ng/L | quarterly | 24-hour composite | EPA 625 |
| Toxaphene | ng/L | quarterly | 24-hour composite | EPA 608 |
| Tributyltin | ng/L | quarterly | 24-hour composite | ** |
| 2,4,6-trichlorophenol | ng/L | quarterly | 24-hour composite | EPA 625 |
| Radioactivity | pCi/L | semi-annually | 24-hour composite | EPA 900 |

SM = Standard Methods, 20 Edition, 1998 (APHA, 1998)
EPA = U.S. Environmental Protection Agency test method
* Acute toxicity is measured as described under EPA (1985). Chronic toxicity is measured using EPA methods 600/4-87/028 (Weber et al., 1988) and Marine Bioassay Project, 90-10WQ (Anderson et al., 1990).
** Tributyltin was analyzed by Battelle-Duxbury Operations, MA using a method by Unger et al., 1986 until October 2003 at which point the analysis was conducted by CRG Marine Lab, Torrance, CA using a method by Krone et al. for Organotins by GCMS.

III. RESULTS AND DISCUSSION

The main objectives in the treatment of wastewater are the removal of suspended and floatable materials and the treatment of biodegradable organics (Metcalf and Eddy 1979). The discharge of materials with high total suspended solids (TSS), biochemical oxygen demand (BOD), and oil and grease (O&G) can cause degradation of the receiving environment through eutrophication and introduction of toxic materials (Morel and Schiff 1983).

TITP's current effluent discharge limits for major wastewater constituents, as well as the 2003 effluent average and the number of permit exceedances are listed in Table 2-2. The 2003 averages for all the major wastewater constituents were much lower than the discharge permit limits. For example, the 30-day average concentration and mass emission limits for BOD are 15 mg/L and 3750 lbs/day, respectively, while the 2003 effluent quality averages were only 2.2 mg/L and 282 lbs/day, respectively. Similarly, the 30-day average discharge limits for suspended solids, O&G, ammonia, and settleable solids are 15 mg/L, 10 mg/L, 15 mg/L, and 0.1 ml/L, while the 2003 effluent concentrations of these constituents were 1.1 mg/L, <3.0 mg/L, 0.6 mg/L, and <0.03 ml/L, respectively.

Table 2-2. The NPDES effluent limits and annual averages of major effluent constituents in 2003.

| <u>CONSTITUENT</u> | <u>UNITS</u> | <u>LIMITS</u> | | | <u>2003 ANNUAL AVERAGE</u> | <u># of EXCEED-ANCES</u> |
|--------------------|--------------|-----------------------|----------------------|----------------------|----------------------------|--------------------------|
| | | <u>30-DAY AVERAGE</u> | <u>7-DAY AVERAGE</u> | <u>DAILY MAXIMUM</u> | | |
| BOD-5 | mg/L | 15 | 30 | 40 | 2.2 | 0 |
| | lbs/day | 3750 | 7500 | 10000 | 282 | 0 |
| | mg/L | 15% INF. | --- | --- | --- | 0 |
| | lbs/day | 15% INF. | --- | --- | --- | 0 |
| Suspended Solids | mg/L | 15 | 30 | 40 | 1.1 | 0 |
| | lbs/day | 3750 | 7500 | 10000 | 140 | 0 |
| | mg/L | 15% INF. | --- | --- | --- | 0 |
| | lbs/day | 15% INF. | --- | --- | --- | 0 |
| Oil and Grease | mg/L | 10 | --- | 15 | <3 | 0 |
| | lbs/day | 2500 | --- | 3750 | <400 | 0 |
| Settleable Solids | ml/L | 0.1 | --- | 0.3 | <0.03 | 0 |
| Residual Chlorine | mg/L | --- | --- | 0.1 | <0.05 | 0 |
| Ammonia-N | mg/L | 15 | --- | 45 | 0.6 | 0 |
| | lbs/day | 3750 | --- | 11250 | 77 | 0 |
| pH | pH unit | 6 - 9 | --- | --- | 7.4 | 0 |
| Temperature | °F | --- | --- | 100 | 78 | 0 |
| Turbidity | NTU | --- | --- | 2* 5NTU** | 0.5 | 0 |

* Daily average
 **Turbidity shall not exceed 5 NTU for more than 5% of the time (72 minutes) during any 24-hour period.

