TECHNICAL REPORT 331

Date: 19 October 1984

Author: Henry Salas, Advisor in Water Pollution

Subject: Water quality evaluations conducted for the Environmental Quality Board of Puerto Rico

1. PURPOSE

In response to a request from the Environmental Quality Board (EQB) of Puerto Rico, channelled through the Environmental Health Program (HEP) in Washington and authorized by the U.S. Public Health Service, a mission was conducted from 27 August to 14 September 1984 to assist the EQB in its evaluation of the impact of industrial discharges in the "Caño Control de la Malaria". During the mission the consultant was also requested by the EQB to assist in a similar evaluation of "Las Mareas" Harbor, to transfer technology concerning the application of the Program MAR 03(1), to respond to technical questions concerning the EQB's waste load allocation program and to comment on the EQB's Revised Water Quality Standards Regulation(2).

2. CAÑO CONTROL DE LA MALARIA

2.1 Background(3)

As a result of the construction of a U.S. Army Terminal in San Juan Harbor during the Second World War, the natural drainage via a series of canals and creeks of the Cataño area was sealed off. This caused additional flooding of this swamp area and induced the propagation of malaria which constituted a serious public health problem at that time. To remedy this situation the U.S. Army Corp of Engineers constructed a canal during 1941-44 which drained the area to San Juan Harbor and assisted in the control of malaria, from which is derived its name, "Caño Control de la Malaria".

The canal has an approximate length of 5.75 kilometers and is located within the municipal boundaries of Cataño, Bayamón and Guaynabo. Major tributaries to the canal are the creeks De Diego, Las Lajas, and Tora (Santa Catalina) as presented in Figure 1. The mouth of the canal is below sea level and discharge is presently controlled by a pumping station managed by the Department of Natural Resources of Puerto Rico.

The area has numerous industries, some of which discharge directly to the drainage system of the canal such as the large refinery of Caribbean Gulf Refinery Corp. (CARECO) which discharges its process wastewaters after lagoon
Figure 1: STUDY AREA - CAÑO CONTROL DE LA MALARIA
treatment to the Quebrada Las Lajas. Untreated domestic sewage also reaches the system through illegal connections to storm overflow networks, direct discharges and drainage ditches. Of particular concern are the Puerto Blanco and Juan Domingo Communities which have inadequate sewage disposal systems for more than 1,500 housing units which discharge directly or to inadequately designed septic tanks and latrines which eventually discharge to the canal and its tributaries. The construction of a sanitary sewer system for Puerto Blanco is planned for 1985-86.

2.2 Water Quality

Caño Control de la Malaria and its tributaries have been classified by the EQB as SD, that is, "surface waters intended for use as a raw water source for public water supply, and propagation and preservation of desirable species(2)". The canal cannot be considered as an estuary both technically and officially (as per EQB Water Quality Standards Regulation) because the ebb and flow of the tides is not felt due to the physical barrier of the pumping facilities. Nevertheless, chloride levels have been observed to increase somewhat in the vicinity of the pumping station which is probably reflective of the underground seepage of waters high in dissolved salts.

The EQB conducted an intensive water quality survey(3) of the canal and its tributaries on 2 June 1980 during which 14 stations were sampled. Field determinations of temperature, pH and dissolved oxygen were taken from 0800 to 1500 hours as were the portions of composite samples for the determination of phenol, metals, BOD₅, TSS, total TDS, turbidity, color, phosphorus, nitrite, nitrate and ammonia. One grab sample at each station was also taken for the analysis of total and fecal coliforms, oil and grease and chromium. Unfortunately no determinations were made of flow in the canal, its tributaries or the waste discharges thus making any credible cause and effect analysis not viable.

Violation of the then current Water Quality Standards (WQS) were observed for phenol (86%)*, iron (80%), zinc (50%), mercury (40%) and copper (30%). Figure 2 presents spatial profiles of some heavy metals and mercury in the canal proper from the vicinity of the Quebrada Santa Catalina to the mouth. Total Coliform (71%) and fecal coliform (64%) violations were also observed throughout the canal and its tributaries with peak values of 78,000 and 11,200 MPN/100 ml in the canal proper. Other parameters in violation were total phosphorus (100% exceeded .025 mg-P/l), color (93%), total dissolved solids (43%), chlorides (26%) and nitrites-nitrates (15%).

