*A Study of*

# Wastewater Discharges from Water Treatment Plants



*prepared in cooperation with:*

**Beaver Falls Municipal Authority**
**Cincinnati Water Works**
**Evansville Water Works**
**Fox Chapel Authority**
**Huntington Water Corporation**
**Indianapolis Water Company**
**Ironton Water Department**
**Kenton County Water District #1**
**Louisville Water Company**
**Municipal Authority of the City of New Kensington**
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*As of March 15, 1981

# A STUDY OF WASTEWATER DISCHARGES FROM WATER TREATMENT PLANTS

*April, 1981*

*prepared by:*

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FOREWORD

State and federal policies regarding the discharge of wastes from water treatment facilities in the eight-state Ohio River Valley Water Sanitation Compact district are currently inconsistent. Helping to coordinate water pollution control policies in the district has long been a task of the commission, and the need to resolve these inconsistencies came to the commission's attention in 1980. The ongoing revision of the commission's effluent standards, scheduled for completion in 1982, has also emphasized the importance of developing a commission policy regarding such discharges. To ensure that adequate information is available in the decision-making process, the commission in September, 1980, voted to authorize the following compilation of available information and data pertaining to the discharge of wastewater from water treatment plants to serve as a basis for revision of the commission's effluent standards and as a resource to water utilities, state and federal officials, and other concerned organizations and individuals.

Funding for the study was provided by water utilities in the Ohio River Basin. W. E. Gates and Associates conducted the study and prepared the following report with direction and assistance from the steering committee:

William H. Cloward, Chief of Permits, US Environmental Protection Agency, Region IV
Don T. Duke, Superintendent of Purification, Louisville Water Company
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Roger A. Kanerva, *Chairman*, Manager, Division of Water Pollution Control, Illinois Environmental Protection Agency
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## CHAPTER I

## SUMMARY AND CONCLUSIONS

The potential impacts of the discharge of the incremental pollutants generated by a water treatment plant to a large river such as the Ohio River are relatively insignificant because of the large dilution capacity of the river and the wide temporal variability of the background water quality. The costs associated with processing and handling the wastes from water treatment plants in order to reduce or eliminate the incremental pollutants are significant in absolute terms and very large relative to the incremental improvements in the river quality afforded by the treatment.

The relative loadings and economic costs of water treatment plant waste handling in the Ohio River are presented graphically in Figure I-1. In the bottom graph in that figure, a representative yearly trace of river quality in the Ohio River (based on 1979 records at Cincinnati) is presented in terms of pounds of solids per million gallons of flow in the river. The potential incremental loadings (solids loadings in excess of that originally derived from the river, i.e., chemical additions) from water treatment plants are illustrated in the middle panel of Figure I-1, which shows the incremental solids addition in terms of pounds per million gallons of treated water for the four primary types of water treatment plants. The impacts of these solids relative to the solids in the river are obviously greatly mitigated by the large flow in the river relative to the amount of water withdrawn for water supply.

The most prevalent solids addition in water treatment plants is in the form of iron and aluminum with representative plant loading rates of 17.6 pounds of elemental iron and 15.4 pounds of aluminum per million gallons of treated water. In the Ohio River, the mass flow of elemental iron ranges from 8.8 to 58.4 pounds per million gallons of river flow. Field measurements are insufficient to establish an estimate of the mass flow of aluminum.

Costs of processing and disposing of the wastes generated by water treatment plants in order to reduce or eliminate the discharge of the small amounts of incremental pollutants to the river are presented in the top panel of Figure I-1. The "envelope" of costs presented represents the minimum and

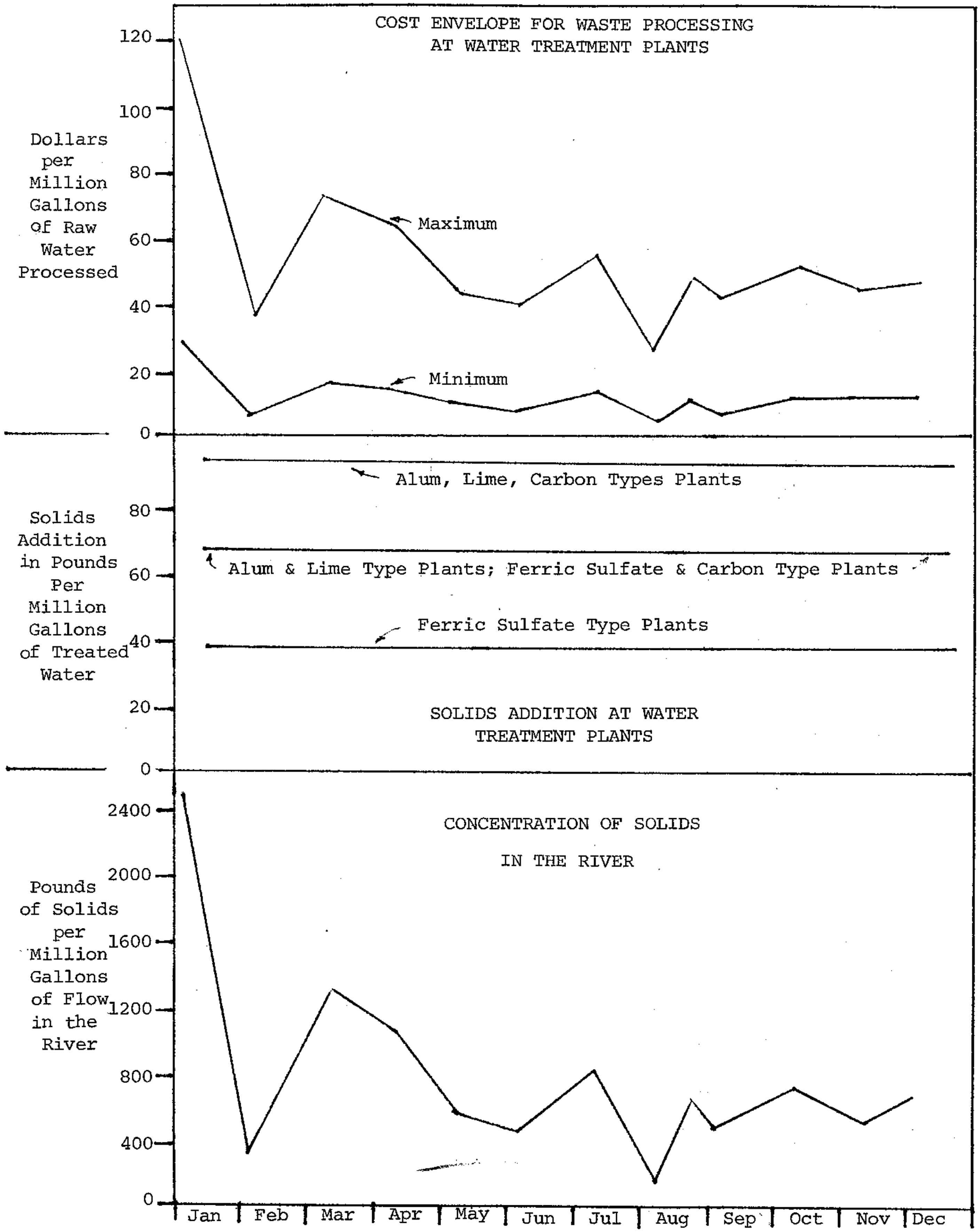



Figure I-1. Generalized Loading and Cost Relationships for Water Treatment Plants on the Ohio River maximum costs, dependent upon the waste handling/disposal processes utilized, in terms of dollars per million gallons of raw water processed.

The implications of the general relationships presented in Figure I-1 are illustrated in Figure I-2 for a 10 MGD water treatment plant. The three panels in Figure I-2 are analogous to those panels in Figure I-1 except that the values are presented in absolute terms. In the lower panel, the solids flow in the river is presented in tons per day. As illustrated, in a typical year this value will vary from several thousand tons per day to over a quarter of a million tons per day. For a 10 MGD plant, however, the incremental solids addition is less than half a ton per day. The relative impact of the incremental loadings on the river is demonstrated by the resultant suspended solids increase of only 0.5 to 4.8 micrograms per liter for the representative annual flow conditions, as compared to a normal range of within-stream concentrations of 18 to 292 milligrams per liter, a minimum factor of at least 4,000 times the incremental loadings from a 10 MGD plant. Similarly, for elemental iron the increase in concentration is in the range of 0.1 to 0.9 micrograms per liter, while the increase in elemental aluminum is 0.09 to 0.8 micrograms per liter. For both of these metals, the generally accepted allowable stream standard of 1,000 micrograms per liter exceeds these incremental additions from a 10 MGD plant by a minimum factor of 1,000.

The costs of reducing or eliminating the pollutant discharges from a 10 MGD plant are presented in the top panel of Figure I-2. As illustrated, these costs could be expected to range as high as almost half a million dollars per year or 20 dollars per year for a family of four.

The regulatory power to set limitations on discharges to the Ohio River is held by ORSANCO under the terms of the compact of 1948. Unfortunately, effluent standards 1-70 and 2-70, promulgated by ORSANCO in 1970 to provide specific discharge limitations to the Ohio River, do not directly address discharges from water treatment plants. Furthermore, there are no federal standards for the water supply industry and state/regional standards display a great degree of variability. In recent years, several specific cases and controversies concerning discharges from water treatment plants on the Ohio River have arisen. These cases and the general ambiguity in current regulations have led the commission to authorize this study to provide information that will allow an

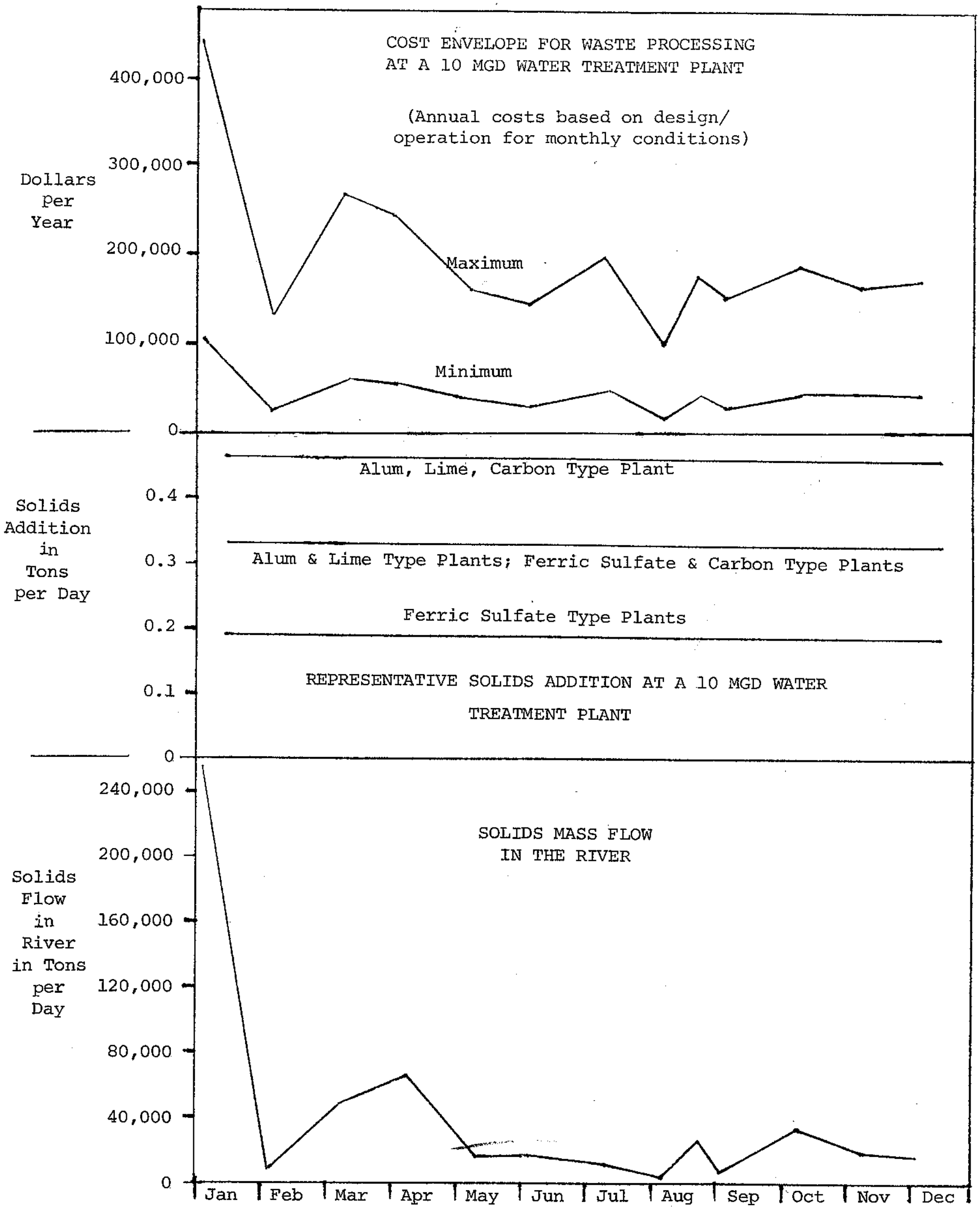



Figure I-2. Loading and Cost Relationships for Representative 10 MGD Water Treatment Plants on the Ohio River informed decision concerning modification/clarification of its policy on such discharges.

Based on the information and analysis in this report, there are three primary alternative policies that ORSANCO may adopt relative to water treatment plant discharges. In order of increasing stringency, these policies are as follows:

- Maintain the present policy, which provides little guidance to the states and localities.
- Formulate and impose discharge limitations on water treatment plants. These limitations may be rigid, general concentration/loading limitations or may consider the benefits and costs associated with a specific discharge.
- Disallow the discharge of any wastes from water treatment plants to the Ohio River, i.e., zero discharge.

The technical and regulatory analysis in this report supports the middle position with the actual limitations and/or policies to be established by ORSANCO.

## CHAPTER II

## REGULATORY AND POLICY ISSUES

### INTRODUCTION

Regulations and policies governing the handling and disposal of water treatment plant wastes have been established at all levels: federal, regional and state. The purpose of this chapter is not only to provide a summary of the regulations and policies that are in effect at these three levels of government, but also to provide perspective on their history and intent.

### ORSANCO REGULATIONS AND POLICIES

The Ohio River Valley Water Sanitation Compact became effective on June 30, 1948. In the compact, the eight signatory states "pledged themselves to cooperate faithfully with each other in the abatement of existing pollution and in the control of future pollution in the Ohio River Basin" (Leach, 1968), and specifically to "place and maintain the waters of said basin in a satisfactory sanitary condition, available for safe and satisfactory use as public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life, free from unsightly or malodorous nuisances due to floating solids or sludge deposits, and adaptable to such other uses as may be legitimate" (ORSANCO, 1948). Towards these ends, in its early years the Ohio River Valley Water Sanitation Commission established quality standards for the Ohio River. These standards were superceded by separate and frequently incompatible standards established by the individual states. In the late 1960's, the commission concluded that it had a responsibility for formulating uniform standards. The result of this recognition was the formulation of Pollution Control Standards I-70 and 2-70, the current regulations regarding effluent limitations.

Concurrent with the development of I-70 and 2-70, there was considerable activity at the committee level within ORSANCO concerning waste discharges from water treatment plants. Between 1967 and 1969, several reports were prepared and resolutions and policies adopted by the Water Users Committee and the Engineering Committee. Included in these categories were the following actions:

- A 1967 resolution of the Engineering Committee directing the staff to "review state requirements and policies and to prepare guidelines for the establishment of a uniform policy on the control of wastewaters discharged to the Ohio River from water treatment plants" (ORSANCO, 1967).

- A 1968 policy statement from the Engineering Committee concerning wastes from water purification plants on the Ohio River stating:

  1. Installation of waste-control facilities will be required as a part of the initial construction of new water-purification plants;

  2. Installation of waste-control facilities will be required at existing water-purification plants whenever substantial improvements or enlargements are made at these plants;

  3. Installation of waste-control facilities will be required at existing water-purification plants when the discharge of untreated wastes results in obvious pollution or in quality levels that do not meet established criteria. In these cases, time schedules for the installation of waste-control facilities shall be established in conformance with the state's plan of implementation (ORSANCO, 1968).

- A 1969 report on disposal of water plant sludge and wastewater prepared by a subcommittee of the Water User's Committee. This report summarized the state requirements, presented information on alternative treatment technologies and discussed the availability of federal funds for treatment of water treatment plant wastes. The subcommittee "supported the abatement of stream pollution through the establishment of water quality criteria and the subsequent treatment of water plant wastes" (Glass, 1968).

Though it may be surmised that the aforementioned reports, policies, and resolutions had some impact upon the development of 1-70 and 2-70, there is no documentation of such a link nor any record that they became official policy of ORSANCO through adoption by the commission.

Within standards 1-70 and 2-70 there are no direct references to water treatment plant wastes, nor are there any direct exclusions for such wastes (ORSANCO, 1970). It is generally assumed by the ORSANCO staff that water treatment plant wastes are considered as a class of "industrial wastes" and thus are covered by these standards. Both the definition of "industrial wastes" and the effluent limitations for such wastes are included in 1-70 and 2-70, which are reproduced here as Appendix A.

## FEDERAL REGULATIONS AND POLICIES

The evolution of federal regulations and policies predates the enactment of PL 92-500 in 1972. The Water Pollution Control Act of 1965 (PL 84-660) required states to set standards for interstate waters and gave them authority to order treatment of wastes from water treatment plants before discharging to surface waters. Some grant money was provided by this law for constructing water treatment projects, but most water treatment projects were assigned a low priority and little attention was given to the operating performance of such plants (AWWA, 1978a).

With the passage of PL 92-500 and the establishment of EPA, a more formal procedure for controlling water treatment plant discharges was theoretically established. Water supply was formally declared as an industry. The implications of this decision were twofold:

- Construction grant monies offered public wastewater plants were not available to water treatment plants even if they were publicly held.

- A procedure for promulgating guidelines for discharges from water treatment plants was established.

The guidance document for the water supply industry (US EPA, 1978) divided water treatment plants into three types:

1. Plants that use one of the following: coagulation, oxidation iron and manganese removal or direct filtration.

2. Plants that use chemical softening procedures.

3. Plants that use a combination of the procedures in the above categories.

For each category, best practical control technology was defined and allowable pH and total suspended solids limitations were established. For Category 1 plants, the allowable pH range was 6.0-9.0 and the allowable total suspended solids varied from 10.8 pounds/million gallons of treated water at plants of less than 1 MGD to 5 pounds/million gallons for plants exceeding 500 MGD. This guidance document, however, did not progress beyond the draft guidance position. Because of court action, USEPA was forced to con-concentrate on 21 primary industries. The water supply industry was considered of only secondary importance, and as a result no final action was taken on the document. A recent inquiry to USEPA indicated that that agency will be reopening the examination of some secondary industries, but that no final action is expected before 1982 and it is probable that the action will be only a reissue of the draft guidance document as final guidance for consideration by the regional offices (Martin, 1980).

In addition to the guidance document, several program guidance memoranda have been issued by USEPA relative to the water supply industry. One such memorandum, issued in 1973, determined that the water supply industry should use gross rather than net accounting, which would disallow credit for raw water pollutants (USEPA). This decision was changed in 1975, with an amendment to NPDES regulations allowing the regional administrator to adjust effluent limitations in permits to reflect credit for pollutants in the applicant's water supply source (USEPA). Another memorandum in 1974, which had a profound effect on the financing of waste processing facilities at water treatment plants, disallowed grant assistance to such facilities (Cahill). Though challenged on the basis that such facilities are "publicly owned treatment works" (Lawson, 1978), USEPA's policy has stood.

With an ambiguous federal effluent guideline, the establishment of such limitations has been left to the regional and state level. A survey of regional policy (summarized in Appendix B) indicates a wide diversity among regions and even among personnel at the regional level. The policies vary from a recognition that the water supply industry is only of secondary concern and thus only minimum requirements should be applied, to a "hardline" policy discouraging any discharges from water treatment plant waste-processing facilities.

In addition to regulations regarding discharge of water treatment plant wastes to streams, several regulations can also affect the disposal of such wastes on land. Both the Solid Waste Disposal Act (PL 91-512) and the Resource Conservation and Recovery Act of 1976 (PL 94-580) potentially impact the land disposal of water treatment plant wastes. These regulations cover the disposal of toxic, hazardous, and/or corrosive wastes. Water treatment plant sludges, however, are generally not considered to fall in these categories and thus these federal regulations should have minimal impact upon the disposal of water treatment plant sludges.

Incomplete knowledge of the potential impact of land disposal of sludges (primarily alum sludges) has led several states to impose relatively strict regulations concerning their disposal. California, New Jersey and New York have all classified water treatment plant sludges as industrial waste and imposed stringent conditions (AWWA, 1978b).

STATE REGULATIONS AND POLICIES

The regulations and policies of states and regional agencies can provide a useful framework in which to consider alternative strategies for ORSANCO. A survey was conducted to determine such policies for a range of states and agencies. Selection of states was based on both geographic diversity and the existence of riverine conditions similar to those of the Ohio River. Examination of regional compacts indicated the existence of only a few agencies which have the regulatory power of ORSANCO. The results of the surveys covering 15 states and one regional agency, are summarized in Appendix B.

Examination of the regulations indicates a range of diversity that is as wide as possible. For example, at one end, Wyoming has a policy disallowing any new water treatment plants from discharging any sludge or filter backwash water to a stream. At the other extreme, Missouri provides no limitations on the discharge of suspended solids resulting from the treatment of water for potable use to the Missouri and Mississippi Rivers. The majority of the regulations allow for the discharge of suspended solids with both a monthly and daily limitation.

Though regulations exist, discussions with several state and water treatment plant personnel indicate that enforcement of these regulations are relatively lax. The prevailing opinion that the impacts of discharges from water treatment plants are of only secondary concern leads to a situation where regulations pertaining to such facilities are minimally enforced and monitoring reports required under NPDES permits are frequently ignored.