Tables 2-3 through 2-5 list the effluent discharge limits, the 2003 annual effluent averages, and the maximum 30-day averages detected in any month for non-carcinogens, carcinogens and marine aquatic life toxicants. Pollutants under these groups include heavy metals, pesticides, and some common solvents used in industries. Among the organic constituents tested, only chloroform, dichloromethane, gamma-hexachlorocyclohexane, and halomethanes were detected. The inorganic constituents detected were arsenic, cadmium, cyanide, copper, lead, mercury, nickel, silver, selenium and zinc. There were no permit exceedances for these constituents.

Table 2-3. NPDES permit limits and 2003 annual averages for non-carcinogens and carcinogens in TITP effluent.

| CONSTITUENT | UNITS | <u>LIMITS</u> | ANNUAL AVERAGE | <u>2003 EFFLUENT</u> |
|--|---------|-----------------------|-------------------|----------------------|
| | | 30-DAY AVERAGE | | YEARLY MAX RESULT |
| <u>NON-CARCINOGENS</u> | | | | |
| 1,2-DICHLOROBENZENE | mg/L | 18 | ND | ND |
| | lbs/day | 4504 | NC | |
| 1,3-DICHLOROBENZENE | µg/L | 2600 | ND | ND |
| | lbs/day | 651 | NC | |
| FLUORANTHENE | ug/l | 42 | ND | ND |
| | lbs/day | 10.5 | NC | |
| TOLUENE | mg/L | 300 | ND | ND |
| | lbs/day | 74700 | NC | |
| TRIBUTYL TIN | ng/L | 5.0 | ND | ND |
| | lbs/day | 0.001251 | NC | |
| <u>CARCINOGENS</u> | | | | |
| ALDRIN | pg/L | 140 | ND | ND |
| | lbs/day | 0.000035 | NC | |
| BENZENE | µg/L | 21 | ND | ND |
| | lbs/day | 5.2 | NC | |
| CHLOROFORM | µg/L | 480 | 0.23 | 0.63 |
| | lbs/day | 120 | 0.029 | 0.076 |
| DICHLOROMETHANE | µg/L | 1600 | 0.4 | 1.42 |
| | lbs/day | 400 | 0.05 | 0.17 |
| 1,4-DICHLOROBENZENE | µg/L | 64 | ND | ND |
| | lbs/day | 16 | NC | |
| HALOMETHANES | µg/L | 480 | 0.18 | 0.72 |
| | lbs/day | 120 | 0.02 | 0.09 |
| HEPTACHLOR EPOXIDE | ng/L | 0.07 | ND | ND |
| | lbs/day | 0.000017 | NC | |
| HEXACHLOROBENZENE | pg/L | 690 | ND | ND |
| | lbs/day | 0.00017 | NC | |
| HEXACHLOROCYCLOHEXANE ALPHA | ng/L | 13 | ND | ND |
| | lbs/day | 0.0032 | NC | |
| BETA | ng/L | 46 | ND | ND |
| | lbs/day | 0.011 | NC | |
| PAH's | ng/L | 31 | ND | ND |
| | lbs/day | 0.0077 | NC | |
| TCDD equivalents | pg/L | 0.014 | ND | ND |
| | lbs/day | 3.5 x10 ⁻⁹ | NC | |
| 2,4,6-TRICHLOROPHENOL | µg/L | 1.0 | ND | ND |
| | lbs/day | 0.25 | NC | |
| ND = NOT DETECTED, NC = NOT CALCULABLE | | | | |