* Percent of all data taken in the canal and its tributaries that violated EQB standards.
**Figure 2**

OBSERVED HEAVY METAL & MERCURY vs DISTANCE
CAÑO CONTROL DE LA MALARIA
June 2, 1980
Observed BOD$_5$ and dissolved oxygen spatial profiles in the canal proper are presented in Figure 3. BOD$_5$ values ranged from 4.0 mg/l upstream to 2.3 mg/l just before the pumping facilities. Average dissolved oxygen levels show a declining trend from about 4.2 mg/l upstream to 0.6 mg/l near the mouth. The temporal variation of the dissolved oxygen levels indicate significant photosynthetic activity. Violation of the dissolved oxygen standard occurred throughout the canal.

On 7 March 1984 the EQB conducted in situ measurements of dissolved oxygen and conductivity in the canal from the vicinity of the Gulf tubes (Station 1) to Puente Blanco (Station 6), a distance reported to be 900 meters in the field report(4) although the USGS map of the area presents the distance to be approximately 1,000 m. Proceeding downstream from the Gulf tubes at 90 meter intervals, dissolved oxygen levels were observed to steadily increase from 0.5 mg/l at 09:55 hours to 1.75 mg/l at about 11:12 hours at Puente Blanco (see Figure 4). Notwithstanding, since no temporal measurements were made at any particular station, it cannot be determined whether this upward trend is indicative of dissolved oxygen recuperation or diurnal variation due to photosynthetic activity; although the latter would probably be the more likely.

On 8 March 1984 a time of travel study was conducted during which 100 ml of Rhodamine WT at 20% were injected instantaneously in the vicinity of the Gulf tubes and the dye distribution was subsequently measured downstream with a fluorometer at the Puente de Madera (Station 5) and Puente Blanco. Canal flow was also measured at these stations as summarized in Table 1. The resulting dye distributions are presented in Figure 5 and are typical of a fresh water stream. Since the tails of the dye profiles were not completed, the areas under dye curve necessary for dye mass estimations and average velocity calculations based on the centroids of the areas could not be conducted. Nevertheless, an average velocity for the portion of the canal studied of 0.049 m/sec (0.045 m/sec between Stations 1 and 5 and 0.053 m/sec between Stations 5 and 6) was calculated based on the passage of the peak dye concentration which may be considered a good approximation.

Figure 6 presents the spatial distribution of chlorides observed on 7 March 1984 in the lower canal and on 25 April 1984 in the upper canal. All values exceed the "SD" chloride standard of 250 mg/l. The chloride gradient observed near the mouth of the canal is probably reflective of underground seepage of high salinity waters.

On 28 August 1984, the consultant with personnel of the EQB visited Caño Control de la Malaria and the pumping facilities. In-situ dissolved oxygen measurements were observed to be less than 2 mg/l throughout the canal as presented in Figure 4. No odors were prevalent during the visit although it is very likely that the system goes anaerobic during non-daylight hours.
Figure 3
OBSERVED BOD$_5$ AND DISSOLVED OXYGEN vs DISTANCE
CAÑO CONTROL DE LA MALARIA
June 2, 1980
Figure 4

OBSERVED DISSOLVED OXYGEN vs DISTANCE
CAÑO CONTROL DE LA MALARIA

AUGUST 28, 1984
0920 - 1010 Hours

MARCH 7, 1984
0955 - 1117 Hours
Table 1

Flow measurement
Cano Control de la Malaria
8 March 1984

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<tr>
<td></td>
<td>1.3</td>
<td>0923 - 0943</td>
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<td></td>
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<td>0955 - 1015</td>
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<td>1110 - 1120</td>
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<td>2.2</td>
<td>1205 - 1213</td>
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<table>
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<td>1120 - 1131</td>
</tr>
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<td></td>
<td>1.7</td>
<td>1434 - 1444</td>
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Figure 5

DYE CONCENTRATION PROFILES
CAÑO CONTROL DE LA MALARIA
March 8, 1983
Figure 6
OBSERVED CHLORIDES vs DISTANCE
CAÑO CONTROL DE LA MALARIA
which would give credance to the complaints of the residents that odors emanate from the canal from time to time. Extensive bottom deposits were observed which upon disturbance released anaerobic gases. These benthal deposits probably play a major role in the dissolved oxygen balance of the system. At the mouth of the canal, pumping with an electric pump is conducted 24 hours a day with one electric and two diesel pumps held as stand-by for use during high runoff periods.