# CHAPTER III

# WATER PLANT WASTE TREATMENT AND DISPOSAL ALTERNATIVES AND COSTS

## INTRODUCTION

Most sources of potable water, including the Ohio River, are not considered suitable for direct use and must undergo some level of treatment prior to distribution and consumption. Most water treatment systems consist of sedimentation aided by the addition of coagulants such as alum or ferric sulfate followed by filtration to remove remaining "fines Some systems include presedimentation in reservoirs or holding basins. Aeration can be used to reduce the concentration of dissolved minerals such as iron. Chlorination is a traditional method for minimizing bacteria and algal growth in the finished water.

The specific design and operational characteristics of any water treatment system are dependent upon the character of the raw water, the expected uses, and the available funds. The choice of presedimentation, the type and amount of coagulants used, and the frequency of filter backwashing are some typical system variables, all of which produce sludges that must be disposed of in some manner. Inasmuch as water treatment plants are usually located near the source of raw water, the most economical ultimate disposal alternative for these sludges is to return them to the raw water source. Because the largest portion of these sludges (water and solids) comes from the raw water source and only the chemicals represent an added increment, it can be argued that discharge to the raw water source is not only economical, but also causes minimal environmental impact.

Other ultimate disposal alternatives include land filling, land spreading, chemical recovery, and discharge to a wastewater treatment system. Land filling and spreading require concentration of the waste stream in order to reduce the volume and the transportation costs. Chemical recovery also requires a concentrated waste stream, but still yields a solids residue for disposal. Discharge to a wastewater treatment system simply displaces the sludge management issue from one system to another. Thus, any alternative to direct discharge to the raw water source involves a cost for waste stream concentration through various means and a cost for transportation.

The purpose of this chapter is to provide information to decision-makers on the available water treatment sludge management alternatives, the cost of these alternatives and their impacts.

## WATER TREATMENT PROCESSES AND WASTE GENERATION

Information relative to water treatment processes and waste generation in the study area was provided by ORSANCO, state regulatory agency personnel and through interviews with plant operators and design engineers.

The coagulation/flocculation/filtration process is the basic method of treating river waters for potable use, but many variations of the basic process exist in the study area. Variable factors include the type of chemicals used in the coagulation/flocculation process, the amount of chemicals used, and auxiliary treatment processes employed. For any given design, operational parameters are varied to optimize treatment in response to changes in raw water quality.

Four basic chemical treatment processes were identified: alum/lime, alum/lime/powdered activated carbon (PAC), ferric sulfate, and ferric sulfate/PAC. Alum and ferric sulfate are used as coagulants to remove turbidity and colloidal matter. Lime is used primarily for pH adjustment but may also be used for softening. PAC is employed as required to alleviate color, organics, taste and odor problems. Use of polymers to enhance flocculation is finding increased popularity.

Auxiliary processes include presettling, aeration and chlorination. Presettling removes coarse sediments and other settleable matter. Aeration and chlorination aid in the removal of dissolved constituents such as iron, and chlorination helps to remove and prevent the growth of plankton, algae and bacteria.

Waste is produced from the presettling, flocculation and filtration processes. Presettling wastes are composed primarily of fine sand and silt and organic constituents. Flocculation basin sludges are comprised of silt clay, colloidal substances and residual chemicals. Filter backwash water is composed of flocculation "fines" and PAC residuals. Presettling and flocculation sludges are high in suspended solids content but relatively low in volume. Filter backwash water comprises approximately 90 percent of the waste discharge volume, but is relatively low in suspended solids. Both alum and ferric sludges are difficult to dewater, but ferric sludges generally exhibit better dewatering characteristics than do alum sludges.

## WASTE TREATMENT AND DISPOSAL ALTERNATIVES

Waste treatment and disposal alternatives were determined through a "state of the art" literature review. A bibliography is presented in Appendix F.

Treatment of water plant wastes consists primarily of concentrating the solids in the waste stream to a point where they may be readily handled and transported to the point of ultimate disposal as economically as possible. Alternative treatment process trains are shown in Figure III-1 and range from direct discharge to sophisticated mechanical dewatering processes and land filling of the dried sludge. Steps in the process of concentrating/dewatering the waste include equalization/holding/settling, thickening, alum/iron recovery and dewatering. Unit processes utilized in these treatment steps are described below.

### Equalization/Holding/Settling

Equalization is utilized to even out flow surges, such as those from basin drainage or filter backwash, and to provide a constant flow rate to downstream treatment units in order to dose chemicals and operate machinery properly. The treatment unit may be a simple holding tank or may resemble a clarifier if some waste concentration is desirable at this point. An effluent stream of approximately one percent solds may be produced if decanting or clarification is employed. Supernate water is usually returned to the plant raw water intake and effluent is pumped to thickening, dewatering or discharge.

### Thickening

Thickening is accomplished by gravity settling or by centrifuging. In either case polymer, lime, clay or fly ash are used as conditioning agents. When properly operated, thickeners may produce an effluent solids concentration of from two to six percent. Supernate is recycled or discharged

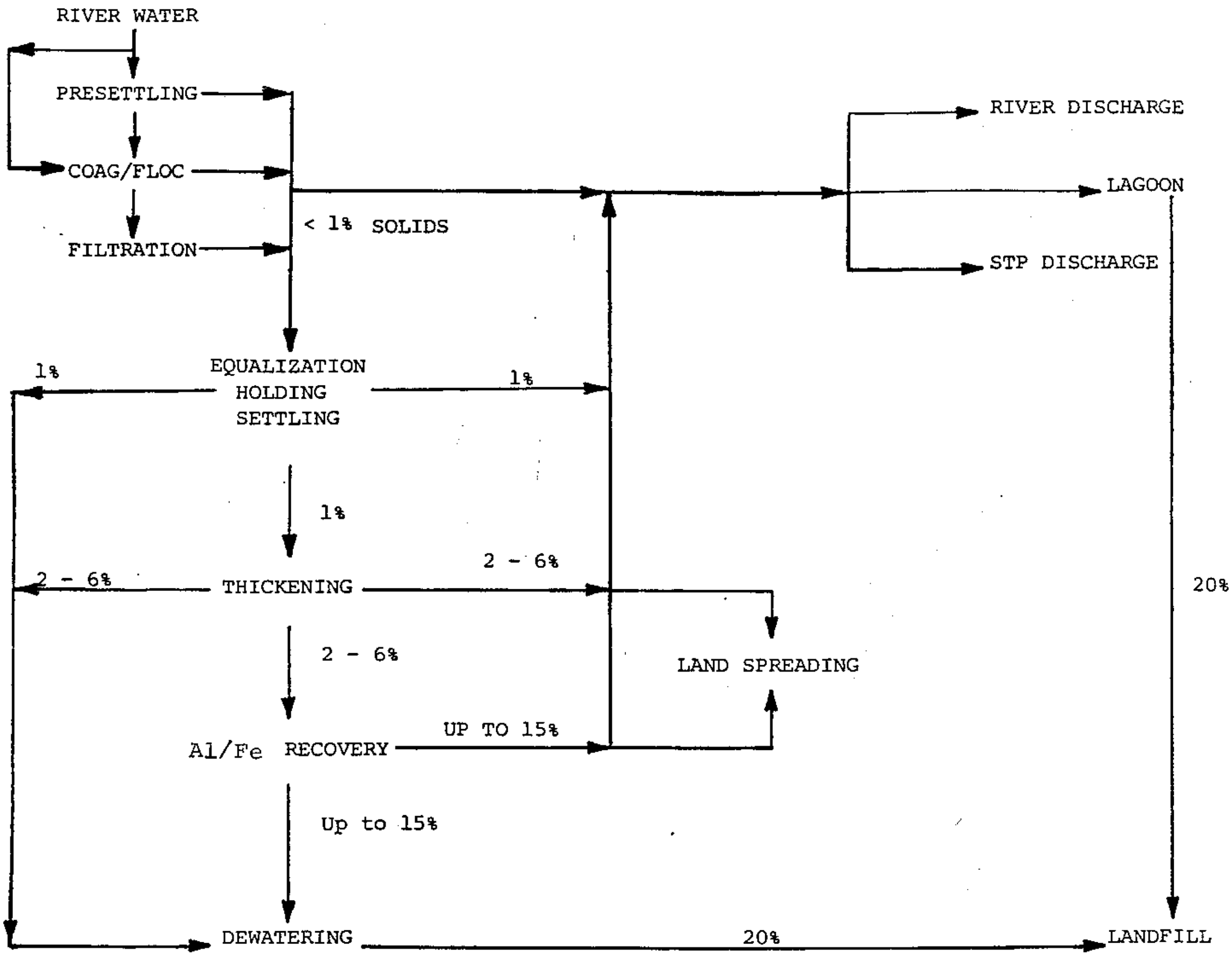



Figure III-1. Waste Treatment Alternatives and thickened sludge is routed to dewatering processes or is transported to a land spreading area. Although coagulant sludges have been shown to improve soil cohesion characteristics, the costs involved in pumping and transporting liquid or semi-liquid sludges generally rule out this disposal operation.

## Alum/Iron Recovery

Coagulant recovery is usually accomplished by acidification of the thickened sludge and may result in concentration of the remaining sludge solids of up to 15 percent. Some concern has been expressed over the use of the recycled coagulants in water treatment processes due to the carry-over and concentration of heavy metals and other contaminants. A recent pilot-scale application of a liquid-to-liquid-ion exchange process to purify recovered alum has been reported, but data on full-scale application of this process were not identified. It is generally assumed that alum recovery is economically feasible only at large facilities ($>$ 100 MGD).

## Dewatering

Dewatering of alum sludges is accomplished by air drying in lagoons or on sand beds or by any of the following mechanical processes:

- Centrifuge
- Filter Press
- Belt Filter Press
- Vacuum Filter

A sludge solids concentration of at least 20 percent is required to permit handling and transport as a "dry" sludge. All dewatering alternatives have been reported to achieve 20 percent or greater concentration either alone or with the addition of polymers or other filter aids.

## Selection of Treatment Alternatives

Lagooning is the most common sludge-handling process because thickening storage and drying are accomplished in the same treatment unit, but large land areas are generally required. After freeze-thawing lagoon sludges of up to 40 percent have been reported. Mechanical dewatering may also achieve high solids concentrations which in turn lower transportation and disposal costs.

Selection of a specific process design depends upon several factors, including the availability of land, sludge characteristics, hauling distance, maintenance requirements and other factors which influence the cost of treatment. Unit process and process train costs are discussed below.

## ALTERNATIVE TREATMENT AND DISPOSAL COSTS

Feasibility of treatment or selection of a treatment or disposal alternative should be considered in the context of cost-effectiveness. Unit process and process train treatment and disposal costs have been developed to aid decision making in this context.

### Cost Derivation

Alternative waste treatment costs were developed using EPA cost curves and reflect similar assumptions (USEPA, 1979). Costs were updated to 1980 dollars by the ENR construction cost index of 11 December 1980 (3382). Construction costs were amortized at 7 percent for 20 years and added to to O/M costs to produce total annual costs.

Unit process costs were developed on the basis of waste solids loading. ORSANCO records of river suspended solids concentrations during 1979 and chemical use information obtained from plant surveys were used to generate loading data for 13 sampling periods in 1979. These loadings were used as the basis for sizing the unit processes and thereby estimating their capital and O/M costs. Because size, thus cost, varies with loading, cost data were developed for a 10 MGD water treatment facility as an example for 10 different unit processes under minimum (242 lbs/mg) and maximum (2527 lbs/mg) loading conditions. These data are presented in Appendix C for each of the four types of chemical treatment identified.

Unit process costs were combined in logical sequences according to the process trains alternatives presented in Figure III-1. Annual cost data for seven process train alternatives for a typical 10 MGD water treatment plant are presented in Table III-1.

## SUMMARY AND CONCLUSIONS

As seen in Table III-1, annual treatment and disposal costs for a 10 MGD water treatment facility range from $109,244 for lagoon treatment to $434,599 for a belt filter press system (surge tank, belt filter press, sludge hauling). In terms of dollars per million gallons, costs range

TABLE III - 1

EXAMPLE PROCESS TRAIN COSTS

10 MGD - LIME + ALUM + PAC PROCESS

| Process Train | TOTAL ANNUAL COST[1] |
|---|---|
| LAGOON ($73,088) + SLUDGE HAUL[2] ($35,156) = | $109,244 |
| SURGE TANK ($41,560) + GRAVITY THICKENER ($25,097) + SAND BED ($95,444) + SLUDGE HAUL[2] ($36,156) = | $198,257 |
| SURGE TANK ($41,560) + GRAVITY THICKENER ($25,097) + FILTER PRESS ($268,359) + SLUDGE HAUL ($36,156) = | $371,172 |
| SURGE TANK ($41,560) + BASKET CENTRIFUGE ($204,033) + SLUDGE HAUL ($36,156) = | $281,749 |
| SURGE TANK ($41,560) + DECANTER CENTRIFUGE ($102,050) + SLUDGE HAUL ($36,156) = | $179,766 |
| SURGE TANK ($41,560) + VACUUM FILTER ($270,080) + SLUDGE HAUL ($36,156) = | $347,744 |
| SURGE TANK ($41,560) + BELT FILTER PRESS ($356,883) + SLUDGE HAUL ($36,156) = | $434,599 |

1 - 1980 dollars
2 - 5MI @ 20%

from \$29.93 for the lagoon system to \$119.07 for the belt filter press system. Although the lagoon system is the most economical form of treatment, the scarcity and cost of land may make this alternative impractical in some instances.

Sand beds and the various mechanical dewatering devices must be considered in terms of the capital cost, operation, and maintenance requirements of each unit process and in terms of cost trade-offs associated with handling and transportation at lesser or greater solids concentrations.

As the data presented in this chapter indicate, the cost of treatment and disposal of water treatment plant sludges is significant and must be a major consideration in regulatory decision-making. This is especially true in light of the small amount of incremental solids (chemicals) these sludge management systems are designed to preclude from being discharged to the river.

CHAPTER IV

POTENTIAL ENVIRONMENTAL IMPACTS OF WATER TREATMENT PLANT WASTES

The processing and handling of wastes from water treatment plants can potentially result in impacts upon the water and land, dependent upon the type of processes employed. The nature of these impacts is discussed in this chapter.

IMPACTS ON THE WATER

The impacts of the discharge of water treatment plant residues on a receiving water may be viewed in two major ways: the total mass perspective and the added pollutant perspective.

If one considers the total mass of constituents in a source/receiving stream, the impact of a water treatment plant on the mass flow will be to reduce the mass flow by the portion of the mass flow that is directed into the water supply system, i.e., that not removed by the water treatment processes, and to increase the mass flow by the total mass of the chemical additives, i.e., coagulants, coagulant aids, and powdered activated carbon (PAC). The bulk of the mass diverted to the water supply system will be returned to the source/receiving stream at the point of wastewater discharge, as illustrated in Figure IV-1.

Mathematically, this perspective may be represented by the following relationships:

$M_R = M_A + (M_{RWS} - M_{WS})$ assuming 100% capture of $M_A$

For high dissolved solids - low turbidity water

$(M_S - M_{RWS}) + M_R < M_S$

For low dissolved solids - high turbidity water

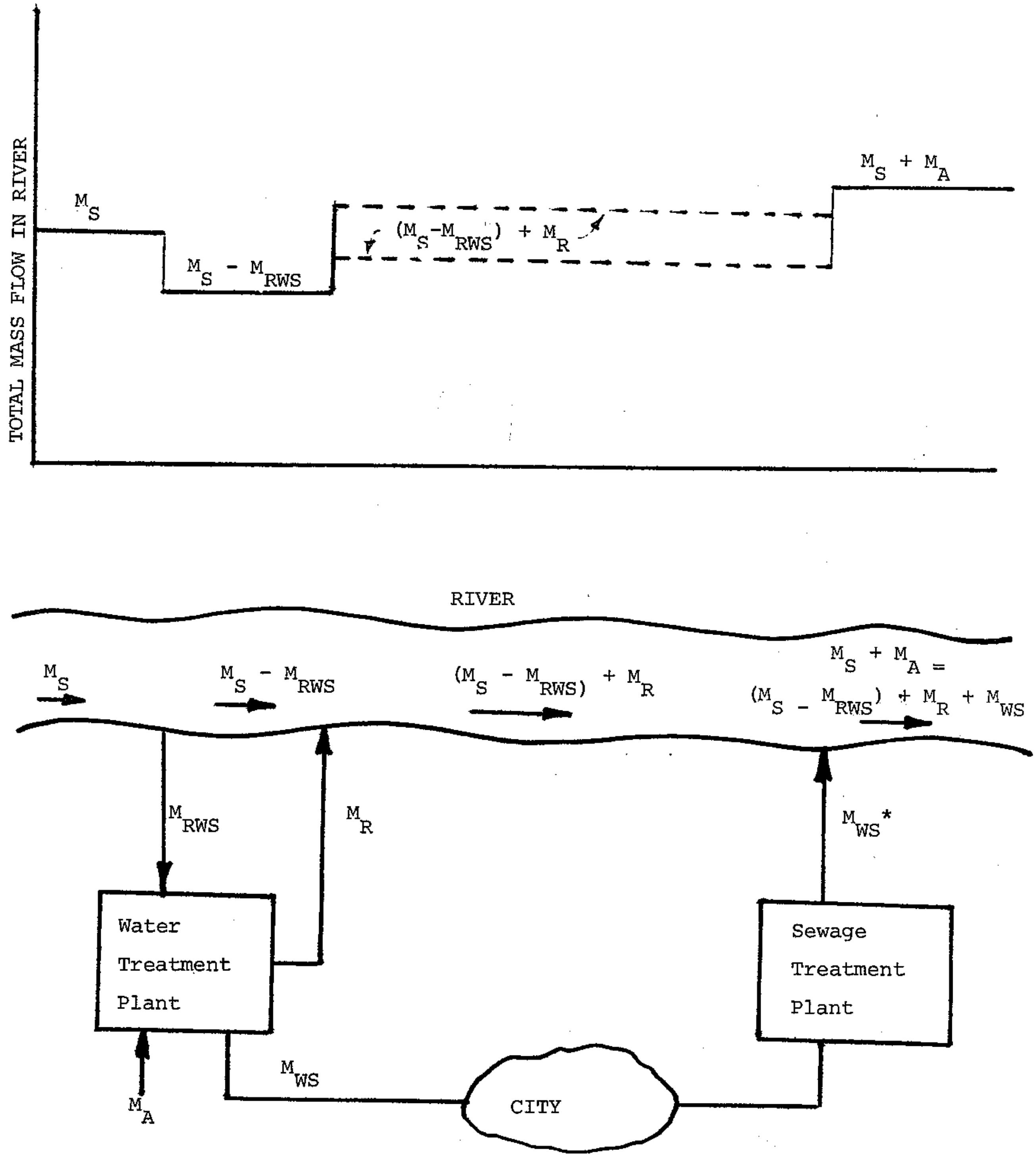
$(M_S - M_{RWS}) + M_R > M_S$

where

$M_S$ = mass flow in stream upstream of water treatment plant

$M_{RWS}$ = Mass flow in raw water supply

$M_A$ = mass flow of additives (coagulants, coagulant aids, PAC)




* NOTE: Sewage Solids are not considered in this diagram

Figure IV-1. Schematic Representation of the Total Mass Perspective of Water Treatment Plant Operation.

$M_R$ = mass flow of treatment plant residues

$M_{WS}$ = mass flow of water supply from plant

NOTE: Sewage solids not considered.

As illustrated in the profile in Figure IV-1 and the above relationships, the mass flow in the river is decreased between the water plant intake and water plant discharge, can increase or decrease after the water plant discharge and before the sewage treatment plant discharge and increases below the sewage treatment plant. For large streams, the relative change in mass flows is miniscule compared to the mass upstream of the water treatment plant. Additionally, the mass involved is generally much less than that contributed by the sewage flows from the sewage treatment plant.