Table 2-4. NPDES permit limits and 2003 annual averages for Marine Aquatic Life Toxicants in TITP effluent

| CONSTITUENT | UNITS | LIMIT | | | 2003 EFFLUENT | |
|-----------------------------------|---------|------------------------|------------------------|---------------|-------------------|----------------------|
| | | 30-DAY AVG | DAILY AVG | INST.* MAX | YEARLY AVERAGE | YEARLY MAX RESULT |
| ARSENIC | µg/L | 10 | 20 | 30 | 2.4 | 4.1 |
| | lbs/day | 2.5 | 5.0 | --- | 0.3 | 0.49 |
| CADMIUM | µg/L | --- | 9.3 | 43 | 0.08 | 0.09 |
| | lbs/day | --- | 2.33 | --- | 0.01 | 0.01 |
| CHROMIUM (VI) | µg/L | --- | 50 | 1100 | ND | ND |
| | lbs/day | --- | 12.5 | --- | NC | |
| CYANIDE | µg/L | 30 | 300 | --- | <5 | 8 |
| | lbs/day | 7.5 | 75 | --- | <0.6 | 1.1 |
| LEAD | µg/L | --- | 5.6 | 140 | 2.9 | 4.9 |
| | lbs/day | --- | 1.40 | --- | 0.4 | 0.6 |
| NICKEL | µg/L | --- | 8.3 | 75 | 5.6 | 6.8 |
| | lbs/day | --- | 2.08 | --- | 0.72 | 0.81 |
| SELENIUM | µg/L | --- | 71 | 300 | 12 | 18 |
| | lbs/day | --- | 17.76 | --- | 1.5 | 1.9 |
| DDT | pg/L | 600 | 1000 | --- | ND | ND |
| | lbs/day | 1.5 x10 ⁻⁴ | 2.5 x10 ⁻⁴ | --- | NC | |
| DIELDRIN | pg/L | 140 | 1900 | --- | ND | ND |
| | lbs/day | 3.5 x10 ⁻⁵ | 4.75 x10 ⁻⁴ | --- | NC | |
| ENDOSULFAN | ng/L | --- | 8.7 | 34 | ND | ND |
| | lbs/day | --- | 2.18 x10 ⁻³ | --- | NC | |
| ENDRIN | ng/L | --- | 2.3 | 37 | ND | ND |
| | lbs/day | --- | 5.76 x10 ⁻⁴ | --- | NC | |
| HEPTACHLOR | ng/L | 0.17 | 3.6 | --- | ND | ND |
| | lbs/day | 4.25 x10 ⁻⁵ | 9.0 x10 ⁻⁴ | --- | NC | |
| HEXACHLOROCYCLO- HEXANE, GAMMA | ng/L | 62 | 160 | --- | <2 | 2 |
| | lbs/day | 0.0155 | 0.040 | --- | <0.0003 | 0.0003 |
| PCBs | pg/L | 70 | 30000 | --- | ND | ND |
| | lbs/day | 1.75 x10 ⁻⁵ | 7.5 x10 ⁻³ | --- | NC | |
| PENTACHLOROPHENOL | µg/L | --- | 7.9 | 13 | ND | ND |
| | lbs/day | --- | 1.98 | --- | NC | |
| TOXAPHENE | ng/L | --- | 0.02 | 210 | ND | ND |
| | lbs/day | --- | 5 x10 ⁻⁶ | --- | NC | |
| CHLORDANE | pg/L | 81 | 4000 | --- | ND | ND |
| | lbs/day | 2.03 x10 ⁻⁵ | 1.0 x10 ⁻³ | --- | NC | |

ND=NOT DETECTED, NC = NOT CALCULABLE
* Instantaneous

Table 2-5. Interim limits (Objectives for Protection of Marine Aquatic Life) in TITP effluent.

| CONSTITUENT | UNITS | LIMITS | | | 2003 EFFLUENT | |
|-------------|---------|----------------|-----------|------------|----------------|-------------------|
| | | 30-DAY AVERAGE | DAILY MAX | INST.* MAX | YEARLY AVERAGE | YEARLY MAX RESULT |
| COPPER | µg/L | 27 | --- | --- | <4 | 15 |
| | lbs/day | 6.75 | --- | --- | <0.5 | 1.6 |
| MERCURY | ng/L | 450 | --- | 2100 | <100 | 220 |
| | lbs/day | 0.1125 | --- | --- | <0.02 | 0.03 |
| SILVER | µg/L | 3.7 | --- | --- | 0.3 | 1.6 |
| | lbs/day | 0.925 | --- | --- | 0.04 | 0.24 |
| ZINC | µg/L | 151 | --- | --- | 22 | 72 |
| | lbs/day | 37.75 | --- | --- | 2.8 | 8.9 |

* Instantaneous

Table 2-6 lists the 2003 monthly averages and annual removal efficiencies for most of the major wastewater constituents. The 2003 average percent removals ranged from 92% for oil and grease, 97% for ammonia, 99% for BOD, to greater than 99% removal of both suspended and settleable solids.