2.3 Proposed CARECO studies

CARECO, which presently discharges its effluent waste waters after lagoon treatment to Quebrada Lajas, is challenging the water certificate issued by the EQB on the basis that it would be very difficult if not impossible to meet with present available treatment technology, as defined by EPA guidelines, for the following parameters: BOD, COD, TSS, phenols and some metals. As part of its challenge, CARECO has proposed a work plan (5) which encompasses a complete definition of all wastewater inputs to the system inclusive of storm water and other non-point source contributions, definition of the area ecology, quantification of surface and sub-surface water resources, a deterministic analysis based on field measurements inclusive of dye studies, among others. The program is considered quite extensive and if executed properly should provide definitive cause and effect relationships for the individual categories of waste discharges. Some minor refinements could enhance the proposed program such as the inclusion of more stations in the canal proper and the separation of dye studies in the tributaries from the canal proper in lieu of conducting such studies from the point of discharge to locations within the canal proper as proposed.

As per the EQB Water Quality Standards Regulation when background levels exceed the specific standard, the former takes precedence. As such, the EQB is confronted with the issue of defining background levels for the superficial waters of Puerto Rico and one of the major objectives of the CARECO study is to define background water quality conditions for the study area.

However, it is noted that there are extensive bottom deposits in the system which probably play a major role in the dissolved oxygen balance and depending on the redox potential could be a source or sink of metals. The impact on water quality of these benthal deposits could be ascertained through special in-situ and/or laboratory studies. Even so, a definition of the historical sources of these deposits would be difficult. Inferences could be made using metals specific to certain industrial discharges along with their spatial distribution but with regards to organic matter the definition of natural background levels characteristic of this swamp area would be at best speculative.
Nevertheless, the deterministic approach proposed by CARECO to define the impact of their discharge and by inference background levels is considered the scientifically most valid.

An alternative to the above to define background levels, which could be conducted by the EQB, would be to ascertain water quality conditions in another area with similar characteristics which has been essentially untouched by human activities. Intensive monthly sampling of the parameters of concern in the water column and sediments would have to be conducted over at least a one-year period. Notwithstanding, the extensive development in Puerto Rico combined with the artificially induced uniqueness of this fresh water marsh in such proximity to the ocean is not encouraging to the discovery of another similar area.

Another proposal of utilizing upland stations within the drainage basis of the canal is considered inappropriate in view of the difference in terrain and should be discounted.

3. LAS MAREAS HARBOR

3.1 Background

Las Mareas Harbor, located in Guayana on the Southern coast of Puerto Rico, was originally covered by a mangrove swamp with a network of channels connecting it to Jobos Bay. There was no direct connection between the lagoon and the open sea. The lagoon was dredged to an average depth of 35 feet and opened to the sea by Phillips Puerto Rico Core Inc. (CORE) in 1967 under an agreement with the Puerto Rico Ports Authority dated 17 November 1966, in order to provide an adequate depth for the free movement of ships and barges in and out of this artificially created harbor.

In conjunction with the development of the port facilities, the Ports Authority granted CORE the right to construct a ditch (Phillips ditch) to convey treated waste waters and is presently used for said purpose by the Guayana Industrial Group which is composed of the following industrial complexes:

1. CORE - produces benzene, cyclotexane, toluene, paraxylene, orthoxylene, mixed xylenes, gasoline and paraffinic stocks with an expected discharge of 600,000 GPD of treated wastewater.

2. SK&F Lab. Co. - manufactures cymetidine which is the active ingredient in Tagamet, a pharmaceutical product used in the treatment of duodenal and gastric ulcers. Treated wastewater discharge is expected to be 131,000 GPD.
Figure 7
Study Area
Las Mareas Harbor
A location map is presented in Figure 7. Phillips Ditch, which also drains the lands to the north and northeast of the Harbor, has been recognized by the EQB as an apportionment to the industries wastewater treatment facilities and, as such, not subject to the EQB Water Quality Standard Regulation. It has been agreed that each of the industries will use the "Best Control Technology Economically Feasible" as referred to in Article 5 of the EQB Regulation which is defined by the effluent guidelines promulgated by the EPA for Best Practical Control Technology Currently Available (BPCTCA) for the respective industrial subcategories. Total maximum daily flow of the combined industrial discharges is expected to be 1,056 MGD.