The added pollutant perspective focuses on the concentration of the substances added during water treatment in the receiving stream. The elements of this perspective are shown graphically in Figure IV-2, using the following terms:

CP = Concentration of pollutant to be added in treatment plant upstream of water intake

QS = Stream flow upstream of water intake

$Q_{RWS}$ = Flow diverted to water treatment plant

$M_P$ = Mass of pollutant added during treatment (# per day)

CPD = Concentration downstream of residual return

QR = Flow of residual stream

$Q_{WS}$ = Flow to water system

CPWS = Concentration pollutant in finished water to water supply

CPDS = Concentration of pollutant in river downstream of sewage treatment plant

The general expression for CPD is:

$$CPD = \frac{Q_{RWS}\ (CP) + M_P - Q_{WS}\ (CPWS)}{QS - Q_{RWS} + QR}$$

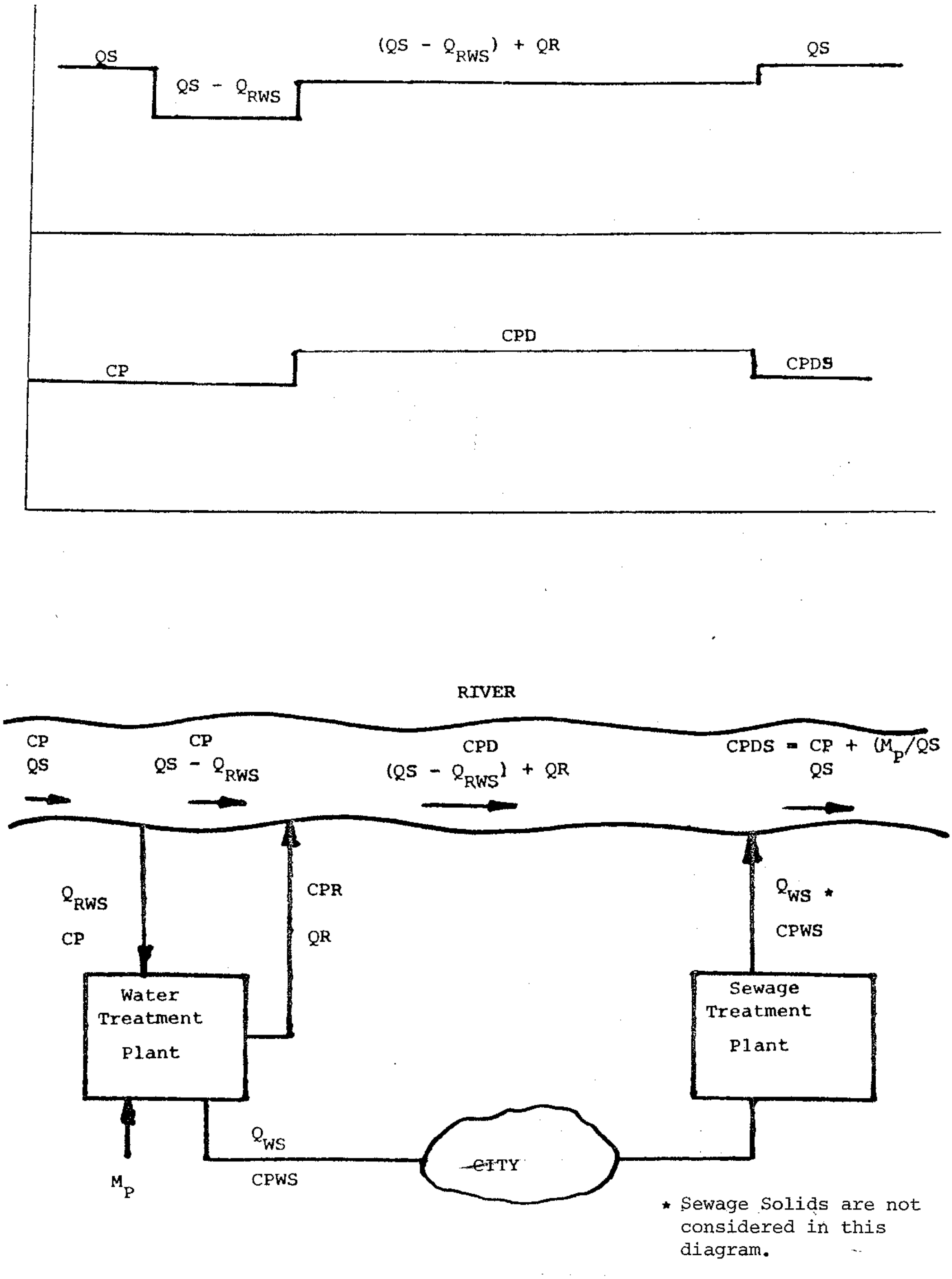



Figure IV-2. Schematic Representation of the Added Pollutant Concentration Perspective of Water Treatment Plant Operation.

The concentration downstream of the sewage treatment plant (ignoring the sewage flow contribution) is simply the concentration upstream of the water treatment plant plus the concentration due to additives in the plant or

$$CPDS = CP + (M_p/QS).$$

For large source/receiving streams it is reasonable to assume that the net increase in pollutant level of added pollutants can be approximated using the mass of added pollutants and the stream flow. The percent increase in pollutant level for the added pollutant is:

$$\text{Percent Increase} = \frac{M_p}{M_p + QS\ (CP)}$$

if QS = 100 MGD and CP = 1 mg/1

$$\text{Percent Increase} = \frac{M_p}{M_p + 834}$$

Thus 100 pounds of pollutant added would result in a 10 percent increase in pollutant concentration in the stream. A useful rule of thumb is that the percent increase in pollutant concentration will be one-tenth of the ratio of pounds added per million gallons per day of stream flow and the ambient concentration of the pollutant in the stream in mg/l.

The use of either the mass balance or the added concentration approach to describe the impact of water treatment process residues will usually show little numerical consequence of discharging such residues to large streams.

Furthermore, the ability to measure or observe the incremental impacts upon the stream due to the incremental changes in concentration is generally beyond the capacity of the scientific community. The other concern in assessing the impacts of such discharges upon the stream is potential localized impacts which must be considered at a smaller spatial scale than can be considered when performing the aforementioned mass balances.

In a typical water treatment plant situation one would expect to find the solids captured by the treatment process in 1,000,000 gallons of raw water to be contained in 5,000 to 10,000 gallons of clarifier underflow, i.e., a concentration factor of from 200 to 1 to 100 to 1 respectively, not considering the materials added. Additionally, many of the solids that are in colloidal or dissolved form in the raw water are in an insoluble, precipitated form in the clarifier underflow. When an underflow is discharged to a receiving stream, resuspension, colloidalization, and solubilization will not occur instantly. If the receiving stream has a high velocity, the material contained in the residue discharge will be swept into resuspension ; then the processes of colloidalization, solubilization, and desorption will start. As these processes proceed and the released materials are subjected to diffusion and dispersion, the receiving stream will come to the average conditions described by the concentration considerations detailed above. The time (distance) required for these average conditions to be achieved will be determined by the rates of diffusion and dispersion, and the rates of colloidalization, solubilization, and desorption. Until the average conditions are realized, the concentrations in certain portions of the water will be higher than the average conditions; at the same time, certain portions of the water body will have concentrations lower than the projected average conditions. The time/distance to achieve average conditions will be pollutant dependent.

If the receiving stream has a low velocity, the material contained in the residue discharge will tend to collect in a sludge deposit in the vicinity of the point of discharge. The sludge deposit will accumulate until either it is removed by scour or the rates of resuspension, colloidalization, solubilization, and desorption equal the rate of deposition. The ecosystem in the immediate vicinity of the sludge blanket is strongly impacted by the sludge deposit. The benthos overlain by the deposit will be the most strongly impacted, i.e., the bottom conditions presented by the sludge deposits will be entirely different than those presented by the unblanketed bottoms. Anaerobic conditions may develop in the sludge deposit resulting in higher rates of colloidalization, solubilization, and desorption than would occur in the water column. Until the rate of release equals the rate of deposition, the concentration of materials in the water will be lower than in a higher velocity stream. Because dispersion will be slower in a low velocity stream, however, it will take longer (time/distance) for average conditions to be realized in the water body when release equals deposition, than required for the same release rate in a high velocity stream.

When runoff increases the velocity in a low velocity stream, erosion (resuspension) of the sludge deposit will occur. The erosion creates, in effect, a shock loading to the stream. The magnitude of the high velocities and the period over which they are sustained will determine how much of the sludge deposit is resuspended. Once resuspension is achieved, the fate of the materials will be the same as though they were initially discharged to a high velocity stream. The extent of downstream deposition following resuspension will depend on the downstream extent of the high velocities and the rates of solubilization, colloidalization, and desorption.

There is little information available in the literature to allow quantitative assessment of these localized impacts of discharges. In a study of the Vermillion River in Illinois, higher concentrations of aluminum were found in the bottom sediments in the vicinity of the outfall; however, the study concluded that the influence of the waste discharges on macro-invertebrates was imperceptible (Evans, et. al., 1979).

On a large river one would expect that the localized concentrations in the river of the chemical additives from water treatment plants would be significantly less than the accepted standards. For iron, the generally accepted standard nationally and locally is 1 mg/l (USEPA, 1976; ORSANCO, 1980a). For aluminum, a concentration of greater than 1.5 mg/l is considered potentially harmful to the biota, while concentrations less than 0.2 mg/l are considered safe (National Academy of Science, 1973). The solubilization of aluminum and iron hydroxides could have a short-term impact on the pH of the receiving stream, depending on the buffer capacity of the stream. The BOD represented by the coagulant aids should not be excessive, and if a sludge deposit exists, much of the degradation can be expected to occur under anaerobic conditions. The PAC will constitute an increase in the suspended solids or local load (sludge deposit). The materials in the raw water supply that are captured during water treatment are concentrated in the clarifier underflow; however, when the underflow is discharged to a receiving stream, these materials are not instantly released to the water column. These materials can only be released as solubilization, colloidalization, and desorption processes that are not instantaneous in character.

Even localized impacts of water treatment plant discharges on large rivers appear to be, at most, of only minor significance. Such impacts are usually localized to areas in the immediate vicinity of the discharge outfalls and can be further mitigated by proper design of the outfall structure.

## IMPACTS ON THE LAND

The primary potential impact of water treatment plant wastes upon the land is associated with the ultimate disposal of sludges. Though study of this area is still in its infancy and the importance of further research is recognized (AWWA, 1978b), there is evidence of potential impacts from the disposal of water treatment plant sludges on the land. At a minimum, this evidence suggests the need for well engineered landfill/disposal sites.

Coagulant (alum) sludges appear to have the greatest potential impact. Landfills are anaerobic systems operating in the acid fermentation stage to produce leachate in the acidic pH range. The leachate is somewhat buffered and may redissolve some of the heavy metals contained in the sludge (AWWA, 1978b). Alum sludges are also potentially difficult to handle because of the high degree of bound water that is present. Thus, adequate provision against pollution from runoff or seepage from landfills containing these sludges must be made.

A final and less esoteric potential impact of disposal of water treatment plant wastes in landfills is the use of an essentially non-renewable resource land. This impact is most significant in large urban areas where the amount of water used is greatest, leading to the largest requirement for land disposal areas, and where the availability (cost) of land is generally most restrictive.

CHAPTER V

# CHARACTERIZATION OF EXISTING CONDITIONS ON THE OHIO RIVER MAINSTEM

## INTRODUCTION

The existing conditions in and along the Ohio River mainstem provide a base of information from which the severity of any problems relative to water treatment plant discharges may be evaluated. In this chapter, the existing conditions within the Ohio River and at water treatment plants along the mainstem are discussed.

## CHARACTERISTICS OF THE OHIO RIVER

Any study concerning the water quality of the Ohio River is greatly benefitted by the extensive data base collected and maintained by ORSANCO, USGS and other agencies. ORSANCO has recently completed an assessment of the water quality conditions on the Ohio River mainstem (1980a). The purpose of this chapter is not to duplicate the information presented in the aforementioned assessment, but rather to summarize and assess the data relative to the potential impacts of water treatment plant discharges on the Ohio River.

The impacts of water treatment plant discharges on a stream are potentially most significant in terms of suspended solids, iron, and aluminum and, to a lesser degree, pH and BOD. The following characterization of the Ohio River mainstem will concentrate on these key quality parameters.

The Ohio River is a major arterial stream. Though it is canalized for the purposes of navigation and many flood control projects have been built on tributaries, the river is largely uncontrolled in terms of overall flow conditions. The spatial and temporal distribution of flows in the river, based on calendar year 1979, are displayed in Figures V-1 and V-2 (ORSANCO, 1980a). As illustrated, the average flow in the river increases from approximately 50,000 cfs at Pike Island, 84.2 miles downstream of Pittsburgh, to approximately 240,000 cfs at Uniontown, 846.0 miles downstream of Pittsburgh. The minimum daily flows at these two locations were approximately 6,000 cfs and 46,000 cfs respectively, while maximum flows were approximately 230,000 cfs and 670,000 cfs respectively. The estimated 7-day/10-year low flows are approximately 5,000 cfs and 13,000 cfs at the two

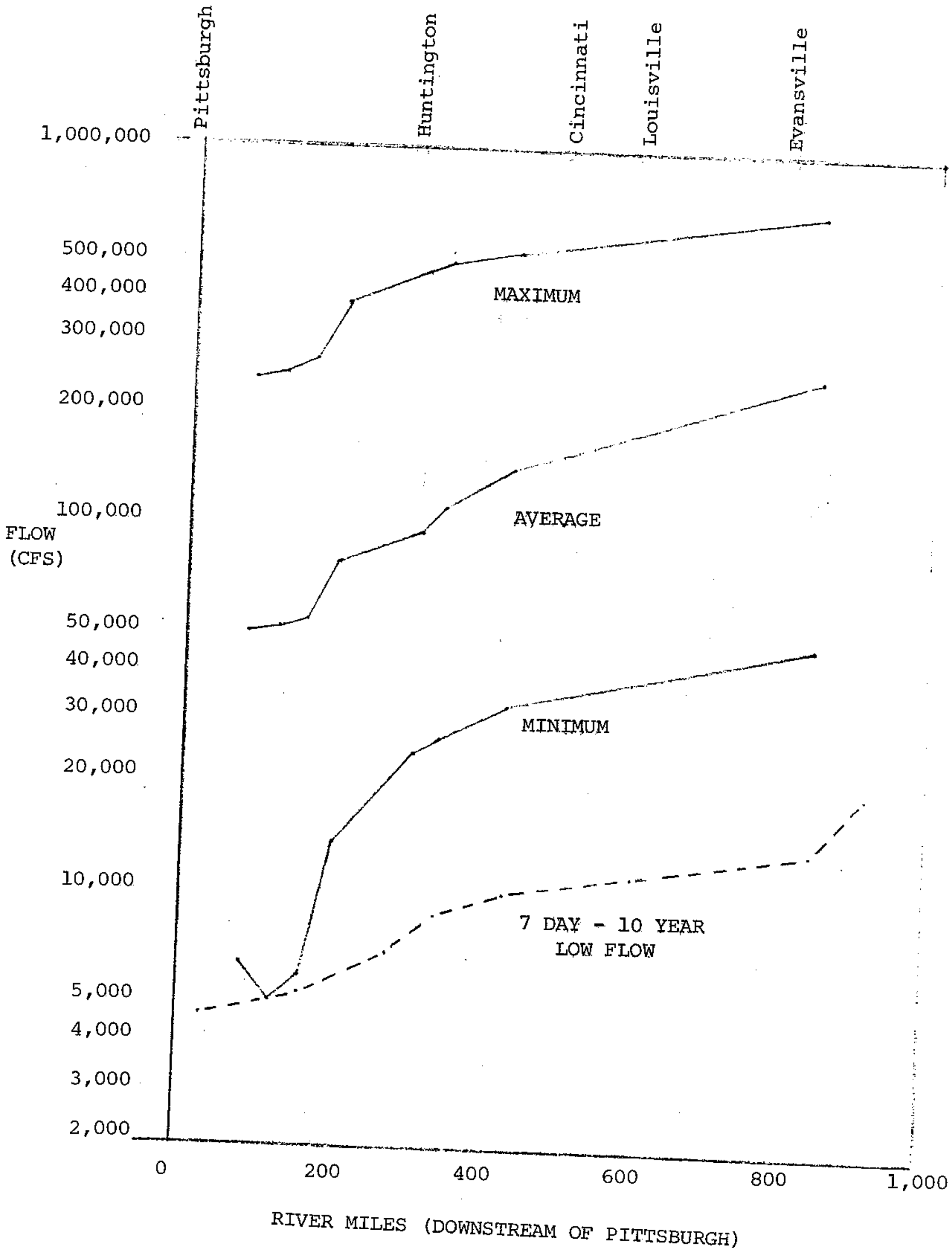



Figure V-1. Profile of Flow in the Ohio River for 1979.

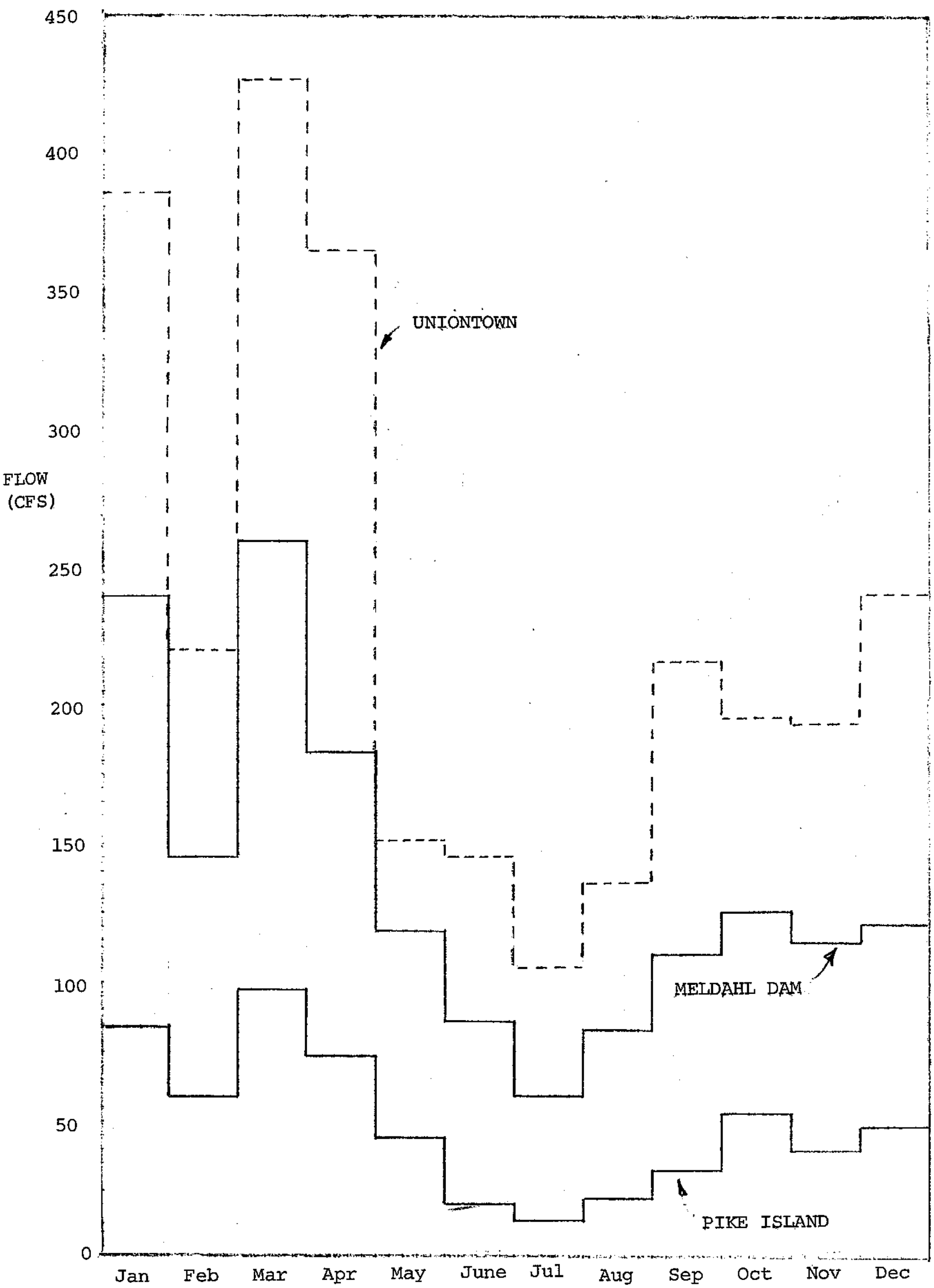



Figure V-2. Average Monthly Flow during 1979 for Selected Locations on the Ohio River stations (ORSANCO, 1980b). Temporally, flows are traditionally highest in the winter and spring, with low flows occuring in the summer months. In 1979, for example, the average flow during January through April was approximately three times as high as the average flow during May through August.

Suspended solids display a highly significant variability in the Ohio River. The spatial and temporal variability is illustrated in Figure V-3. This graph, which contains the profile of suspended solids concentration (minimum, average and maximum) for the year 1979, shows both a general trend of increasing solids from upstream to downstream and an even greater temporal variability at each station. Plotted on semi-log paper to accommodate the wide variation in concentrations, the graph indicates approximately a five-fold increase in average suspended solids concentrations from the upper to lower Ohio River and a typical factor of 50 to 1 between minimum and maximum concentrations at any location.

The temporal variation in total suspended solids concentration is displayed in more detail in Figures V-4, V-5, V-6, and V-7. Contained in these graphs are plots of both suspended solids concentration and flow for a three-and-one-half year period for four widely spaced locations on the Ohio River. The graphs indicate both a wide variation in TSS concentration and flow and a general correlation between TSS concentration and flow. This relationship is further displayed and the correlation confirmed by the plots in Figures V-8 and V-9. A regression performed between flow and TSS concentration yields the following relationships and coefficients of determination ($R^2$):

South Heights, Pennsylvania

$C = 0.51 + 0.00105Q$ $\qquad R^2 = 0.419$

Greenup Dam

$C = -13.9 + 0.00072Q$ $\qquad R^2 = 0.571$

Cincinnati, Ohio

$C = -1.85 + 0.000929Q$ $\qquad R^2 = 0.526$

Louisville, Kentucky

$C = -29.8 + 0.000763Q$ $\qquad R^2 = 0.632$

The strong correlation between flow and TSS concentration leads to a large variability in the mass flux of suspended solids due to the multiplicative effect of flow and concentration in calculating flux. This variability

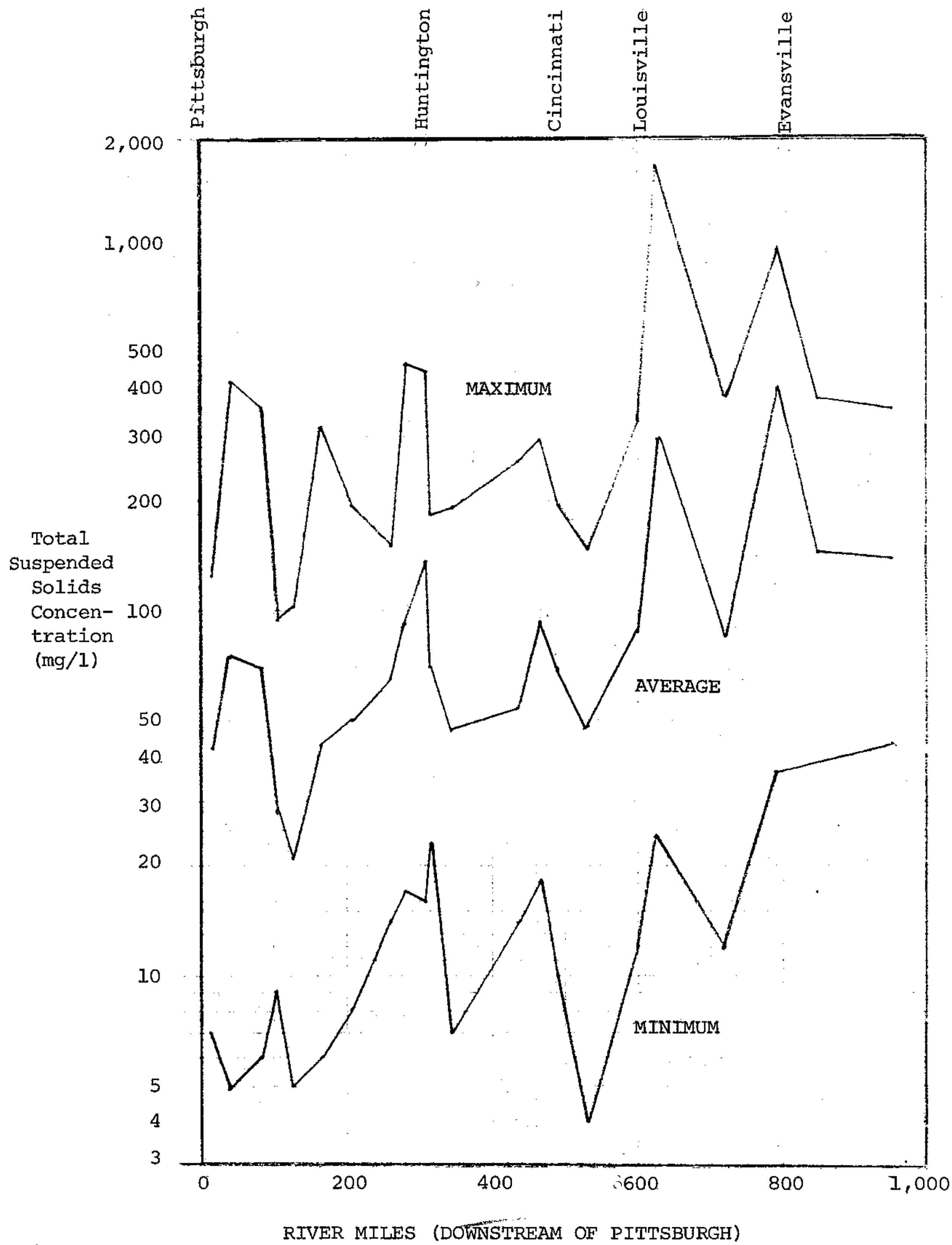



Figure V-3. Profile of Total Suspended Solids Concentration in the Ohio River for 1979.