Table 2-6. 2003 monthly averages for major wastewater constituents.

| 2003 | FLOW | TEMP | TURB | pH | | TSS | | 5-d BOD | | OIL & GREASE | | SETT. SOLID | | AMMONIA-N | |
|----------|------|------|------|-----|-----|------|------|---------|------|--------------|------|-------------|-------|-----------|------|
| | INF | EFF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF |
| | MGD | °F | NTU | | | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | ml/L | ml/L | mg/L | mg/L |
| JAN | 16.5 | 76 | 0.5 | 7.4 | 7.3 | 194 | 1 | 242 | 3 | 44 | <3.0 | 12.4 | <0.03 | 25.6 | 2.1 |
| FEB | 16.9 | 74 | 0.6 | 7.6 | 7.3 | 169 | 1 | 218 | 3 | 37 | <3.0 | 11.6 | <0.03 | 23.9 | 1.2 |
| MAR | 15.8 | 74 | 0.5 | 7.6 | 7.3 | 180 | 1 | 210 | 2 | 46 | <3.0 | 11.0 | <0.03 | 23.8 | 1.3 |
| APR | 14.3 | 75 | 0.5 | 7.5 | 7.3 | 225 | 1 | 212 | 2 | 50 | <3.0 | 15.9 | <0.03 | 25.1 | 0.6 |
| MAY | 15.7 | 77 | 0.5 | 7.6 | 7.3 | 207 | 1 | 199 | 2 | 47 | <3.0 | 12.1 | <0.03 | 23.5 | 0.4 |
| JUN | 14.3 | 79 | 0.5 | 7.6 | 7.5 | 194 | 1 | 222 | 2 | 40 | <3.0 | 11.6 | <0.03 | 23.9 | 0.2 |
| JUL | 15.5 | 82 | 0.5 | 7.4 | 7.5 | 209 | 1 | 233 | 2 | 44 | <3.2 | 10.8 | <0.03 | 23.1 | 0.5 |
| AUG | 14.5 | 83 | 0.6 | 7.4 | 7.5 | 212 | 1 | 240 | 2 | 39 | <3.0 | 12.5 | <0.03 | 23.0 | 0.3 |
| SEP | 14.0 | 83 | 0.5 | 7.4 | 7.5 | 196 | 1 | 218 | 2 | 37 | <3.0 | 11.7 | <0.03 | 22.8 | 0.2 |
| OCT | 13.6 | 84 | 0.4 | 7.6 | 7.5 | 209 | 1 | 230 | 3 | 31 | <3.0 | 13.4 | <0.03 | 25.0 | 0.5 |
| NOV | 16.6 | 78 | 0.4 | 7.5 | 7.6 | 175 | 1 | 234 | 2 | 45 | <3.0 | 10.9 | <0.03 | 23.0 | 0.2 |
| DEC | 16.0 | 75 | 0.4 | 7.5 | 7.5 | 172 | 1 | 234 | 2 | 35 | <3.0 | 11.7 | <0.03 | 22.7 | 0.4 |
| *MAX | 23.1 | 90 | 1.0 | 8.3 | 7.8 | 644 | 2 | 498 | 12 | 54 | 4.0 | 65 | 0.05 | 33.3 | 3.2 |
| *MIN | 10.8 | 69 | 0.3 | 6.6 | 7.0 | 79 | <1 | 120 | <2 | 18 | <1 | 3.0 | <0.03 | 16.0 | <0.1 |
| MEAN | 15.3 | 78 | 0.5 | 7.5 | 7.4 | 195 | 1.1 | 224 | 2.2 | 36 | <3 | 13.1 | <0.03 | 23.8 | 0.6 |
| %REMOVAL | | | | | | | 99.4 | | 99.0 | | 92 | | 100 | | 97 |

* Daily maximum or minimum results for 2003

Table 2-7 lists the annual averages from 1993 to 2003 for major wastewater constituents. Prior to 1994, most of the exceedances at TITP were associated with a high level of settleable solids caused by occasional bulking in the aeration tanks. At that time, after excessive bulking occurred, there were several successive days of high settleable solids before the biological aeration process could be brought under control. Since then, improved process control has led to fewer process upsets.