Las Mareas Harbor has been classified by the EQB as SC, that is, "Coastal water for uses where the human body may come in indirect contact with the water (such as fishing, boating, etc.), and for use in propagation and maintenance of desirable species".(2)

3.2 Mixing zone petition

As part of its request to the EQB to establish a mixing zone pursuant to the provisions of the EQB Water Quality Standards Regulation, the Guayana Industrial Group has conducted extensive monitoring campaigns to define the water quality of the wastewater discharges, Phillips Ditch, Las Mareas Harbor and the adjacent ocean waters since 1977. A key premise adopted by the Industrial Group is that certain parameters the "background" levels in the study area exceed EQB standards applied in the preliminary permit and as such variances should be granted as provided for within the EQB Regulation. Through joint agreement, a station in the open ocean waters adjacent to the Harbor was selected for purposes of ascertaining background levels which would be considered by the EQB to be indicative of background levels in the Harbor. It is noted that this EQB policy position is somewhat subject to criticism in that a bay system would normally be more responsive to external natural or man-made inputs than open ocean waters due to the lesser dilution afforded by the different ambient current structures. Notwithstanding, the deepness of the harbor and probable extensive interchange with ocean waters supports to some degree this premise of representativity at the ocean station.

Utilizing data of the permit parameters generally obtained on a monthly basis from August 1981 to November 1982 at the background ocean station, the Industrial Group contends(7) that background levels exceed EQB standards for Cu, Fe, Zn, Phenols, Fl and total Cr based on the maximum values observed during the period of record. This approach is considered to be invalid in that no adequate statistical evaluation of the data was performed. For example, the possible existence of outliers in the data set due to sample contamination, laboratory error and/or isolated incident of contamination in the area, among others, was not considered.
The author has conducted a statistical analysis of the data taken at the "background" station outside of Las Marinas Harbor, the computer printouts of which are included as Annex 1. The computer coding of the program used for the analyses which was originally developed for the CEPIES Interlaboratory Quality Control Studies (8) is also enclosed herewith as Annex 2.

A two-stage procedure is utilized for the elimination of outliers. First of all, values more than four standard deviations ( ) from the mean are rejected. These values are indicated as R₁ on the computer printouts. The two-tail t-test is then applied to all remaining values at a 99% probability level; that is, with 99% assurance that the additional data points rejected do not pertain to the data set and should be rejected. These values are indicated as R₂ in the computer printouts. Statistical calculations are based on those values remaining after rejection of all outliers. As the analyses demonstrate, outliers on the high side were eliminated for total nitrogen, total Cr, Fe, Zn and Phenol (see Table 2).

A review of the analyses of the parameter Zn demonstrates the following: Of the 59 measurements one R₁ value of 0.5 mg/l and one R₂ value of 0.16 were identified as outliers and eliminated. The average of the remaining 57 values was calculated to be 0.05 mg/l and, as such, equivalent to the EQB standard. The standard deviation of the filtered data is ± 0.03 mg/l with a range of 0.01 to 0.11 mg/l.

Of the thirteen parameters, the average concentration of the filtered background data exceeds the EQB water quality standards only for Fe, Mn and F. It is noted that the detection limit problems are suspect for Cd, hexavalent Cr and Pb in that the majority of measurements are identical.

It is considered that the average of the filtered background data is the best statistical estimate of the long-term background average condition of the water body which the EQB wishes to define and maintain at all times. The use of the maximum values, as proposed by the Industrial Group, or minimum values, as proposed by the EQB, for this purpose, is statistically invalid.

In those cases where the background levels are applied as the standards, the concept of a mixing zone becomes superfluous for conservative substances* and the background value becomes essentially an end of pipe effluent standard for the dischargers. The justification of using an average

* With reference to this point, on p. 58 of the Water Quality Standards Regulation (English version), item 5.2.2 E-2, constitutes a theoretically impossible situation for a conservative parameter in that if the proposed effluent concentration exceeds the natural background values the boundaries of the IHZ or FMZ would have to be the theoretically infinity.
Table 2

SKF/Phillips Background Station
(Aug. '81 - Aug. '83)

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<tr>
<th>Parameter</th>
<th># of measurements</th>
<th># of R&lt;sub&gt;1&lt;/sub&gt;</th>
<th># of R&lt;sub&gt;2&lt;/sub&gt;</th>
<th>EQB standards</th>
<th>All data Ave.</th>
<th>Average</th>
<th>Range</th>
<th>St. Deviat.</th>
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<td>.19225</td>
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*All concentration in mg/l

*Background exceeds EQB standards

**Outliers probably indicative of high runoff event
of the wastewater effluent discharge simply because an average value was used to develop the background condition is totally invalid statistically because the two phenomena are independent and not correlated, and as such their respective averages and variations over time would not be interrelated in any way (analogous to comparing apples and oranges).