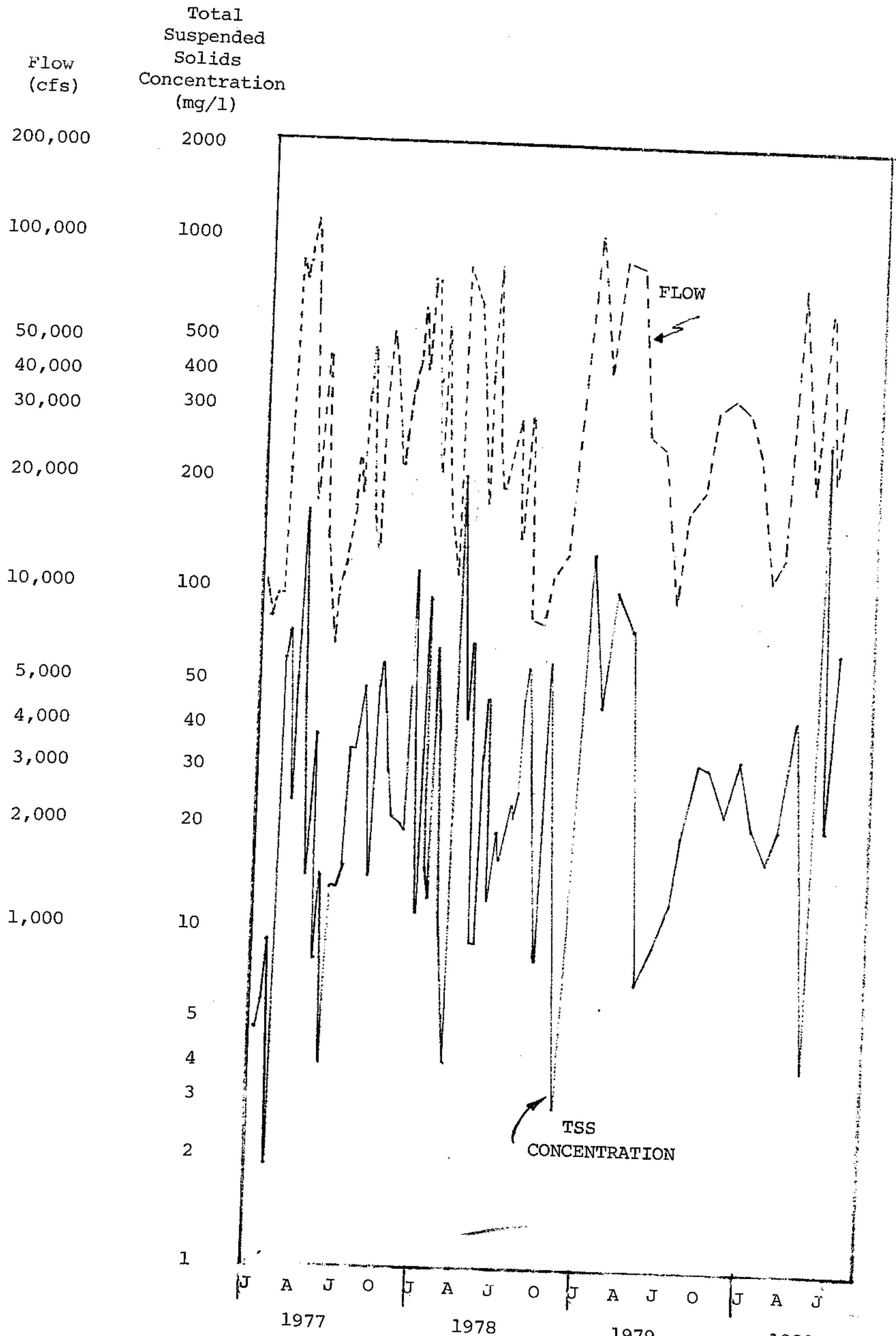



Figure V-4. Flow and Quality Measurements on the Ohio River at South Heights, Pennsylvania.

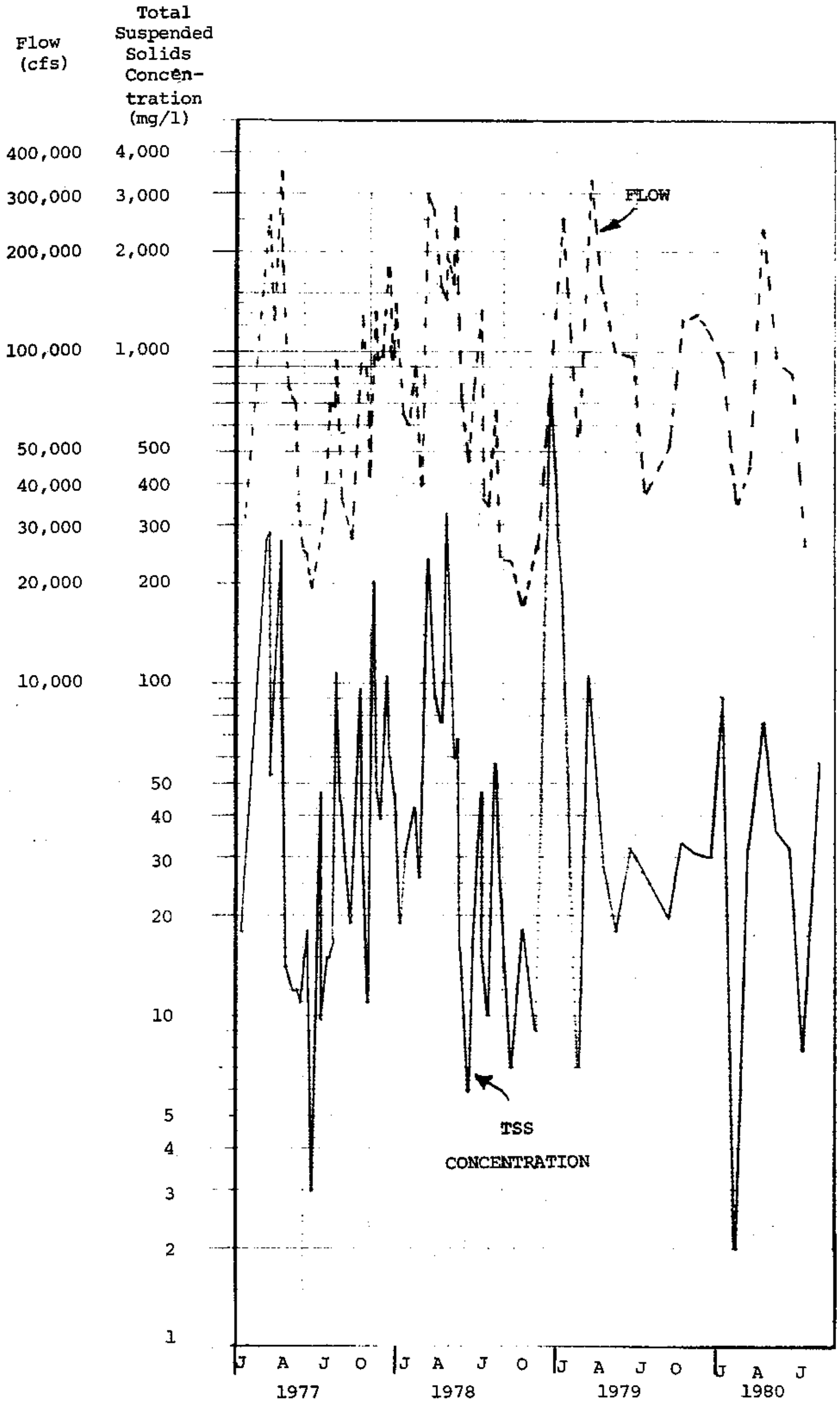



Figure V-5. Flow and Quality Measurements on the Ohio River at Greenup Dam

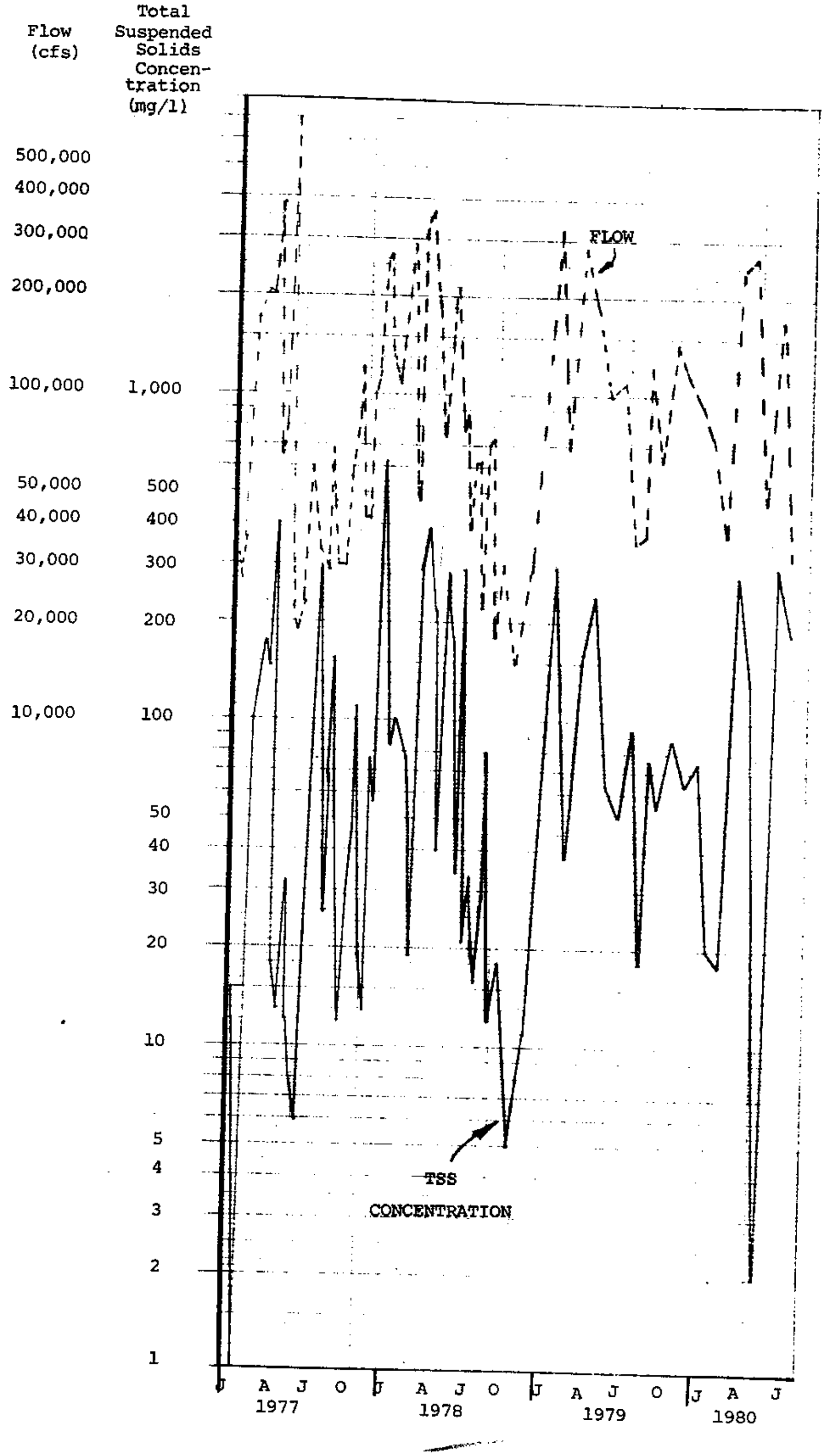



Figure V-6. Flow and Quality Measurements on the Ohio River at Cincinnati, Ohio

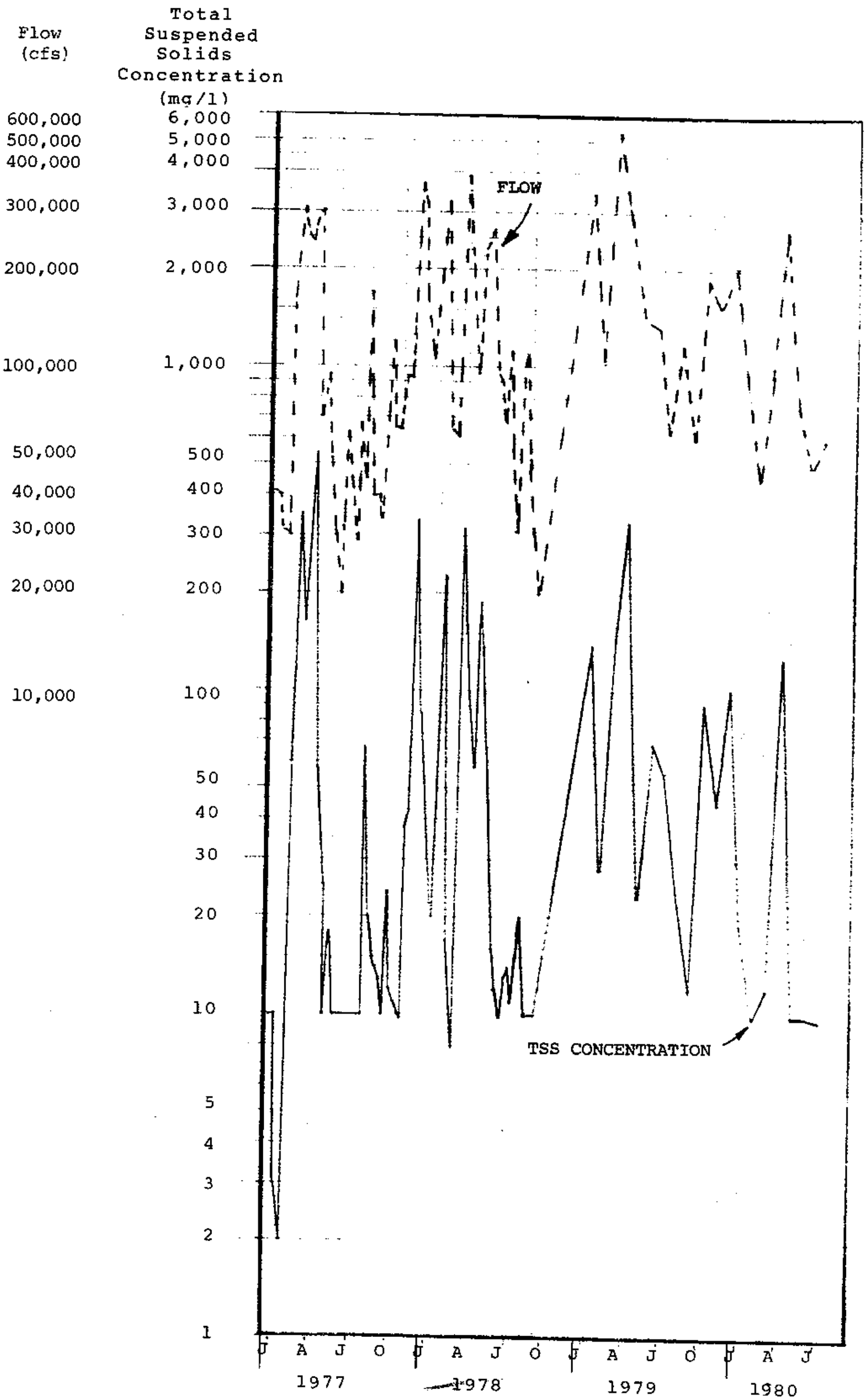



Figure V-7. Flow and Quality Measurements on the Ohio River at Louisville, Kentucky

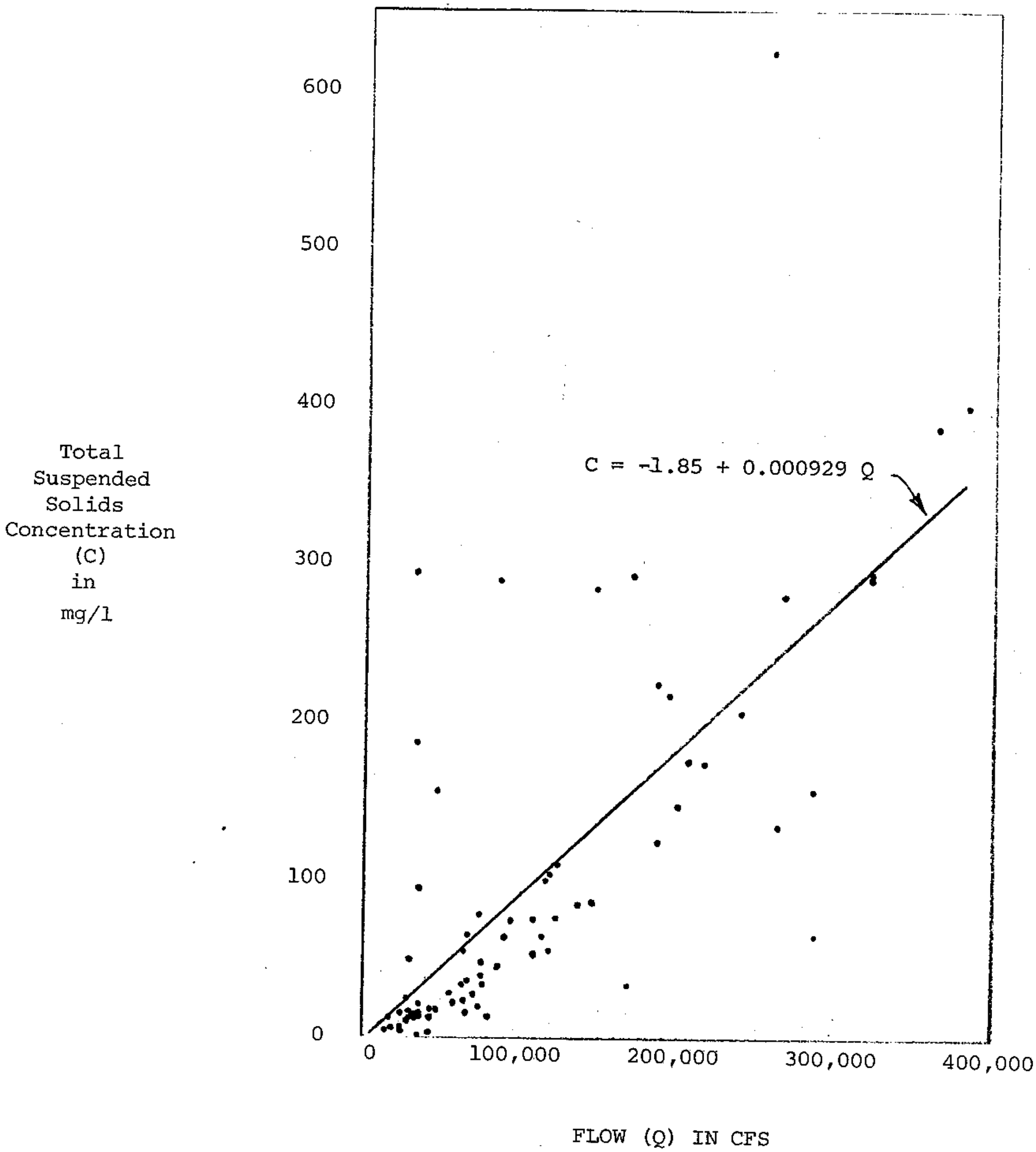



Figure V-8. Relationship between Flow and Total Suspended Solids Concentration in the Ohio River at Cincinnati, Ohio.