Table 2-7. Annual average of major wastewater constituents from 1993 to 2003.

| Year | Flow | Turb. | | pH | | Susp. Solids | | BOD-5 | | Oil & Grease | | Sett. Solids | | Ammonia-N | |
|------|------|-------|------|-----|------|--------------|------|-------|------|--------------|------|--------------|------|-----------|--|
| | INF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF | INF | EFF | |
| MGD | NTU | | mg/L | | mg/L | | mg/L | | mg/L | | ml/L | | mg/L | | |
| 1993 | 17.2 | 3.1 | 7.6 | 6.8 | 193 | 11 | 244 | 5 | 54 | 2.9 | 13.8 | 0.32 | 29.5 | 0.3 | |
| 1994 | 16.1 | 2.9 | 7.6 | 7.3 | 199 | 7 | 221 | 5 | 54 | 3.4 | 16.0 | 0.03 | 32.3 | 0.4 | |
| 1995 | 16.9 | 2.5 | 7.6 | 7.3 | 195 | 6 | 194 | 3 | 48 | 3.3 | 14.1 | <0.03 | 28.5 | <0.3 | |
| 1996 | 15.9 | 1.2 | 7.6 | 7.2 | 187 | 5 | 201 | 3 | 49 | 2.2 | 12.6 | 0.03 | 28.5 | 0.4 | |
| 1997 | 16.3 | 1.0 | 7.6 | 7.4 | 185 | 2 | 193 | 2 | 48 | 2.0 | 12.5 | <0.03 | 28.5 | 1.8 | |
| 1998 | 16.6 | 1.0 | 7.4 | 7.3 | 195 | 1 | 192 | 4 | 43 | 1.0 | 15.3 | <0.03 | 29.7 | 6.2 | |
| 1999 | 15.1 | <0.5 | 7.5 | 7.4 | 234 | 2 | 251 | 3 | 41 | 1.0 | 16.0 | <0.03 | 32.6 | 3.4 | |
| 2000 | 15.9 | 0.5 | 7.5 | 7.3 | 227 | 1 | 237 | 2 | 40 | 2.0 | 15.9 | <0.03 | 33.7 | 1.6 | |
| 2001 | 15.2 | 0.5 | 7.4 | 7.3 | 216 | 1.1 | 251 | <2 | 39 | 1.2 | 13.6 | <0.03 | 30.6 | 0.6 | |
| 2002 | 15.1 | 0.5 | 7.5 | 7.4 | 193 | 1.1 | 233 | <2 | 42 | 3.2*** | 12.1 | <0.03 | 24.9 | 0.3 | |
| 2003 | 15.3 | 0.5 | 7.5 | 7.4 | 195 | 1.1 | 224 | 2 | 36 | <3 | 13.1 | <0.03 | 23.8 | 0.6 | |