The EQB policy position that may be taken is that at no time is the average background long-term condition to be violated which justifies enforcement and sanction based on any single random measurement of the wastewater discharge end of pipe concentration. Under this premise, the only deviation from a specific numerical standard which might be considered would be the precision and accuracy of the measurements conducted at the EQB laboratory. Continual up-dated estimates of this precision and accuracy for all parameters should be maintained through an internal analytical quality control program. Replicate samples would also be recommended especially for the more likely violaters.

For a non-conservative substance the concept of a mixing zone becomes credible.

If enforcement and sanction are based on in-situ measurements at the edge of the IMZ or FMZ the issues are not as clear cut because of the random natural fluctuations around the background average which may or may not be due to external man-made inputs. Statistical comparisons would be necessary. For example, the 95% confidence interval would be as follows:

Single measurement: ± 1.96 standard deviations
Mean value (for \( N \geq 30 \)): ± 1.96 standard errors

where standard error = standard deviation/\( \sqrt{N} \) and \( N \) is the number of observations.

For Zn, the following confidence intervals would result:

Single measurement: 0.0 - 0.11 mg/l
Mean value: 0.043 - 0.057 mg/l

In practical terms, the use of a mean value to ascertain compliance is not tenable because of the overburdening of the EQB monitoring and laboratory capacities and the potential risk to the environment over the period of establishing the mean.

In view of the difficulties associated with in-situ monitoring, the best approach would be to conduct an adequate deterministic analysis from which specific effluent allocations are established and monitor compliance at the end of the canal based on individual random measurements. A review of the models proposed by the Industrial Group follows.
3.3 Water Quality Modeling Analyses

The consultants of the Guayana Industrial Group have developed a mathematical model(6) which describes plume velocity, temperature, density, concentration of trace species, width and depth. The model is a sophisticated dilution model which assumes a jet discharge velocity into a large body of water flowing at a uniform velocity parallel to the shore. Such models are generally applied to open water situations where dilution waters are constantly re-stratified and do not consider the accumulation of materials that may occur due to rotary currents often observed in bay situations.

The EQB has indicated disagreement with some of the basic assumptions of the model. For example, the EQB contends that discharge over the canal weir often occurs onto terrain and not directly to the Harbor proper as assumed. Also, the EQB questions the discharge depth utilized of 0.25 ft. Unfortunately, the writer did not visit the study area and, as such, is unable to comment on these questions. A joint field visit should be conducted to resolve these issues.

Other key issues of concern to the writer include the use of a flow velocity structure, constant both in magnitude and direction, for all model runs. Las Mareas Harbor is subject to tidal fluctuation and although there may be a net intertidal velocity, it is very likely that intratidal velocity fluctuations occur. Bay current surveys, conducted by the Industrial Groups' Consultants(6) demonstrated that flow direction varied. As such, the model should be run under various flow regimes to ascertain critical design conditions. Also, the model does not consider the possible accumulation of metals in the Harbor or the potential interchange with the sediments which could have long term implications on the ecological balance in the Harbor. A finite difference segmented model such as HAR 03(1), would be more appropriate to address these long-term issues.

Nevertheless, assuming that these phenomena are not significant and that the questions concerning some of the assumptions of the model are resolved, the Industrial Group model is considered adequate to evaluate the dilution of the waste discharge at the edge of the TMZ/FMZ if a proper calibration/verification procedure is performed. It is the understanding of the writer that such a calibration/verification analysis is under way.

The Industrial Group has proposed that mixing zone criteria be eliminated for total nitrogen and that the SK&F discharge limitation be modified to 1,800 mg/l, with a limitation for Phillips equal to the Water Quality Criteria. The justification utilized is that the nitrogen values observed in the receiving water body were sporadically affected by intensive rain periods in the area. However, the potential for eutrophication of Las Mareas Harbor as a result of the input of this macro-nutrient is simply not dealt with. At the very least the magnitude of the proposed industrial
nitrogen discharge should be compared to those of other sources and if relatively significant, evaluation of the eutrophication potential of the system should be conducted. It is recognized that Las Mareas Harbor is in reality not used for recreational purposes but even so, it is contrary to the spirit of the EQB regulations to allow that the system become hypereutrophic with the associated nuisance problems and, as such, the Industrial Group request should be evaluated in that framework.