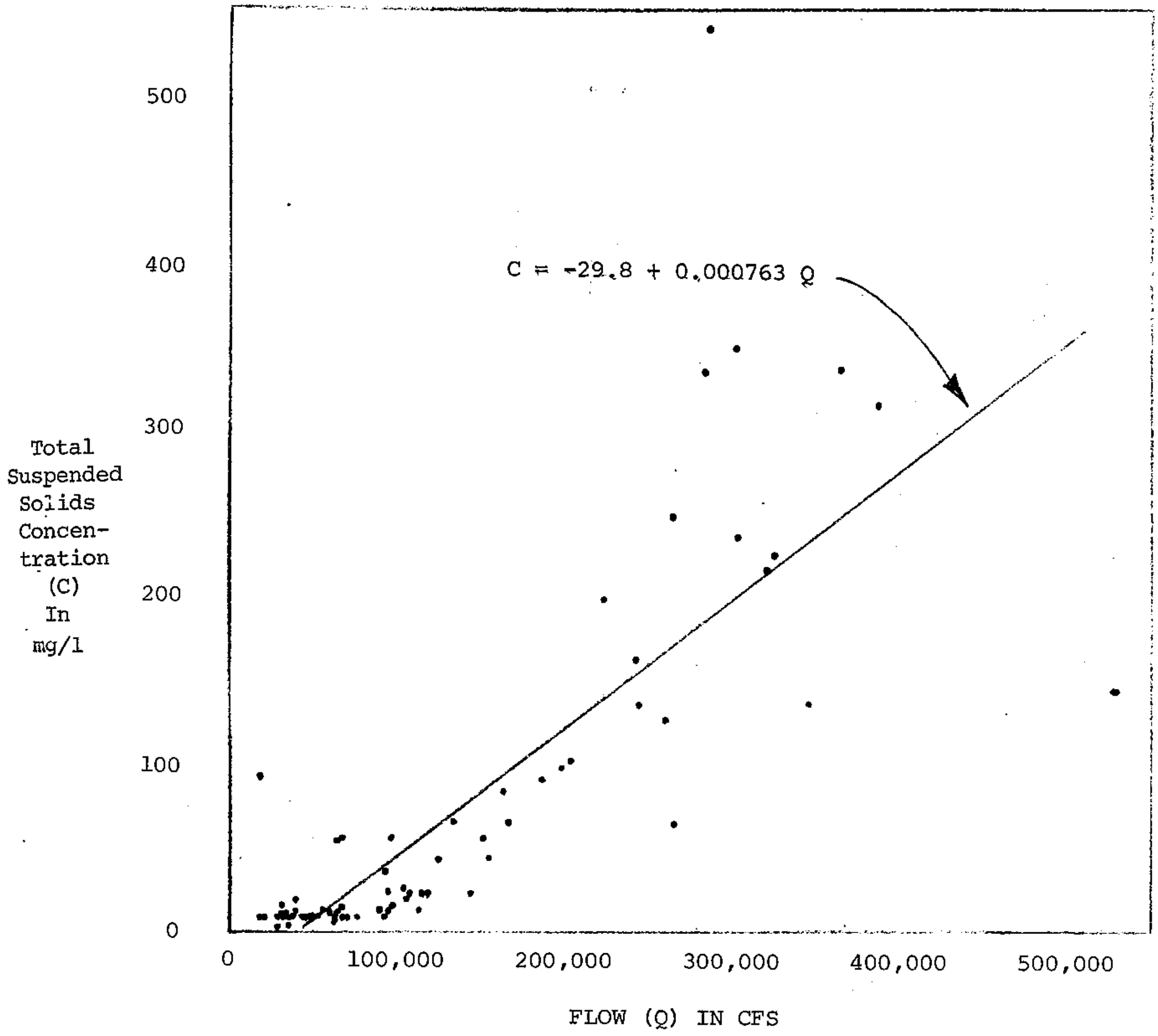



Figure V-9. Relationship between Flow and Total Suspended Solids Concentration in the Ohio River at Louisville, Kentucky.

is illustrated in Figure V-10, which contains a plot of the period's records at Cincinnati. The variability is emphasized here because of its potential impact relative to the operation of a water treatment plant.

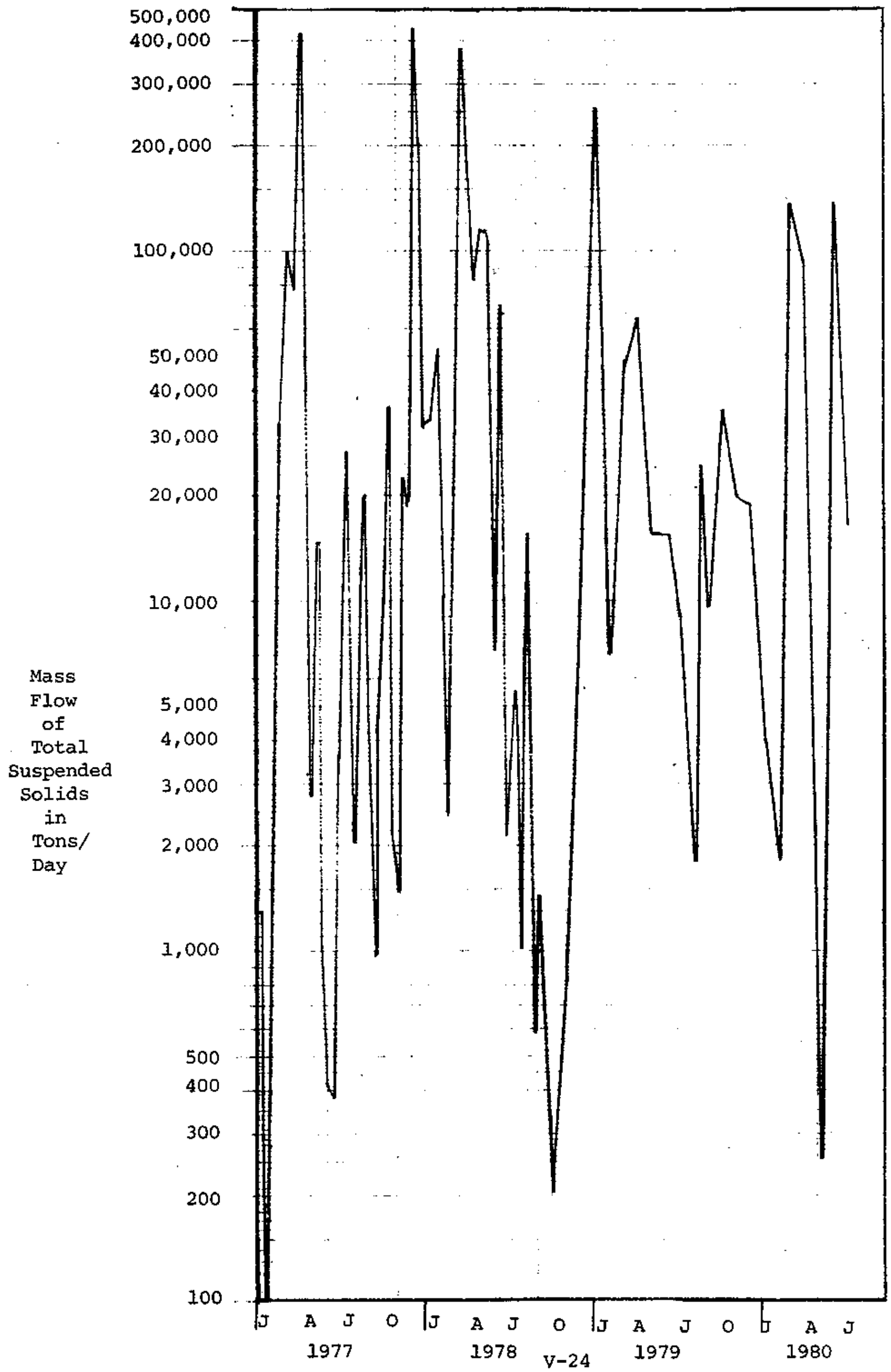
The spatial variation of iron concentration in the Ohio River is shown in Figure V-11. Both the relative variability and the trend toward increasing concentration in the lower Ohio River are reflective of the plot of suspended solids (Figure V-3) for the same time period. Aluminum, another potentially significant constituent relative to water treatment plant operation, is not routinely measured on the Ohio River and thus the background concentrations cannot be assessed.

The variation in both pH and BOD are relatively small. Examination of extensive measurements of pH by the ORSANCO electronic monitors for the years 1978 and 1979, indicates a range of pH from 6.6 to 8.6; however, an overwhelming majority of pH measurements fall in the much narrower range of 6.9 to 7.3. The annual average BOD for the year 1979 varied between 1 and 4.5 mg/l for the 22 ORSANCO-maintained manual stations. The measurements are taken approximately once per month and during 1979 the maximum BOD measured was 8.4 mg/l.

In summary, both flow and concentrations of suspended solids and iron vary significantly. There is a trend of increasing values for both flow and solids/iron from upstream to downstream. Additionally, there is significant correlation between flow and solids concentration, resulting in an even larger variation in the mass flux of solids, which is a multiplicative combination of flow and concentration.

EXISTING WATER TREATMENT PLANT DISCHARGES

An inventory of potable water treatment plants with surface intakes from or discharges to the Ohio River was conducted to identify existing waste treatment and discharge characteristics. A composite list of potential intakes and discharges was compiled from the ORSANCO drinking water intake list (1980) and the ORSANCO wastewater discharge list (1980) as well as an ORSANCO list of water intakes on the Ohio River mainstem (1979). The composite list was then reviewed with state regulatory agency personnel to determine the availability of waste discharge and treatment information and to verify the list. Data collected from state agencies were then verified




V-24

Figure V-10. Total Mass Flow of Suspended Solids in the Ohio River at Cincinnati, Ohio

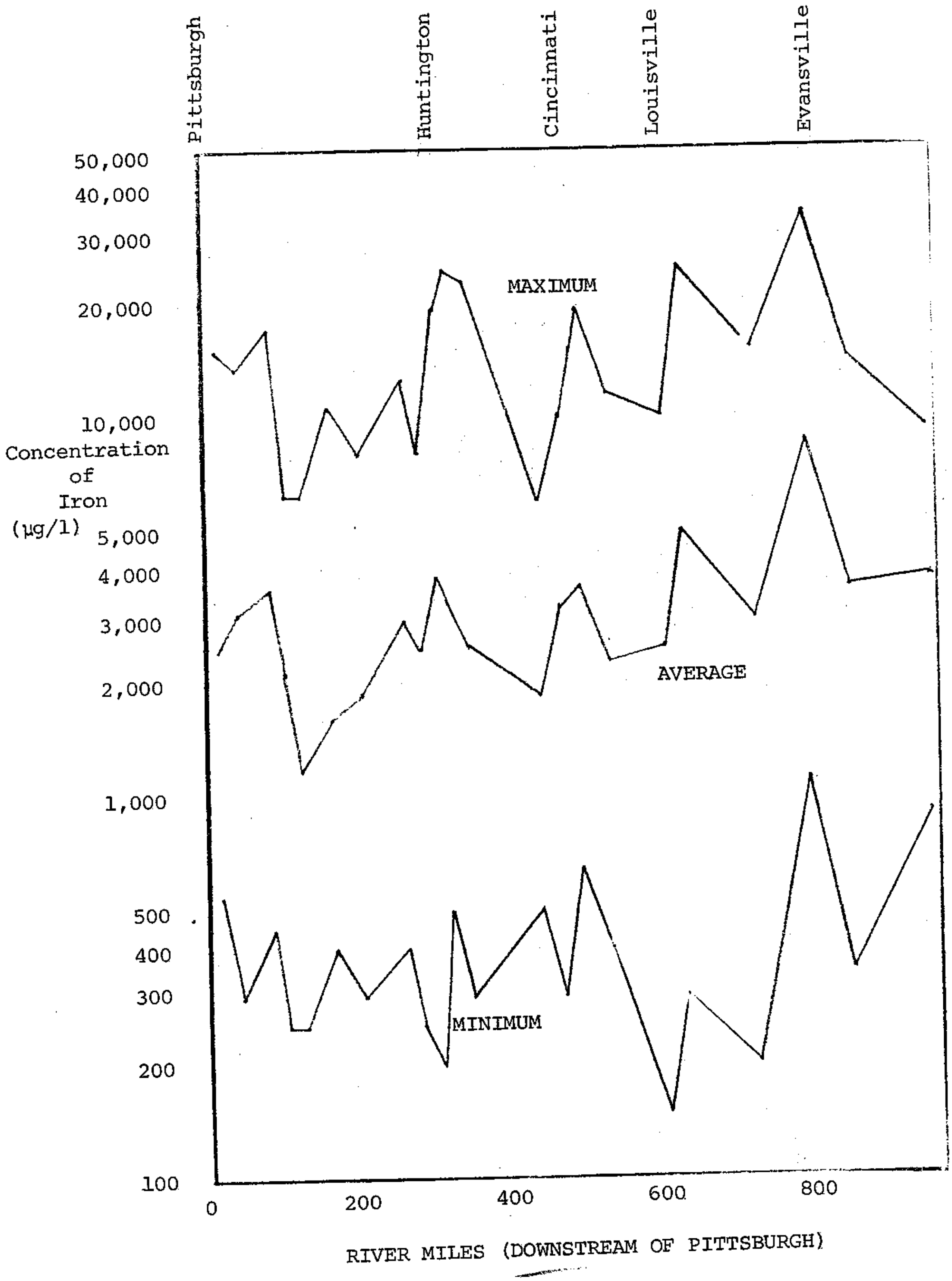



Figure V-11. Profile of Iron Concentration in the Ohio River for January, 1978 - August, 1980.

through telephone interviews with plant personnel and additional data were gathered.

The treatment plant inventory and general plant information is presented in Table V-1. Industrial water users were identified in the ORSANCO listing of water intakes and an industrial discharge listing prepared by the Ohio Environmental Protection Agency. The ORSANCO list is presented in Appendix D; however, it was not possible within the scope of the study to identify industrial water treatment plant waste information from the general discharge data.

Of the 31 identified municipal surface water treatment plants using coagulation/filtration processes, 22 plants discharge wastes directly to the river without treatment, six plants discharge wastes to municipal sewage systems and two plants use lagoon systems and discharge lagoon supernate to the river. Only one facility has installed a mechanical dewatering unit. The 10 MGD Wheeling, West Virginia WTP recently installed a system of sludge thickeners and belt filter presses at a total project cost of $2,193,000.

Analysis of waste discharge, process flow, and chemical use data revealed that an average waste discharge of 0.024MG is produced for each million gallons of water processed. Average reported chemical use per million gallons of process water was 333 lbs. for alum/lime systems, 88 lbs. for ferris sulfate systems, 361 lbs. for alum/lime/PAC systems and 116 lbs. for ferris sulfate/ PAC systems. Six plants use ferric coagulants, while the majority use alum/ lime systems. Powdered carbon is used as required to alleviate taste, color and odor problems. Minimum chemical usage was reported by the plants that use Ranney collectors. Plants utilizing reservoirs or presettling basins also showed lower chemical usage than those using no pretreatment.

Detailed plant effluent data were available for backwash/coagulant waste streams from the Mt. Vernon, Huntington, Louisville and Portsmouth plants. A mass flux analysis was performed to determine the ratio of river suspended solids to discharge suspended solids. These data are presented in Appendix E.

TABLE V - 1

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| WESTVIEW | PA | 4.6 | GROUND WATER AND OHIO RIVER | OHIO RIVER | 24 | 18 | FERRIC CHLORIDE<br>POLYMER<br>SETTLING<br>GAC FILTRATION | LAGOON SUPERNATE | 2 LAGOONS<br>UNDER CONSTRUCTION<br>SOME BACKWASH RECYCLING<br>DRIED SLUDGE TO BE LANDSPREAD |
| DIXMONT HOSPITAL | PA | 7.6 | OHIO RIVER | STP | | | | | STP |
| ROBINSON TWP. | PA | 8.6 | OHIO RIVER | OHIO RIVER | 1.5 | 1.25 | ALUM/LIME<br>$KMnO_4$<br>GAC FILTRATION | BACKWASH 40,000 gpd | NONE |
| CORAOPOLIS BOROUGH | PA | 10.2 | GROUND WATER | | | | | | |
| SEWICKLEY | PA | 11.4 | 60% GROUND WATER<br>40% OHIO RIVER | | | | | | |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| MOON TWP. | PA | 11.7 | GROUND WATER | | | | | | |
| EDGEWORTH | PA | 12.8 | GROUND WATER | | | | | | |
| AMBRIDGE BOROUGH | PA | 17.4 | RESERVOIR | | | | | | |
| ALIQUIPPA BOROUGH | PA | 19.3 | GROUND WATER | | | | | | |
| BADEN BOROUGH | PA | 20.1 | PURCHASE | | | | | | |
| CONWAY BOROUGH | PA | 21.5 | PURCHASE | | | | | | |
| FREEDOM | PA | 23.8 | PURCHASE | | | | | | |
| MONACA | PA | 25.3 | GROUND WATER | | | | | | |
| BEAVER FALLS | PA | 26.0 | BEAVER RIVER | BEAVER RIVER | | 4.5 | ALUM/LIME FILTRATION | BACKWASH 11,000 gpd SLUDGE DISCHARGED ONCE/MO. | NONE |
| MIDLAND BOROUGH | PA | 36.3 | OHIO RIVER | STORM SEWER TO OHIO RIVER | | 4.5 | $FeSO_4$/POLYMER LIME $KMnO_4$ GAC FILTRATION | BASIN 15,000 gpd 7% SOLIDS BACKWASH 60,000 gpd | NONE |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| PITTSBURGH | PA. | | ALLEGHENY RIVER | STP | 200 | 100 | ALUM<br>FERRIC CHLORIDE<br>LIME<br>$KMnO_4$<br>GAC FILTRATION | 7.25 mgd/MO.<br>10,000 PPMSS | BACKWASH RECYCLED |
| CHESTER | W. VA. | 42.1 | OHIO RIVER (RANNEY COLLECTOR) | STP | | | IRON/MANGANESE ION EXCHANGE | | |
| WEIRTON | W. VA. | 62.8 | GROUND WATER | | | | | | |
| WELLSBURG | W. VA. | 74.0 | GROUND WATER | | | | | | |
| WHEELING | W. VA. | 86.8 | OHIO RIVER | SUPERNATE TO STP | 16 | 10 - 11 | PRESETTLING<br>PAC<br>$FeSO_4$ + LIME<br>FILTRATION | | 2 GRAVITY THICKENERS<br>2 BELT FILTER PRESSES<br>5 TONS SLUDGE PER 10 MGD PER DAY<br>BACKWASH WATER RECYCLED<br>5 TONS/DAY TO LANDFILL |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| NEW MARTINSVILLE | W. VA. | 128.1 | GROUND WATER | | | | | | |
| SISTERSVILLE | W. VA. | 137.1 | OHIO RIVER | OHIO RIVER | | 0.23 - 0.26 | ALUM/LIME<br>SODA ASH<br>R.S. FILTRATION | BASIN DRAINED ANNUALLY<br>BACKWASH AS REQUIRED | NONE |
| ST. MARYS | W. VA. | 155.5 | GROUND WATER | | | | | | |
| BELMONT | W. VA. | 158.0 | GROUND WATER | | | | | | |
| PARKERSBURG | W. VA. | 182.2 | OHIO RIVER (RANNEY COLLECTOR) | OHIO RIVER | | 6.5 | ALUM/POLYMER<br>$KMnO_4$<br>FILTRATION | | NONE |
| HUNTINGTON | W. VA. | 304.2 | OHIO RIVER | LAGOON DISCHARGE TO OHIO RIVER | | 17.6 | $FeSO_4$<br>LIME<br>POLYMER | 1 mgd SLUDGE<br>14.8 mgd BACKWASH<br>LOGOON EFFLUENT<br>24.9 mg/d SS<br>1.13 mg/d Fe | 2 LAGOONS<br>SAND BEDS<br>SLUDGE SOLIDS TO LANDFILL |
| HAVERSON HEIGHTS | W. VA. | 70.6 | GROUND WATER | | | | | | |
| EAST LIVERPOOL | OHIO | 40.2 | OHIO RIVER | OHIO RIVER | | 3.2 | ALUM/LIME<br>PAC<br>FILTRATION | BACKWASH<br>60,000 gpd<br>BASINS<br>1 mg/yr<br>ONCE A YEAR | NONE |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| WELLSVILLE | OHIO | 47.2 | YELLOW CREEK | FOUR MILE CREEK | | 1.5 to 1.7 | ALUM/LIME<br>$KMnO_4$<br>R.S. FILTRATION | BACKWASH<br>60,000 gpd<br>BASINS DRAINED EVERY 4 to 5 MO.<br>10,000 GAL. | |
| TORONTO | OHIO | 59 | OHIO RIVER | OHIO RIVER | 2 | | ALUM/LIME<br>PAC<br>R.S. FILTRATION | BASINS DRAINED EVERY 3 MO.<br>500,000 gal. | |
| STEUBENVILLE | OHIO | 65.2 | OHIO RIVER | STP | | 5 - 5.5 | ALUM/LIME<br>PAC<br>$KMnO_4$<br>R.S. FILTRATION | | STP<br>NO CHARGE TO WATER COMPANY |
| MINGO JUNCTION | OHIO | 71 | GROUND WATER | | | | | | |
| TILTONSVILLE | OHIO | 83 | GROUND WATER | | | | | | |
| YORKSVILLE | OHIO | 83.7 | GROUND WATER | | | | | | |
| MARTINS FERRY | OHIO | 88.6 | GROUND WATER | | | | | | |
| BRIDGEPORT | OHIO | 90.2 | WELLS | | | | | | |
| BELLAIRE | OHIO | 94 | GROUND WATER AND OHIO RIVER | | | | | | |
| MARIETTA | OHIO | 171.3 | GROUND WATER | | | | | | |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| POMEROY | OHIO | 250.3 | GROUND WATER | | | | | | |
| GALLIPOLIS | OHIO | 268.6 | GROUND WATER | | | | | | |
| IRONTON | OHIO | 327 | OHIO RIVER | STORMS CREEK 3 MI UPSTREAM OF OHIO RIVER | 5 | 2.46 | ALUM/LIME PAC $KMnO_4$ FILTRATION | BACKWASH BASINS CLEANED TWICE/ YR - 20,000 gpd 1775 mg/l SS | NONE |
| PORTSMOUTH | OHIO | 355.5 | OHIO RIVER | OHIO RIVER | | 7 | ALUM/LIME R.S. FILTRATION | .13 MGD BACKWASH 0.02 MGD SLUDGE | |
| CINCINNATI CALIFORNIA PLANT | OHIO | 462.8 | OHIO RIVER | LITTLE MIAMI RIVER (PROPOSED DISCHARGE TO OHIO RIVER) | 135 MGD (200 MGD PROPOSED) | | PRESETTLING ALUM/POLYMER FERRIC SULFATE GAC FILTRATION | LAGOON DRAINAGE ONCE/YR PROPOSED DAILY DRAINAGE | |
| NEW RICHMOND | OHIO | 449.8 | GROUND WATER | | | | | | |
| ASHLAND | KY | 319.7 | OHIO RIVER | | | | | | |
| GREENUP | KY | 334.7 | LITTLE SANDY RIVER | | | | | | |
| GREENUP | KY | 336.2 | LITTLE SANDY RIVER | | | | | | |
| KENTON CO. TAYLOR MILL PLANT | KY | 462.9 | LICKING RIVER | BANKLICK CREEK | | 10 MGD | PRESETTLING ALUM/LIME PAC MM FILTRATION | 200,00 gpd | HOLDING TANK SUPERNATE RECYCLED |
| KENTON CO. FORT THOMAS PLANT | KY | 463 | OHIO RIVER | CREEK TO LICKING RIVER | 18 | 9.5 to 10 | PRESETTLING ALUM/LIME FILTRATION | BACKWASH 150,000 gpd SLUDGE 2,000 gpd | |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| MAYSVILLE | KY | 408.5 | OHIO RIVER | OHIO RIVER | 2.4 | 1.304 | ALUM/LIME<br>PAC<br>R.S. FILTRATION | BACKWASH-DAILY<br>SLUDGE 2X/YR | NONE |
| NEWPORT | KY | 463.5 | OHIO RIVER | CREEK<br>TO<br>OHIO RIVER | 10.5 | 8.5 | 2 RESERVOIRS<br>ALUM/LIME<br>FILTRATION | SLUDGE<br>10 M. GAL/YR<br>1400 mg/d SS<br>BACKWASH<br>93 M. GAL/YR<br>400-800 MG/L SS | |
| OLDHAM CO. | KY | 582 | OHIO RIVER<br>(RANNEY<br>COLLECTOR) | | 2.8 | 2.2 | C/2<br>SODIUM TRI-POLY<br>PHOSPHATE | NO DISCHARGE | |
| LOUISVILLE<br>CRESCENT HILL<br>PLANT | KY | 600.6 | OHIO RIVER | | | 120 GMD | PRESETTLING<br>ALUM/POLYMER<br>LIME/SODA ASH<br>SOFTENING<br>FILTRATION | LAGOON<br>SUPERNATE<br>4.3 MGD | 1 LAGOON SYSTEM SERVES<br>BOTH PLANTS<br>75 ACRES<br>30-40 YR STORAGE CAPACITY<br>BACKWASH WATER RECYCLED |
| LOUISVILLE<br>B.E. PAYNE<br>PLANT | KY | 594.5 | OHIO RIVER | | | 15 MGD | ALUM/POLYMER<br>LIME/SODA ASH<br>SOFTENING<br>FILTRATION | " | " |
| HAWESVILLE | KY | 723.0 | | | | | | | |
| OWENSBORO | KY | 753.5 | GROUND WATER | | | 10 MGD | AERATION<br>LIME SOFTENING<br>FILTRATION | LAGOON<br>SUPERNATE | 20 ACRE LOGOON<br>25 YEAR CAPACITY |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| HENDERSON | KY | 803.2 | OHIO RIVER (POWER CO. COOLING WATER DISCHARGE) | STP | 6 | 4.5 | ALUM/LIME $KMnO_4$ FILTRATION | BACKWASH 203,300 gpd | STP NO CHARGE TO WATER COMPANY |
| MORGANFIELD | KY | 839.9 | OHIO RIVER | STP | 4 | 1.5 to 2 | RESERVOIR ALUM/LIME PAC R.S. FILTRATION | 50,000 gpd | STP |
| UNIONTOWN | KY | 842.5 | OHIO RIVER | | | | | | |
| MORGANFIELD | KY | 843.0 | OHIO RIVER (RANNEY COLLECTOR) | | | | | | |
| STURGIS | KY | 871.5 | OHIO RIVER AND GROUND WATER | | | | | | |
| PADUCAH | KY | 934.4 | TENNESSEE RIVER | | | | | | |
| INDIANA CITIES WATER CO. EAGLE CREEK | IN. | 609.0 | RESERVOIR | STP | | 24 | ALUM/LIME PAC R.S./GAC FILTRATION | 24,000 gpd 10,000 PPMSS | EQUALIZATION TANK |
| EVANSVILLE | IN. | 791.5 | OHIO RIVER | OHIO RIVER | | 28 | ALUM /LIME PAC CLARIFIERS FILTRATION | | |
| MOUNT VERNON | IN. | 829.3 | OHIO RIVER | OHIO RIVER | 2 | 2 | PRESETTLING ALUM/LIME CLARIFIERS R.S. FILTERS | | NONE |