| Year | As | | Cr | | Cu | | Pb | | Hg | | Se | | Ag | | Zn | |
|------|------|------|-------|-------|------|--------|------|-------|------|---------|------|------|------|--------|------|-------|
| | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff |
| | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| 1993 | 8 | 4 | 10 | 2 | 59 | 6 | <2 | <2 | 0.7 | <0.2 | 22 | 12 | 2.2 | <0.4 | 222 | 50 |
| 1994 | 4 | 3 | 10 | <4 | 47 | 7 | <2 | <2 | <0.2 | <0.2 | 46 | 25 | 1.9 | <0.4 | 115 | 44 |
| 1995 | 4 | 4 | <5 | <4 | 41 | <10* | <6 | <4 | <0.3 | <0.3 | 20 | 14 | 2.0 | <0.4 | 118 | 47 |
| 1996 | 4 | 2 | 4 | <4 | 50 | <10 | 6 | <3 | <0.3 | <0.3 | 20 | 14 | 1.8 | <0.4 | 154 | 44 |
| 1997 | 4 | 3 | <4 | <4 | 32 | <10 | 4 | <3 | <0.3 | <0.3 | 29 | 19 | 0.9 | <0.4 | 86 | 25 |
| 1998 | 3 | 1 | <4 | <4 | 40 | <10 | 3 | <3 | <0.3 | <0.3 | 25 | 12 | 0.8 | <0.4 | 103 | 8 |
| 1999 | 3 | 2 | <4 | <4 | 26 | <10 | <3 | <3 | <0.3 | <0.3 | 22 | 14 | 0.7 | <0.4 | 107 | 34 |
| 2000 | 4 | 3 | 4 | 3 | 33 | <10 | <3 | <3 | <0.3 | <0.3 | 26 | 10 | 0.5 | <0.4 | 103 | 27 |
| 2001 | 3 | 3 | <10** | <10** | 39 | <10 | <5** | <5** | <0.3 | <0.3 | 21 | 10 | 1.0 | <0.6** | 127 | 26 |
| 2002 | 3 | 3 | <10 | <3*** | 37 | 6.8*** | 16 | <3*** | <0.2 | <0.1*** | 19 | 10 | 0.7 | <0.6 | 115 | 22*** |
| 2003 | 3 | 2 | 3 | <1 | 47 | <4 | 5 | 3 | 0.2 | <0.1 | 14 | 12 | 2.8 | 0.3 | 129 | 22 |

* MDL changed in 1995
** MDL changed in 2001
*** MDL changed in 2002

TITP's secondary filtration system started operating in December 1996, and since 1997 the entire flow of secondary-treated effluent has received sand filtration. This additional treatment has further improved and stabilized the quality of the effluent. Since 1997, with the exception of chronic toxicity, there have only been two permit violations, one each for turbidity and acute toxicity, since 1997.

The removal efficiency of metals through the treatment processes is related to the chemical and physical characteristics of the individual metal. In general, higher removal efficiencies are found in metals that are less soluble in wastewater and have greater tendencies to associate with particles in the wastewater (Chen et al., 1974). This group of less soluble metals includes chromium, mercury, lead, copper, silver, and zinc. Arsenic and selenium are more soluble in wastewater and are not easily removed.

Removal efficiencies of eight detected priority pollutant metals are shown in Table 2-7. Consistent with the above findings, removal efficiencies of chromium, mercury, copper, silver, and zinc were much higher than the removal efficiencies of the more wastewater soluble metals, arsenic and selenium.

The Terminal Island Treatment Plant is required under its NPDES permit to conduct both acute and chronic toxicity tests. The acute limit allows no single test with survival less than 70% and no survival less than 90% in three consecutive tests in TITP effluent. In 2003 there were no exceedances of the acute toxicity limit using the fathead minnow survival test. Since November 1998, routine acute toxicity tests have been pH-adjusted to reduce the toxicity of non-ionized ammonia and to prevent pH drift during the test. This has greatly reduced the occurrences of acute toxicity permit violations.

The monthly chronic toxicity test limit is based on a TUC=1.0. This is equivalent to a no observable effect concentration (NOEC) of 100% effluent. Due to procedural difficulties of testing a low saline effluent with the saltwater species *Haliotis rufescens* (red abalone), the highest possible concentration of effluent tested is 60%. Therefore, no effect at the highest concentration tested (60%) is not considered a violation.

In 2003, the plant experienced one permit exceedance with chronic toxicity test results using the *Haliotis rufescens* (red abalone) larval development test. A TUC of 2.5 was found in the final effluent in October 2003. The cause(s) of this exceedance using the red abalone *Haliotis rufescens* has not been determined definitively at this time. A toxicity reduction evaluation (TRE) plan (EPA, 1999) was developed by the Terminal Island Treatment Plant operations in the early months of 2003. The TRE plan appears to have helped the plant significantly reduce chronic toxicity in the effluent and reduced the number of chronic toxicity permit exceedances from ten in 2002 to just one in 2003.

IV. CONCLUSION

In general, TITP achieved overall excellent effluent quality in 2003. This is due, in part, to continuous efforts to upgrade the plant. The current level of effluent quality can be attributed mainly to the following:

- 1) Aggressive industrial pretreatment enforcement,
- 2) Activated sludge selector system,
- 3) Intensive process control program, and
- 4) Capital improvements, such as the addition of an advanced filtration system.

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