4. PROGRAM HAR 03

Program HAR 03, which was originally developed by Hydrosience, Inc. and subsequently modified and published by the Environmental Protection Agency Region II(1), was found to be operating correctly on the EQB computer facilities. This finite difference multidimensional steady-state water quality model can be applied to natural water bodies to evaluate BOD and DO inclusive of the impact of nitrification, benthic oxygen demand and algal photosynthesis and respiration. Conservative and non-conservative (first order kinetics) substances can also be analyzed. The model allows both advective and dispersive transport. The version on the EQB computer facilities is dimensioned for 25 segments which could be readily increased.

A very preliminary two dimensional model of Las Mareas Harbor was developed with Carlos Irizarry of the EQB, with the goal of demonstrating the theory, data input procedures and practical application of HAR 03 to a natural water body system.

5. EQB REVISED WATER QUALITY STANDARDS REGULATION

The EQB Revised Water Standards Regulation states that, "It is the goal of this Board, and these Regulations to preserve, maintain and enhance the quality of the waters of Puerto Rico compatible with the social and economic needs of the Commonwealth of Puerto Rico". The least restrictive classifications are SC, indirect recreational contact, in the case of coastal waters and SD, raw water source for public water supply, in the case of surface waters. It is within this spirit and framework that the author has conducted the evaluations presented in this report.

However, the use of Caño Control de la Malaria as a raw potable water supply is highly improbable as is the use of Las Mareas Harbor as a recreational area in view of the more desirable alternatives in the immediately vicinity. In essence, the classifications of these water bodies
is not consistent with their present nor probable future uses, but the EQB Regulation does not offer alternatives. The concept being promulgated within the EQB Regulation is that commonly referred to as "zero discharge" especially with regard to the maintenance of "background levels" which, in certain situations, can economically overburden, and therefore restrict, development.

There are two extreme poles: On the one hand, there is the situation often encountered in other Latin American countries where uncontrolled discharges have converted natural water bodies into open sewers and on the other hand, the zero discharge concept applied in some more developed countries which has been postponed or even abandoned in some cases once the cost associated with its attainment was tabulated. A compromise lies in the maximum utilization of the assimilative capacity of the natural water body within the framework of its probable uses while assuring the protection of its major ecological systems and avoiding nuisance conditions. In the context of the EQB Regulation, this suggests the establishing of an additional classification. This, of course, constitutes a policy decision of the government of the Commonwealth. PAHO/CEPIS could provide information concerning the policies applied in other Latin American countries for purposes of comparison.

6. EQB WASTE LOAD ALLOCATION PROGRAM

The author reviewed and addressed detailed technical questions of Mr. Roberto Berrrto of the EQB concerning the monitoring procedures and the mathematical water quality models being developed under the EQB's waste load allocation program for the fresh water rivers of Puerto Rico.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 A review of historical water quality data of Caño Control de la Malaria shows that the EQB Water Quality Standards Regulation was violated for the majority of the parameters measured inclusive of various heavy metals and dissolved oxygen. Visual observations indicate the existence of extensive benthic deposits of organic materials which probably have a significant impact on the dissolved oxygen balance of the system.

7.2 The work plan proposed by the consultants of CARECO, which includes a deterministic analysis of the canal system, is the best scientific approach to determine the impact of the CARECO discharge and by inference background levels. As an alternative to the above, the EQB could consider the water quality monitoring of a similar area which is not affected by human activities to establish, also by inference, background levels for the study area.
7.3 The dilution model proposed by the consultants of the Guayana Industrial Group is considered adequate to determine the dimensions of the DMZ/FMZ under the supposition that questions concerning the physical characteristics of the discharge and the current structure of Las Mareas Harbor are resolved. However, this model does not consider the possible accumulation of metals in the Harbor nor the potential interchange with the sediments which may have a significant impact on water quality in the Harbor in the long term. Also, the potential eutrophication of the Harbor should be taken into account with regard to nitrogen discharges.

7.4 Based on a statistical analysis of the filtered data, obtained at a station in the ocean waters adjacent to Las Mareas Harbor and designated as representative of background levels for the Harbor, the average concentrations of the thirteen parameters evaluated exceed EQB water quality standards only for Fe, Mn and F. Justification of the use of single random measurements at the end of the canal to monitor compliance has been presented. In the circumstance of utilizing in-situ measurements to ascertain compliance statistical comparisons would be necessary.

7.5 The range of water body uses designated in the EQB Revised Water Standards Regulation is not always consistent with the present or probable future uses of certain bodies of waters. The Government of Puerto Rico should consider the development of an additional classification to deal with these situations.
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