TABLE V - 1 CONT'D

MUNICIPAL POTABLE WATER TREATMENT PLANT INVENTORY

| PLANT NAME | STATE | RIVER MILE | RAW WATER SOURCE | DISCHARGE TO | CAPACITY MGD | AVERAGE PROCESS FLOW MGD | WATER TREATMENT SYSTEM | WASTE DISCHARGE CHARACTERIZATION | WASTE TREATMENT CHARACTERIZATION |
|---|---|---|---|---|---|---|---|---|---|
| ROSICLARE | ILL | 891.3 | OHIO RIVER | OHIO RIVER | | 0.15 to 0.2 | ALUM/LIME FILTRATION | | |
| GOLCONDA | ILL | 902.3 | OHIO RIVER | LUSK CREEK UPSTREAM OF OHIO RIVER | | 0.13 - 0.18 | ALUM/LIME PAC R.S. FILTRATION | BACKWASH AS REQUIRED SLUDGE EVERY 3 MONTHS | NONE |
| CAIRO | ILL | 977.8 | OHIO RIVER | STP | | | | | |

## CHAPTER VI

## COMMENTS AND RESPONSES

### INTRODUCTION

This document was presented and discussed at meetings of the Committee for the Study of Wastewater Discharges from Water Treatment Plants and the Technical Advisory Committee for ORSANCO on January 6 and 7, 1981. Several issues were raised by members of ORSANCO with regard to the report, both at these meetings and by subsequent written communication. The purpose of this chapter is to summarize and address the substantive issues which were raised.

### COMMENTS AND RESPONSES

The issue of using diffusers as an alternative or additional waste treatment option was raised. Of particular concern were the cost and practicality of diffusers.

Estimates of the costs of diffusers for various sized water treatment plants are presented below:

| Water Treatment Plant Capacity (Million Gallons Per Day) | Diffuser Costs (Dollars Per Foot) |
|---|---|
| 1 | 90 |
| 10 | 130 |
| 100 | 300 |

These estimates are based on December, 1980, costs for discharge of water treatment wastes and do not include sludge treatment costs (prior to discharge) or the cost of transport (including any necessary pumping) to the edge of the receiving stream. These costs should be used only as average values, because the actual construction costs may vary considerably depending upon: the type of pipe used, the method of bracing and anchoring the pipe, and the availability of local contractors and equipment.

The practicality of effluent diffusers to dispose of water treatment sludge in the Ohio River is somewhat questionable. Analyses of thermal discharges to the Ohio River (Argonne, 1974) has shown complete lateral mixing of waste discharges, generally within much less than one mile from the point of discharge. Thus, considerable dispersion capacity exists without the utilization of diffusers. The existence of the navigational channel in the middle of the river would complicate construction of the diffusers at effective distances off shore. The density of river traffic would impede construction within the channel (if not make it impossible) and a limited distance between the shore and the edge of the channel may preclude the effective use of diffusers in this area. If dispersion of effluent solids beyond that achieved by existing outfalls is desirable, it may be appropriate to construct an outfall to the edge of the shipping channel, thereby taking advantage of the potential lateral and vertical mixing induced by the extensive navigation in this area.

Two commentators requested that data pertaining to the toxic concentration of water treatment plant sludges be provided in the report. The limited amount of toxic data available is presented in Appendix G. Except for iron and aluminum, these effluent concentrations reflect the background levels of toxics resident in the river at the point of the raw water intake to each water treatment facility; thus, discharge of these constituents constitutes no additional loading to the river. The addition of iron and aluminum to the receiving stream, as a result of water treatment practices, is adequately discussed in the foregoing chapters of the report.

One commentor also suggested that "the problem of precursors of trihalomethane formation" be addressed. Trihalomethane formation is a result of chlorine reacting with certain chemicals present in a raw water supply. While concentration of these materials in water treatment plant sludges along the Ohio River is largely undocumented, precursors of such reactions would occur in water treatment sludges only where prechlorination ahead of those processes producing waste sludges occur. Such prechlorination practices are not very common among water treatment facilities along the Ohio River. In any case, ORSANCO is currently developing changes in its existing regulations to require that the character of the handling and ultimate discharge of water treatment sludges be examined and predicated on a case-by-case basis. Any problems with trihalomethane precursors or other toxics contained in water treatment sludges will necessarily be part of the resulting regulations.

Another commentator indicated that "best professional judgment" should be applied to each water treatment plant discharge to derive the level of treatment required. This comment is in complete agreement with alternative two as presented in Chapter I of this report, which is the course of action currently being undertaken by ORSANCO (as discussed above); however, this commentator is also advocating a "basinwide or nationwide" standard which seems to preclude consideration of best professional judgment or cost-effective analysis on a case-by-case basis.

This same commentator also questioned the "large differences among EPA regions and between the states" with regard to the administrative approaches to the permitting of water treatment plants discharges and whether these differences "are not somewhat exaggerated." The presentation of the procedures for permitting water treatment plant discharges conducted by the various agencies are factual descriptions based on interviews with or letters from the various entities involved. These interviews/letters are presented as they were recorded or received in Appendix B; no attempt was made to "exaggerate" the positions or responses provided by the entities or individuals contacted.

# APPENDICES

# OHIO RIVER VALLEY WATER SANITATION COMMISSION

*An interstate agency representing: Illinois • Indiana • Kentucky • New York • Ohio • Pennsylvania • Virginia • West Virginia. Headquarters: 414 Walnut Street, Cincinnati, Ohio 45202*

## Notice of Requirements (Standards Number 1-70 and 2-70) Pertaining to Sewage and Industrial Wastes Discharged to the Ohio River

You are hereby notified that on November 13, 1970, the Ohio River Valley Water Sanitation Commission, acting in accordance with and pursuant to authority contained in Article VI of the Ohio River Valley Water Sanitation Compact, established, subject to revision as changing conditions require, the attached standards for the modification or treatment of all sewage from municipalities or other political subdivisions, public or private institutions, corporations, or watercraft, and for the modification or treatment of all industrial wastes discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0, to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi rivers, and being 981.0 miles downstream from Pittsburgh, Pennsylvania.

Under terms and provisions of the Ohio River Valley Water Sanitation Compact all sewage from municipalities or other political subdivisions, public or private institutions, corporations or watercraft and all industrial wastes discharged or permitted to flow into the Ohio River will be required to be modified or treated to the extent specified in the attached standards.

Robert K. Horton
*Executive Director and Chief Engineer*

## DEFINITIONS AND PROCEDURES FOR APPLICATION OF POLLUTION CONTROL STANDARDS NOS. 1-70, 2-70

The following definitions and application procedures are incorporated as part of Pollution Control Standards Nos. 1-70, 2-70:

(a) "Sewage" means the water carried human or animal wastes from residences, buildings, industrial, commercial or governmental establishments, public or private institutions, watercraft and floating facilities, or other places, together with such groundwater infiltration and surface-waters as may be present. The admixture with sewage, as defined, of industrial wastes, as hereinafter defined, shall also be regarded as sewage;

(b) "Industrial waste," other than cooling water, means any liquid, gaseous, solid material or waste substance or combination thereof including garbage, refuse, decayed wood, sawdust, shavings, bark, sand, lime, cinders, ashes, offal, oil, tar, dyestuffs, acids, chemicals, heat and all discarded matter resulting from any process or operation, including storage and transportation, manufacturing, commercial, agricultural and government operations, or from the development and recovery of any natural resources;

(c) "Cooling water" means water used as a heat transfer medium to which no process, waste or other materials, exclusive of chlorine, are added intentionally or unintentionally prior to discharge;

(d) "Substantially complete removal" means removal to the lowest practicable level attainable with current technology;

(e) Methods for determining waste constituents and characteristics shall be those set forth in the most recent edition of "Standard Methods for the Examination of Water and Wastewater," prepared and published jointly by the American Public Health Association, American Water Works Association, and the Water Pollution Control Federation, except that such other methods may be used as are approved by the Commission.

## POLLUTION CONTROL STANDARD NO. 1-70

All sewage from municipalities or political subdivisions, public or private institutions, or installations, or corporations, or watercraft, and all industrial wastes, other than cooling water as hereinafter defined, discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0, to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi rivers, and being 981.0 miles downstream from Pittsburgh, shall be so treated or otherwise modified as to provide for:

A. Substantially complete removal of settleable solids;

B. Substantially complete removal of oil (in whatever state, including free, emulsified, dispersed and dissolved oils), debris, scum, and other floating materials;

C. Reduction of suspended solids, dissolved solids and other materials to such degree that the discharge will not produce turbidity, color or odor in the river, or impart taste to potable water supplies, or cause the tainting of fish flesh;

D. Reduction of any and all constituent materials to such a degree that the concentration thereof, singly or in combination, in any discharge is not harmful to human health, and reduction of the following chemicals to such a degree that the concentrations thereof in any discharge do not exceed (1) the limits specified in the tabulation below or (2) such lower limits as may be required for compliance with subparagraph (E) of this Pollution Control Standard No. 1-70:

| | Limiting concentration (mg/1) |
|---|---|
| **Inorganic chemicals** | |
| Arsenic | 0.05 |
| Barium | 1.0 |
| Cadmium | 0.01 |
| Chromium (hexavalent) | 0.05 |
| Lead | 0.05 |
| Mercury | 0.005 |
| Selenium | 0.01 |
| Silver | 0.05 |
| **Organic chemicals** | |
| Cyanide | 0.2 |
| **Pesticides** | |
| Aldrin | 0.017 |
| Chlordane | 0.003 |
| DDT | 0.042 |
| Dieldrin | 0.017 |
| Endrin | 0.001 |
| Heptachlor | 0.018 |
| Heptachlor epoxide | 0.018 |
| Lindane | 0.056 |
| Methoxychlor | 0.035 |
| Organic phosphates plus carbamates (as parathion equivalent cholinesterase inhibition) | 0.1 |
| Toxaphene | 0.005 |
| **Herbicides** | |
| 2,4-D plus 2,4,5-T plus 2,4,5-TP | 0.1 |

E. Reduction of any material or, if necessary, all materials contained in any discharge which singly or in combination are toxic or harmful to aquatic life to such a degree or degrees that the calculated concentration(s) of such material or materials in the river does not exceed one-twentieth of the 96-hour median tolerance limit (96-hr. $TL_m$) for aquatic life;

F. Reduction of radioactive materials to such degree that (1) concentrations of *unidentified* radionuclides in the discharge do not exceed (a) 30 pc/l or (b) limiting values specified by the Atomic Energy Commission for water in which certain radionuclides are known to be absent, as set forth in Column 2, Table II, Paragraph 3.C, Notes to Appendix B, Title 10, Chapter 1, Code of Federal Regulations (January 1, 1970), or (2) concentrations of *identified* radionuclides in the discharge do not exceed limiting values for water specified by the Atomic Energy Commission, as set forth in Column 2, Table II, Appendix B, Title 10, Chapter 1, Code of Federal Regulations (January 1, 1970);

G. Reduction of fecal coliform bacteria to such degree that (1) during the months of May through October fecal coliform density in the discharge does not exceed 200 per 100 ml as a monthly geometric mean (based on not less than ten samples per month), nor exceed 400 per 100 ml in more than ten percent of the samples examined during a month, and (2) during the months of November through April the density does not exceed 1,000 per 100 ml as a monthly geometric mean (based on not less than ten samples per month), nor exceed 2,000 per 100 ml in more than ten percent of the samples examined during a month;

H. Control of hydrogen ion concentration to such degree that the pH is not less than 5.0 nor greater than 9.0;

I. Reduction in 5-day biochemical-oxygen-demand load (pounds per day) of not less than 92 percent (as a monthly-average value), provided, however, that a lesser degree of reduction may be applied, but not less than 85 percent (monthly-average value), if as a result the biochemical-oxygen-demand (BOD) load does not exceed that amount which will increase the BOD of the river, on a calculated basis, by more than 0.05 milligrams per liter at flows equal to or exceeding "critical" flow values specified in the following table:

| River Reach | | Critical flow in cfs* |
|---|---|---|
| From | To | |
| Pittsburgh (mi. 0.0) | Willow Is. Dam (161.7) | 6,600 |
| Willow Is. Dam (161.7) | Gallipolis Dam (279.2) | 7,700 |
| Gallipolis Dam (279.2) | Meldahl Dam (436.2) | 9,900 |
| Meldahl Dam (436.2) | McAlpine Dam (605.8) | 12,100 |
| McAlpine Dam (605.8) | Uniontown Dam (846.0) | 14,300 |
| Uniontown Dam (846.0) | Smithland Dam (918.5) | 20,000 |
| Smithland Dam (918.5) | Cairo Point (981.0) | 48,500 |

*Minimum 7-day flow once in ten years.

J. Reduction of heat content to such degree that the aggregate heat-discharge rate from the municipality, subdivision, institution, installation or corporation, as calculated on the basis of discharge volume and temperature differential (temperature of discharge minus average upstream river temperature), does not exceed the amount calculated by the following formula, provided, however, that in no case shall the aggregate heat-discharge rate be of such magnitude as will result in a calculated increase in river temperature of more than 5 deg. F.;

Allowable heat-discharge rate (Btu/sec) =
$62.4 \times$ river flow (cfs) $\times (T_A - T_R) \times 90\%$

Where:

$T_A$ = Allowable maximum temperature (deg. F.) in the river as specified in the following table:

| | $T_A$ | | $T_A$ |
|---|---|---|---|
| January | 50 | July | 89 |
| February | 50 | August | 89 |
| March | 60 | September | 87 |
| April | 70 | October | 78 |
| May | 80 | November | 70 |
| June | 87 | December | 57 |

$T_R$ = River temperature (daily average in deg. F.) upstream from the discharge

River flow = measured flow but not less than critical flow values specified in the following table:

| River Reach | | Critical flow in cfs* |
|---|---|---|
| From | To | |
| Pittsburgh, Pa. (mi. 0.0) | Willow Is. Dam (161.7) | 6,500 |
| Willow Is. Dam (161.7) | Gallipolis Dam (279.2) | 7,400 |
| Gallipolis Dam (279.2) | Meldahl Dam (436.2) | 9,700 |
| Meldahl Dam (436.2) | McAlpine Dam (605.8) | 11,900 |
| McAlpine Dam (605.8) | Uniontown Dam (846.0) | 14,200 |
| Uniontown Dam (846.0) | Smithland Dam (918.5) | 19,500 |
| Smithland Dam (918.5) | Cairo Point (981.0) | 48,100 |

*Minimum daily flow once in ten years.

# POLLUTION CONTROL STANDARD NO. 2-70

All cooling water from municipalities or political subdivisions, public or private institutions, or installations, or corporations discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0 to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi rivers, and being 981.0 miles downstream from Pittsburgh, Pennsylvania, shall be so regulated or controlled as to provide for reduction of heat content to such degree that the aggregate heat-discharge rate from the municipality, subdivision, institution, installation or corporation, as calculated on the basis of discharge volume and temperature differential (temperature of discharge minus upstream river temperature) does not exceed the amount calculated by the following formula, provided, however, that in no case shall the aggregate heat-discharge rate be of such magnitude as will result in a calculated increase in river temperature of more than 5 deg. F.:

Allowable heat-discharge rate (Btu/sec) = $62.4 \times$ river flow (cfs) $\times (T_A - T_R) \times 90\%$

Where:

$T_A$ = Allowable maximum temperature (deg. F.) in the river as specified in the following table:

| | $T_A$ | | $T_A$ |
|---|---|---|---|
| January | 50 | July | 89 |
| February | 50 | August | 89 |
| March | 60 | September | 87 |
| April | 70 | October | 78 |
| May | 80 | November | 70 |
| June | 87 | December | 57 |

$T_R$ = River temperature (daily average in deg. F.) upstream from the discharge

River flow = measured flow but not less than critical flow values specified in the following table:

| River Reach: From | River Reach: To | Critical flow in cfs[a] |
|---|---|---|
| Pittsburgh, Pa. (mi. 0.0) | Willow Is. Dam (161.7) | 6,500 |
| Willow Is. Dam (161.7) | Gallipolis Dam (279.2) | 7,400 |
| Gallipolis Dam (279.2) | Meldahl Dam (436.2) | 9,700 |
| Meldahl Dam (436.2) | McAlpine Dam (605.8) | 11,900 |
| McAlpine Dam (605.8) | Uniontown Dam (846.0) | 14,200 |
| Uniontown Dam (846.0) | Smithland Dam (918.5) | 19,500 |
| Smithland Dam (918.5) | Cairo Point (981.0) | 48,100 |

[a] Minimum daily flow once in ten years.

## APPENDIX B

## REPRESENTATIVE STATE/REGIONAL/FEDERAL

## REGULATIONS CONCERNING WATER TREATMENT PLANT DISCHARGES

### ARKANSAS

Reference: Avelino DeGuzman, Chief Water Engineer, Permits Branch, Department of Pollution Control and Ecology, Personal Communication, November 19, 1980.

State policy encourages the recycle of filter backwash waters. Where recycle is not possible, general regulations concerning discharges are applied. The parameters involved are generally pH, TSS, turbidity, color and possible some heavy metals such as iron, zinc, barium, and manganese. At present, the marginal treatment permittable is a holding basin or lagoon with at least 24 hours detention time and 10-year sludge holding capacity, provided with proper baffles for energy dissipation and prevention of floating solids carryover. In addition, the available free board should be adequate to contain the high flows during backwash cycles. Discharge outlets should be for a uniform rate of flow to assure sufficient detention time in the basin.

### CALIFORNIA

Reference: Edwin Anton, Supervising Water Resources Control Engineer, Technical Services Division, State Water Resources Control Board, Personal Communication, November 20, 1980.

There is no state policy specifically designed to control discharges from water treatment plants. Generally effluent requirements for filter backwash water include limitations only on total suspended solids.

### GEORGIA

Reference: Gene B. Walsh, Chief, Water Protection Branch, Environmental Protection Division, Department of Natural Resources, Personal Communication, December 17, 1980.

There are no specific state policies or regulations on waste discharges from water treatment plants. NPDES permits are being issued on a case-by-case basis.

### ILLINOIS

Reference: Illinois Pollution Control Board Rules and Regulations, Chapter 3: Water Pollution

State policy requires an NPDES permit for all water treatment plants. The following effluent limitations must be met by all discharges:

| | |
|---|---|
| Total Suspended Solids | $< 15$ mg/l |
| Total Iron | $< 2$ mg/l |
| pH | 5 - 10 |

INDIANA

Reference: Indiana Water Treatment Plant NPDES Criteria

Requirement based on stream/discharge dilution ratio:

| RATIO | SUSPENDED SOLIDS | |
|---|---|---|
| | Monthly Avg. | Daily Avg. |
| less then 3:1 | 10 mg/l | 20 mg/l |
| 3:1 or greater | 20 mg/l | 30 mg/l |
| 3:1 or greater - surface water plant returning solids to same source as intake provided there is no sludge deposition. | No limit except for new plants. | |

KENTUCKY

Reference: Clyde P. Baldwin, Department for Natural Resources and Environmental Protection, Personal Communication, October 18, 1978.

All new water treatment plants are required to provide facilities to treat the sedimentation basin waste and the filter backwash water. All facilities are permitted under NPDES-established effluent limitations.

MISSOURI

Reference: Rules of Department of Natural Resources, Division 20, Clean Water Commission, Chapter 7, Water Quality

For the Missouri and Mississippi Rivers the release of suspended solids which are present in stream water and which are removed during treatment may be returned to the same body of water from which they were taken, along with any additional suspended solids resulting from the treatment for a public potable water supply or industrial water supply using essentially the same process as a public water treatment process.

NEW YORK

Reference: George Hansen, New York State Department of Environmental Conservation, Personal Communication, October 31, 1979.

All facilities must meet suspended solids limits of 20 mg/l daily average, 40 mg/l daily max.

NORTH CAROLINA

Reference: Division of Environmental Management Policy Concerning Waste Discharges from Water Treatment Plants

All water treatments discharging sludges or filter backwash must obtain an NPDES permit and comply with the following limitations:

(a) Total Suspended Solids, Average 30 mg/l; Daily Maximum, 60 mg/l

(b) 30 Minutes Settleable Solids, Average 0.1 mg/l; Daily Maximum 0.2 mg/l.

In addition to the effluent limitations, the discharge may not increase the in-stream turbidity by more than 10 Jackson Turbidity Units in cold water streams nor 50 JTU's in warm water streams. The discharge may not increase the pH in the receiving stream to above 8.5 nor reduce it to below 6.0.

Disposal of sludges resulting from the operation of treatment works must comply with the Resource Conservation and Recovery Act and regulation promulgated pursuant thereto.

OHIO

Reference: Water Treatment Plants, Tentative Guidelines, July, 1975.

State policy includes "tentative guidelines" for various types of water treatment plant facilities. Suggested maximum effluent concentrations in lime-soda type WTP's are as follows:

| | Min. | Ave. | Max. |
|---|---|---|---|
| Suspended Solids | - | 30 | 90 |
| pH | 7.0 | - | 11.5 |

No discharge to a stream is suggested for alum sludge from plain purification plants.

PENNSYLVANIA

Reference: Department of Environmental Resources, Title 25 Rules and Regulations

Water treatment plant wastes are considered as industrial wastes and thus must adhere to the following general standards:

Industrial wastes regulated by this Chapter shall meet the following quality standards:

(1) There shall be no discharge of wastes which are acid.

(2) Wastes shall have a pH of not less than 6.0 and not greater than 9.0 except the wastes discharged to acid streams may have a pH greater than 9.0.

(3) Wastes shall not contain more than 7.0 mg/l of dissolved iron.

(4) When surface waters are used in the industrial plant, the quality of the effluent need not exceed the quality of the raw water supply if the source of supply would normally drain to the point of effluent discharge.

Specific effluent requirements for filter backwash are as follows:

(a) The backwash from the operation of water filters shall be settled in sumps or equivalent devices adequate to provide at least an eight-hour retention period, and so arranged as to provide quiescent sedimentation and the discharge of the clarified effluent free from settleable solids and substantially free from turbidity.

(b) The sludge from any sedimentation basins which precede the filter units shall be removed periodically and disposed of in such a manner so as not to be drained or washed into the waters of this Commonwealth.

TEXAS

Reference: Dick Whittington, Deputy Director, Texas Department of Water Resources, Personal Communication, November 19, 1980.

State policy encourages the recycling of wastewater. Where a discharge is made, a permit is required regulating total suspended solids as follows:

| | |
|---|---|
| 30-day average | < 25 mg/l |
| Daily maximum | < 45 mg/l |

VIRGINIA

Reference: Memo to State Water Control Board from Larry G. Lawson, September 28, 1978.

State policy calls for all facilities to provide treatment by July 1, 1984, to meet the following:

pH - based on water quality standards

Suspended solids - daily average 30 mg/l, daily maximum 60 mg/l.

WEST VIRGINIA

Reference: West Virginia Administrative Regulations, State Water Resources Board, Chapter 20, Articles 5 and 5A; and Memo to Industrial Staff from Randy Sovic, DNR, on August 14, 1979.

State regulations require treatment and specify methods of disposal that may be considered (lagoons, sludge beds, community wastewater facilities, etc.).

Policy is to require the following suspended solids limits:

| | Avg. (mg/1) | Max. (mg/1) |
|---|---|---|
| Facilities monitored more than monthly | 30 | 60 |
| Facilities monitored monthly or less | -- | 60 |
| Facilities on low flow streams | -- | 45 |

WISCONSIN

Reference: Memo to Industrial Wastewater Section from Paul Didier and Bob Baumeister, dated June 6, 1975.

The following guidelines are employed in issuing permits to water treatment plants:

| | | | LIMIT | |
|---|---|---|---|---|
| Type of Plant (1) | Parameter | Min. | Avg. | Max. |
| Alum Coagulation | Suspended Solids | --- | 20 mg/1 | 40 mg/1 |
| | pH | 6.0 | --- | 9.0 |
| Lime Softening | Suspended Solids | --- | 20 mg/1 | 40 mg/1 |
| | pH | 6.0 | --- | 11.0 |
| Iron Removal | Suspended Solids | --- | 20 mg/1 | 40 mg/1 |
| Zeolite Softening | Total Dissolved Solids (2) | | Controlled Release Rate | |

(1) For plants performing a combination of these activities, the parameters shall be additive; that is, an alum coagulation and lime softening plant would have suspended solids limits of 20 average, 40 maximum and pH limited to the 6.0 - 11.0 range. Likewise, a combination iron removal, zeolite softening plant would have suspended solids limited to 20 average, 40 maximum and also monitor total dissolved solids and discharge the waste at a controlled rate.

(2) For those zeolite softening plants discharging to a sufficiently large receiving water, a controlled-release rate, and thus total dissolved solids monitoring, will not be required.

## WYOMING

Reference: Memo to Water Quality Division Engineers from William L. Garland, September 26, 1977.

No new water treatment plant may discharge sludges or filter backwash water to a stream.

## DELAWARE RIVER BASIN COMMISSION

Reference: Delaware River Basin Commission, Resolution No. 80-2, Amendment to the Comprehensive Plan and Basin Regulations

Water treatment plants are considered as equivalent to industrial facilities which must meet the following limitations on total suspended solids:

- < 100 mg/l as a 30-day average
- at least 85 percent reduction as a 30-day average.

## USEPA REGION I

Reference: Bernie Sachs, Personal Communication, December 4, 1980.

Policy encourages discharges to community treatment facilities. Where discharge is to the stream, the limitations on total suspended solids are;

< 30 mg/l monthly average

< 50-60 mg/l daily average

Recycling is encouraged with emergency discharge allowed on a period not to exceed 24 days per year.

## USEPA Region IV

Reference: William Cloward, Chief of Permits, Personal Communication, December 11, 1980.

Mr. Cloward indicated that the policy that Region IV follows is that once the solids are removed from the raw water they should not be discharged to a stream.

USEPA Region V

Reference: Peter Sperapolis, Personal Communication, December 2, 1980.

Water treatment plants are considered industrial dischargers. Since there are no federal regulations, state discharge limitations and water quality standards apply. The effluent limitations are generally in the range of 20-40 mg/l of TSS.

APPENDIX C

MAXIMUM - MINIMUM UNIT PROCESS COSTS - 10 MGD WATER TREATMENT PLANT

| UNIT PROCESS | | DATE 1979 | TOTAL[1] SOLIDS GENERATED LBS./10 mgd | LIME + ALUM CAPITAL COST $/10 mgd | LIME + ALUM O & M COST $/10 mgd | LIME + ALUM TOTAL[2] ANNUAL COST $/10 mgd | LIME + ALUM TOTAL COST $/LB. | TOTAL[1] SOLIDS GENERATED LBS./10 mgd | LIME + ALUM + PAC CAPITAL COST $/10 mgd | LIME + ALUM + PAC O & M COST $/10 mgd | LIME + ALUM + PAC TOTAL[2] ANNUAL COST $/10 mgd | LIME + ALUM + PAC TOTAL COST $/LB. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAGOON | -MAX | 4 JAN. | 24,990 | 80,920 | 65,450 | 73,088 | 2.925 | 25,270 | 80,920 | 65,450 | 73,088 | 2.892 |
| | -MIN | 7 AUG. | 2,140 | 15,470 | 6,902 | 8,362 | 3.908 | 2,420 | 16,660 | 7,378 | 8,951 | 3.699 |
| SAND BEDS | -MAX | 4 JAN. | 24,990 | 380,800 | 59,500 | 95,444 | 3.819 | | 380,800 | 59,500 | 95,444 | 3.777 |
| | -MIN | 7 AUG. | 2,140 | 53,550 | 11,781 | 16,836 | 7.867 | | 57,120 | 13,090 | 18,482 | 7.637 |
| BELT FILTER | -MAX | 4 JAN. | 24,990 | 2,142,000 | 154,700 | 356,890 | 14.281 | | 2,142,000 | 154,700 | 356,883 | 14.123 |
| PRESS | -MIN | 7 AUG. | 2,140 | 249,900 | 22,610 | 46,198 | 21.588 | | 261,800 | 23,800 | 48,511 | 20.046 |
| GRAVITY | -MAX | 4 JAN. | 24,990 | 214,200 | 4,879 | 25,097 | 1.004 | | 214,200 | 4,879 | 25,097 | 0.993 |
| THICKENER | -MIN | 7 AUG. | 2,140 | 73,780 | 2,023 | 8,987 | 4.20 | | 77,350 | 2,142 | 9,443 | 3.902 |
| FILTER | -MAX | 4 JAN. | 24,990 | 952,000 | 178,500 | 268,359 | 10.739 | | 952,000 | 178,500 | 268,359 | 10.62 |
| PRESS | -MIN | 7 AUG. | 2,140 | 428,400 | 101,150 | 141,587 | 66.162 | | 452,200 | 101,150 | 143,833 | 59.435 |
| VACUUM | -MAX | 4 JAN. | 24,990 | 654,500 | 202,300 | 264,078 | 10.567 | | 654,500 | 208,250 | 270,028 | 10.686 |
| FILTER | -MIN | 7 AUG. | 2,140 | 238,000 | 38,080 | 60,545 | 28.292 | | 249,900 | 41,650 | 65,238 | 26.958 |
| DECANTER | -MAX | 4 JAN. | 24,990 | 476,000 | 54,740 | 99,670 | 3.988 | | 476,000 | 57,120 | 102,050 | 4.038 |
| CENTRIFUGE | -MIN | 7 AUG. | 2,140 | 214,200 | 17,850 | 38,068 | 17.789 | | 214,200 | 19,040 | 39,258 | 16.222 |
| BASKET | -MAX | 4 JAN. | 24,990 | 952,000 | 111,860 | 201,719 | 8.072 | | 963,900 | 113,050 | 204,033 | 8.074 |
| CENTRIFUGE | -MIN | 7 AUG. | 2,140 | 226,100 | 19,040 | 40,382 | 18.87 | | 226,100 | 19,040 | 40,382 | 16.687 |
| SURGE TANK | -MAX | 4 JAN. | 24,990 | 440,300 | NA | 41,560 | 1.663 | | 440,300 | NA | 41,560 | 1.645 |
| $/10 MGD | -MIN | 7 AUG. | 2,140 | 440,300 | NA | 41,560 | 19.421 | | 440,300 | NA | 41,560 | 17.174 |
| SLUDGE HAUL | -MAX | 4 JAN. | 24,990 | 130,900 | 23,800 | 36,156 | 1.447 | | 130,900 | 23,800 | 36,156 | 1.431 |
| 10 MGD 5 MI | -MIN | 7 AUG. | 2,140 | 65,450 | 3,570 | 9,748 | 4.555 | | 69,020 | 3,689 | 10,204 | 4.216 |

NOTES: 1 - Total Solids = River Suspended Solids Plus Residual Chemical Solids
2 - Capital Costs Amortized @ 7% for 20 years. (.09439)
3 - Assumes 20% Sludge Cake Solids



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APPENDIX C
CONT'D

## MAXIMUM - MINIMUM UNIT PROCESS COSTS - 10 MGD WATER TREATMENT PLANT

| UNIT PROCESS | | DATE 1979 | FERRIC SULFATE: TOTAL[1] SOLIDS GENERATED LBS./10 mgd | FERRIC SULFATE: CAPITAL COST $/10 mgd | FERRIC SULFATE: O & M COST $/10 mgd | FERRIC SULFATE: TOTAL[2] ANNUAL COST $/10 mgd | FERRIC SULFATE: TOTAL COST $/LB. | FERRIC SULFATE + PAC: TOTAL[1] SOLIDS GENERATED LBS./10 mgd | FERRIC SULFATE + PAC: CAPITAL COST $/10 mgd | FERRIC SULFATE + PAC: O & M COST $/10 mgd | FERRIC SULFATE + PAC: TOTAL[2] ANNUAL COST $/10 mgd | FERRIC SULFATE + PAC: TOTAL COST $/LB. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAGOON | -MAX | 4 JAN. | 24,720 | 77,350 | 65,450 | 72,751 | 2.943 | 25,000 | 76,160 | 65,450 | 72,638 | 2.906 |
| | -MIN | 7 AUG. | 1,870 | 14,280 | 5,950 | 7,298 | 3.903 | 2,150 | 15,470 | 6,902 | 8,362 | 3.889 |
| SAND BEDS | -MAX | 4 JAN. | | 380,800 | 59,500 | 95,444 | 3.861 | | 380,800 | 59,500 | 95,444 | 3.818 |
| | -MIN | 7 AUG. | | 47,600 | 11,305 | 15,798 | 8.448 | | 53,550 | 11,900 | 16,955 | 7.886 |
| BELT FILTER | -MAX | 4 JAN. | | 2,142,000 | 154,700 | 356,883 | 14.437 | | 2,142,000 | 154,700 | 356,883 | 14.275 |
| PRESS | -MIN | 7 AUG. | | 226,100 | 21,420 | 42,762 | 22.867 | | 249,900 | 22,610 | 46,198 | 21.487 |
| GRAVITY | -MAX | 4 JAN. | | 214,200 | 4,879 | 25,097 | 1.015 | | 214,200 | 4,879 | 25,097 | 1.004 |
| THICKENER | -MIN | 7 AUG. | | 71,400 | 1,904 | 8,643 | 4.622 | | 73,780 | 2,023 | 8,987 | 4.180 |
| FILTER | -MAX | 4 JAN. | | 952,000 | 178,500 | 268,359 | 10.856 | | 952,000 | 178,500 | 268,359 | 10.734 |
| PRESS | -MIN | 7 AUG. | | 404,600 | 99,960 | 138,150 | 73.877 | | 428,400 | 101,150 | 141,587 | 65.854 |
| VACUUM | -MAX | 4 JAN. | | 654,500 | 202,300 | 270,028 | 10.923 | | 666,400 | 208,250 | 271,152 | 10.846 |
| FILTER | -MIN | 7 AUG. | | 232,050 | 34,510 | 56,413 | 30.167 | | 238,000 | 38,080 | 60,545 | 28.160 |
| DECANTER | -MAX | 4 JAN. | | 476,000 | 57,120 | 102,050 | 4.128 | | 476,000 | 57,120 | 102,050 | 4.082 |
| CENTRIFUGE | -MIN | 7 AUG. | | 214,200 | 16,660 | 36,878 | 19.721 | | 214,200 | 17,850 | 38,068 | 17.706 |
| BASKET | -MAX | 4 JAN. | | 952,000 | 110,670 | 200,529 | 8.112 | | 952,000 | 110,670 | 200,529 | 8.021 |
| CENTRIFUGE | -MIN | 7 AUG. | | 226,100 | 17,850 | 39,192 | 20.958 | | 226,100 | 17,850 | 39,192 | 18.229 |
| SURGE TANK | -MAX | 4 JAN | | 440,300 | NA | 41,560 | 1.681 | | 440,300 | NA | 41,560 | 1.662 |
| $/10 MGD | -MIN | 7 AUG. | | 440,300 | NA | 41,560 | 22.225 | | 440,300 | NA | 41,560 | 19.330 |
| SLUDGE HAUL | -MAX | 4 JAN. | | 130,900 | 23,800 | 36,156 | 1.463 | | 130,900 | 23,800 | 36,156 | 1.446 |
| 10 MGD | -MIN | 7 AUG. | | 64,260 | 3,332 | 9,398 | 5.025 | | 65,450 | 3,570 | 9,748 | 4.534 |

5MI

NOTES:
1 - Total Solids = River Suspended Solids Plus Residual Chemical Solids
2 - Capital Costs Amortized @ 7% for 20 years. (.09439)
3 - Assumes 20% Sludge Cake Solids



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APPENDIX D

## WATER INTAKES ON THE OHIO RIVER MAIN STEM
## Primarily Indicated on Ohio River Charts

| Water Company or Industry | Location | Milepoint |
|---|---|---|
| Duquesne Light Co. | Pittsburgh, PA | PA 2.1 L* |
| Duquesne Light Co. | Pittsburgh, PA | PA 2.3 L |
| Lockhart Iron & Steel | McKees Rocks, PA | PA 2.6 L |
| Pittsburgh & Lake Erie RR Co. | McKees Rocks, PA | PA 2.7 L |
| Conrail | Bellvue, PA | PA 3.4 R* |
| Westview Municipal Authority (MI**) | Westview, PA | PA 4.6 L |
| Shenango Inc. | Neville, PA | PA 5.2 L |
| Vulcan Materials Co. | Neville, PA | PA 7.4 L |
| Dixmont Hospital | Dixmont, PA | PA 7.6 R |
| Pennsylvania Dept. of Welfare | Dixmont, PA | PA 8.0 R |
| Witherow Steel Co. | Neville, PA | PA 8.2 L |
| Pittsburgh & Lake Erie RR | Coraopolis, PA | PA 8.3 L |
| Robinson Township Authority (MI) | Coraopolis, PA | PA 8.6 L |
| Coraopolis Borough (MI) | Coraopolis, PA | PA 10.2 L |
| Blawknox Co. | Coraopolis, PA | PA 11.3 L |
| Sewickley Water Works Co. (MI) | Sewickley, PA | PA 11.4 R |
| Moon Township Authority (MI) | Coraopolis, PA | PA 11.7 L |
| Edgeworth Water Co. | Edgeworth, PA | PA 12.8 R |
| Bethlehem Steel Corp. | Leetsdale, PA | PA 14.3 R |
| Duquesne Light Co. | Wireton, PA | PA 15.1 L |
| American Bridge Co. | Ambridge, PA | PA 15.7 R |
| American Bridge Co. | Ambridge, PA | PA 15.8 R |
| Jones & Laughlin Steel Corp. | Aliquippa, PA | PA 17.3 L |
| Ambridge Borough (MI) | Ambridge, PA | PA 17.4 R |
| National Supply Co. | Ambridge, PA | PA 17.6 R |
| Jones & Laughlin Steel Corp. | Aliquippa, PA | PA 18.6 L |
| A. M. Byers Co. | Legionville, PA | PA 18.8 R |
| Aliquippa Borough (MI) | Aliquippa, PA | PA 19.3 L |
| Baden Borough (MI) | Baden, PA | PA 20.1 R |
| Conrail | Conway, PA | PA 21.4 R |
| Conway Borough (MI) | Conway, PA | PA 21.5 R |
| Colonial Steel Co. | Monaca, PA | PA 23.0 L |
| Freedom Water Works Co. (MI) | Freedom, PA | PA 23.8 R |
| Monaca Water Works Co. (MI) | Monaca, PA | PA 25.3 L |
| Beaver Borough (MI) | Beaver, PA | PA 26.0 R |
| St. Joseph Lead Co. | Bellowsville, PA | PA 28.4 L |
| St. Joseph Lead Co. | Bellowsville, PA | PA 29.1 L |
| ARCO Polymers | Kobuta, PA | PA 29.8 L |
| Pennsylvania Power Co. | Shippingport, PA | PA 33.6 L |

* L *(Left)* and R *(Right)* indicate descending bank
** (MI) indicates *Municipal Intake*

| Water Company or Industry | Location | Milepoint |
|---|---|---|
| Duquesne Light Co. | Shippingport, PA | PA 34.8 L |
| Duquesne Light Co. | Shippingport, PA | PA 34.9 L |
| Duquesne Light Co. | Shippingport, PA | PA 35.0 L |
| Crucible Steel Co. | Midland, PA | PA 36.0 R |
| Midland Borough (MI) | Midland, PA | PA 36.3 R |
| Conrail | Midland, PA | PA 37.4 R |
| *State Line--PA, WV, OH* . . . . . . . . . . . . . . . . . . . . . . . . . . . | | *40.0* |
| City of East Liverpool (MI) | East Liverpool, OH | OH 40.2 |
| City of Chester (MI) | Chester, WV | WV 42.1 |
| City of Wellsville (MI) | Wellsville, OH | OH 47.2 |
| Conrail | Wellsville, OH | OH 48.6 |
| Ohio Edison Co. | Stratton, OH | OH 53.8 |
| Cresent Brick Co. | New Cumberland, WV | WV 54.6 |
| City of Toronto (MI) | Toronto, OH | OH 59.0 |
| Toronto Water Works Co. (MI) | Toronto, OH | OH 59.2 |
| Toronto Titanium Metals Co. | Toronto, OH | OH 60.6 |
| National Steel Corp. | Weirton, WV | WV 61.7 |
| National Steel Corp. | Weirton, WV | WV 62.2 |
| Steubenville Water Works (MI) | Steubenville, OH | OH 65.2 |
| Hartje Brothers | Steubenville, OH | OH 67.3 |
| Wheeling Pittsburgh Steel Co. | Steubenville, OH | OH 68.0 |
| Wheeling Pittsburgh Steel Co. | East Steubenville, WV | WV 68.1 |
| Wheeling Pittsburgh Steel Co. | Steubenville, OH | OH 68.6 |
| Wheeling Pittsburgh Steel Co. | Steubenville, OH | OH 68.7 |
| Wheeling Pittsburgh Steel Co. | East Steubenville, WV | WV 68.8 |
| Koppers Co. | Follansbee, WV | WV 69.3 |
| Wheeling Pittsburgh Steel Co. | Mingo Junction, OH | OH 70.8 |
| Conrail | Mingo Junction, OH | OH 70.9 |
| Mingo Junction Water Co. (MI) | Mingo Junction, OH | OH 71.0 |
| National Steel Corp. | Mingo Junction, OH | OH 71.7 |
| Ohio Power Co. | Brilliant, OH | OH 76.2 |
| Ohio Power Co. | Brilliant, OH | OH 76.5 |
| Wheeling Pittsburgh Steel Corp. | Beech Bottom, WV | WV 79.2 |
| Ohio Power Co. | Beech Bottom, WV | WV 79.8 |
| Wheeling Pittsburgh Steel Corp. | Tiltonsville, OH | OH 83.2 |
| Wheeling Pittsburgh Steel Corp. | Tiltonsville, OH | OH 83.3 |
| Wheeling Pittsburgh Steel Corp. | Tiltonsville, OH | OH 83.4 |
| Warwood Tool Co. | Warwood, WV | WV 86.6 |
| City of Wheeling (MI) | Wheeling, WV | WV 86.8 |
| Wheeling Pittsburgh Steel Corp. | Martins Ferry, OH | OH 87.7 |
| City of Martins Ferry (MI) | Martins Ferry, OH | OH 88.6 |
| Baltimore & Ohio Railroad Co. | Bridgeport, OH | OH 90.1 |
| Bellaire Water Works Co. (MI) | Bellaire, OH | OH 94.0 |
| Wheeling Pittsburgh Steel Corp. | Benwood, WV | WV 94.6 |
| Baltimore & Ohio Railroad Co. | McMechan, WV | WV 95.6 |
| Ohio Edison Co. (Burger Plant) | Shadyside, OH | OH 102.2 |

| Water Company or Industry | Location | Milepoint |
|---|---|---|
| North American Coal Co. | Shadyside, OH | OH 104.0 |
| Allied Chemical & Dye Corp. | Moundsville, WV | WV 105.9 |
| Kammer Generating Co. | Captina, WV | WV 111.1 |
| Ohio Power Co. (Mitchell) | Captina, WV | WV 112.4 |
| Consolidation Coal Co. | Woodlands, WV | WV 113.1 |
| PPG Industries | Natrium, WV | WV 119.0 |
| PPG Industries | Natrium, WV | WV 119.3 |
| Mobay Chemical Co. | Natrium, WV | WV 121.2 |
| Olin Matheson Chemical Corp. | Clarington, OH | OH 123.6 |
| City of New Martinsville (MI) | New Martinsville, WV | WV 128.1 |
| City of Sistersville (MI) | Sisterville, WV | WV 137.1 |
| Union Carbide Corp. (Ranney Collector) | Long Reach, WV | WV 144.8 |
| Union Carbide Corp. (Ranney Collector) | Long Reach, WV | WV 145.4 |
| Union Carbide Corp. (Ranney Collector) | Long Reach, WV | WV 145.6 |
| Union Carbide Corp. (Ranney Collector) | Long Reach, WV | WV 145.9 |
| American Cyanamid Corp. (Ranney Collector) | Willow Island, WV | WV 160.1 |
| Monongahela Power Co. | Willow Island, WV | WV 160.5 |
| American Cyanamid Corp. (Ranney Collector) | Willow Island, WV | WV 161.8 |
| Marietta Intake (MI) [*unused*] | Marietta, OH | OH 171.3 |
| Union Carbide Metals Co. | Marietta, OH | OH 176.8 |
| City of Parkersburg (MI) (Ranney Collector) | Parkersburg, WV | WV 182.2 |
| City of Parkersburg (MI) [*unused*] | Parkersburg, WV | WV 183.0 |
| City of Parkersburg (MI) [*unused*] | Parkersburg, WV | WV 183.2 |
| Monongahela Power Co. | Parkersburg, WV | WV 183.9 |
| Shell Chemical Co. | Marietta, OH | OH 188.6 |
| E. I. duPont de Nemours & Co. | Parkersburg, WV | WV 190.3 |
| E. I. duPont de Nemours & Co. (Ranney Collector) | Parkersburg, WV | WV 190.4 |
| E. I. duPont de Nemours | Parkersburg, WV | WV 190.8 |
| Appalachian Power Co. | Grahams Station, WV | WV 241.6 |
| Ohio Electric Co. | Addison, OH | OH 258.3 |
| Ohio Electric Co. | Addison, OH | OH 258.4 |
| Ohio Valley Electric Corp. | Addison, OH | OH 260.0 |
| City of Gallipolis (MI) | Gallipolis, OH | OH 268.6 |
| Appalachian Power Co. | Applegrove, WV | WV 281.5 |
| Huntington Water Corp. (MI) | Huntington, WV | WV 304.2 |
| Huntington Water Corp. (MI) | Huntington, WV | WV 306.9 |
| Oglebay Norton Co. | Ceredo, WV | WV 314.6 |
| Allied Chemical Corp. Nitrogen Div. | South Point, OH | OH 318.2 |
| City of Ashland (MI) | Ashland, KY | KY 319.7 |

| Water Company or Industry | Location | Milepoint |
|---|---|---|
| Allied Chemical Corp. Semet Solvay Div. | Ashland, KY | KY 320.0 |
| Allied Chemical Corp. Semet Solvay Div. | Ashland, KY | KY 320.1 |
| Allied Chemical Corp. Semet Solvay Div. | Ashland, KY | KY 320.2 |
| Armco Steel Corp. | Ashland, KY | KY 322.0 |
| Mansbach Metal Co. | Ashland, KY | KY 322.1 |
| Armco Steel Corp. | Ashland, KY | KY 323.2 |
| Armco Steel Corp. | Ashland, KY | KY 324.0 |
| Allied Chemical Corp. | Ironton, OH | OH 324.6 |
| Armco Steel Corp, Pump Incline | Ashland, KY | KY 324.7 |
| City of Ironton (MI) | Ironton, OH | OH 327.0 |
| C & O Railway Co. | Russell, KY | KY 327.7 |
| E. I. duPont de Nemours & Co. | Riverton, KY | KY 333.2 |
| Town of Greenup (MI) | Greenup, KY | KY 334.7 |
| Town of Greenup (MI) | Greenup, KY | KY 336.2 |
| Portsmouth Municipal Waterworks (MI) | Portsmouth, OH | OH 350.8 |
| Empire-Detroit Steel Corp. | Portsmouth, OH | OH 351.0 |
| Empire-Detroit Steel Corp. | Portsmouth, OH | OH 351.1 |
| Empire-Detroit Steel Corp. | Portsmouth, OH | OH 351.4 |
| City of Portsmouth (MI) | Portsmouth, OH | OH 355.5 |
| C & O Railway Co. | Fullerton, KY | KY 356.0 |
| Dayton Power & Light Co. | Aberdeen, OH | OH 404.7 |
| City of Maysville (MI) | Maysville, KY | KY 408.5 |
| C & O Railway Co. | Maysville, KY | KY 409.0 |
| Cincinnati G & E, Beckjord Station | New Richmond, OH | OH 453.0 |
| City of Cincinnati (MI) | Cincinnati, OH | KY 462.8 |
| Kenton Co. Water District No. 1 (MI) | Ft. Thomas, KY | KY 462.9 |
| City of Newport (MI) | Newport, KY | KY 463.5 |
| City G & E Co., West End | Cincinnati, OH | OH 471.4 |
| Cincinnati G & E Co., Miami Fort | North Bend, OH | OH 490.3 |
| Indiana & Michigan Electric Co., Tanners Creek | Lawrenceburg, IN | IN 494.0 |
| Ghent Power Plant | Ghent, KY | KY 535.3 |
| Indiana & Kentucky Power Corp., Clifty Creek Station | Madison, IN | IN 560.0 |
| Oldham County Water District #1 (MI) | Westport, KY | KY 582.2 |
| Indiana Ordinance | Clark County, IN | IN 589.3 |
| Louisville Water Co. (MI) | Louisville, KY | KY 594.5 |
| Louisville Water Co. (MI) | Louisville, KY | KY 600.6 |
| Louisville G & E Co., Waterside Sta. | Louisville, KY | KY 603.6 |
| Colgate Palmolive Co. | Jefferson, IN | IN 603.6 |
| Louisville G & E Co., Canal Sta. | Louisville, KY | KY 604.9 |
| Indiana Cities Water Co. (MI) | Falls City, IN | IN 609.0 |

| Water Company or Industry | Location | Milepoint |
|---|---|---|
| Public Service of Indiana-Gallagher | New Albany, IN | IN 610.0 |
| National Carbide Corp. | Louisville, KY | KY 612.6 |
| Louisville G & E Co., Paddys Run Station | Louisville, KY | KY 612.9 |
| E. I. duPont de Nemours & Co. | Louisville, KY | KY 613.5 |
| Publicker Chemical Co. (Rohm & Haas) | Louisville, KY | KY 613.5 |
| Louisville G & E Co., Cane Run Station | Louisville, KY | KY 616.6 |
| Indiana Glass Sand Co. | Harrison County, IN | IN 620.6 |
| Louisville G & E Co., Mill Creek | Louisville, KY | KY 625.9 |
| Kosmos-Portland Cement Co. | Kosmosdale, KY | KY 627.0 |
| Olin Corp. | Brandenburg, KY | KY 643.4 |
| Olin Corp. | Brandenburg, KY | KY 644.0 |
| Kosmos-Portland Cement Co. | Brandenburg, KY | KY 654.1 |
| Can-Tex Industries | Cannelton, IN | IN 724.3 |
| Big Rivers RECC, Coleman Station | Hawesville, KY | KY 728.3 |
| Owensboro Utilities Commission (MI) | Owensboro, KY | KY 753.5 |
| Owensboro Municipal Power Co. | Owensboro, KY | KY 755.6 |
| Southern Indiana G & E Co. | Yankeetown, IN | IN 773.0 |
| Alcoa-Warrick Works | Yankeetown, IN | IN 773.6 |
| City of Evansville (MI) | Evansville, IN | IN 791.5 |
| Southern Indiana G & E Co. | Evansville, IN | IN 793.7 |
| Henderson Water Works (MI) | Henderson, KY | KY 803.2 |
| Henderson Electric Power Co. | Henderson, KY | KY 803.6 |
| Agrico Chemical Co. | Henderson, KY | KY 806.5 |
| Agrico Chemical Co. | Henderson, KY | KY 806.6 |
| Agrico Chemical Co. | Henderson, KY | KY 807.2 |
| City of Mt. Vernon (MI) | Mt. Vernon, IN | IN 829.3 |
| General Electric | Mt. Vernon, IN | IN 831.2 |
| City of Morganfield (MI) | Morganfield, KY | KY 839.9 |
| City of Uniontown (MI) | Uniontown, KY | KY 842.5 |
| City of Morganfield (MI) | Morganfield, KY | KY 843.0 |
| City of Sturgis (MI) | Sturgis, KY | KY 871.5 |
| City of Rosiclare (MI) | Rosiclare, IL | IL 891.3 |
| Aluminum Co. of American *(inactive)* | Rosiclare, IL | IL 892.2 |
| City of Golconda (MI) | Golconda, IL | IL 902.3 |
| City of Paducah (Tennessee River) | Paducah, KY | KY 934.3 |
| Shawnee Steam Plant (TVA) | Paducah, KY | KY 946.0 |
| Electric Energy Plant | Joppa, IL | IL 952.2 |
| City of Cairo (MI) | Cairo, IL | IL 977.8 |

# APPENDIX E

## COMPARISON BETWEEN WATER TREATMENT PLANT DISCHARGES AND RIVER QUALITY FOR REPRESENTATIVE PLANTS ON THE OHIO RIVER

Discharge records for four representative types and sizes of water treatment plants on the Ohio River were compared to the water quality records for the river at or near the discharge locations. The comparative relationships are presented in tabular and graphical form in Table E-1 and Figure E-1.

TABLE E-1

MASS FLUX ANALYSIS

| FACILITY | DATE | DISCHARGE TYPE | RANGE OF MASS FLUX RATIO RIVER SS/DISCHARGES SS |
|---|---|---|---|
| MOUNT VERNON | 2/20/80 to 7/15/80 | UNTREATED | 8,300 to 76,700 |
| HUNTINGTON | 9/10/79 to 7/7/80 | LAGOON EFFLUENT | 14,200 to 1,027,800 |
| LOUISVILLE | 8/7/79 to 7/7/80 | LAGOON EFFLUENT | 2,800 to 249,900 |
| LOUISVILLE | 8/7/79 to 7/7/80 | LAGOON INFLUENT (UNTREATED WASTE) | 50 to 11,200 |
| PORTSMOUTH | 8/7/79 to 7/7/80 | UNTREATED DISCHARGE | 4,000 to 240,000 |

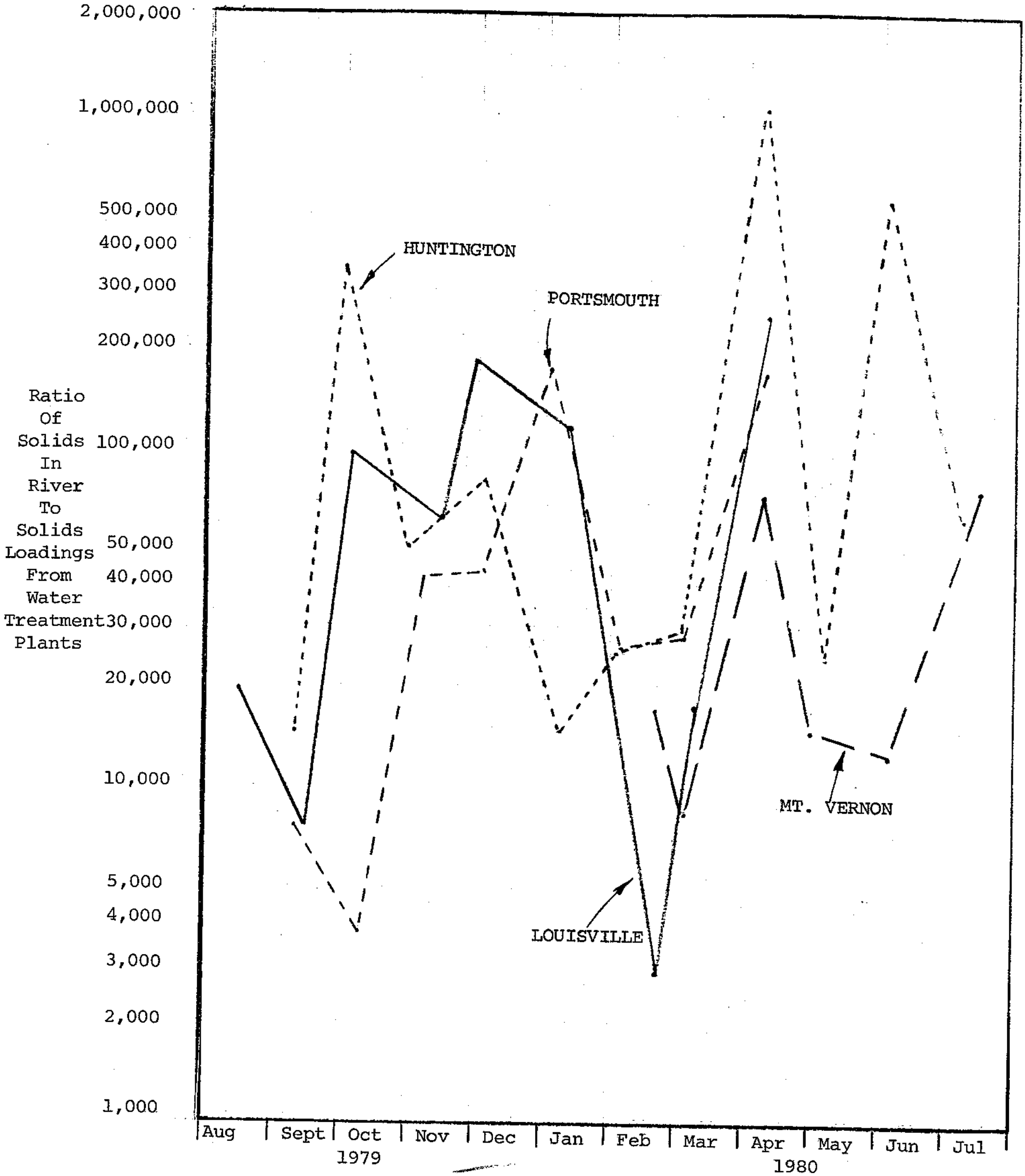


Figure E-1. Comparison of Solids Flow in the Ohio River to Loadings from Representative Water Treatment Plants

APPENDIX F

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# APPENDIX G

## SLUDGE SAMPLING INFORMATION
## FOR WATER TREATMENT PLANTS ON THE OHIO RIVER

PLANT: : CINCINNATI

DATE :

DESCRIPTION: HEAVY METALS IN SETTLING BASIN SLUDGE

| | % OF SLUDGE |
|---|---|
| Arsenic | 0.0105 |
| Barium | 0.0610 |
| Cadmium | 0.0002 |
| Chromium | 0.0144 |
| Lead | 0.0098 |
| Mercury | 0.0000 |
| Selenium | 0.0000 |
| Silver | 0.0001 |
| Copper | 0.0113 |
| Iron | 4.64 |
| Manganese | 0.158 |
| Zinc | 0.0440 |
| Aluminum | 6.80 |

PLANT : CINCINNATI

DATE :

DESCRIPTION: HEAVY METALS IN WASH WATER RECOVERY TANK SLUDGE

| | % OF SLUDGE |
|---|---|
| Arsenic | 0.0067 |
| Barium | 0.060 |
| Cadmium | 0.0004 |
| Chromium | 0.0068 |
| Lead | 0.00121 |
| Mercury | 0.000 |
| Selenium | 0.000 |
| Silver | 0.0003 |
| Copper | 0.0788 |
| Iron | 16.650 |

| | |
|---|---|
| Manganese | 0.258 |
| Zinc | 0.078 |
| Aluminum | 9.45 |

PLANT : HUNTINGTON

DATE : September 26, 1980

DESCRIPTION: SLUDGE DRYING BED

| | CONCENTRATION | |
|---|---|---|
| Arsenic | < 0.03 | mg/l |
| Barium | 0.9 | mg/l |
| Cadmium | < 0.01 | mg/l |
| Chromium | < 0.02 | mg/l |
| Lead | < 0.1 | mg/l |
| Mercury | 1 | µg/l |
| Selenium | < 1 | µg/l |
| Silver | < 0.01 | mg/l |
| Endrin | < 0.00005 | mg/l |
| Methorychlor | < 0.0001 | mg/l |
| Lindane | 0.00003 | mg/l |
| Toxaphene | < 0.0005 | mg/l |
| 2, 4, -D | < 0.0001 | mg/l |
| 2, 4, 5 - TP (silvex) | < 0.0001 | mg/l |

PLANT : LOUISVILLE

DATE : March 12, 1980

DESCRIPTION: HEAVY METALS IN BOTTOM SLUDGE OF LAGOON. THIS SLUDGE WAS ACCUMULATED AND CONCENTRATED OVER A PERIOD OF 8 TO 10 YEARS.

| | CONCENTRATION ( mg/l ) |
|---|---|
| Arsenic | < 0.015 |
| Barium | 8.580 |
| Cadmium | 0.0022 |
| Chromium | <0.008 |
| Copper | 0.080 |
| Lead | 0.077 |
| Manganese | 75.90 |

| | |
|---|---|
| Mercury | 0.0008 |
| Selenium | 0.009 |
| Silver | 0.002 |
| Sodium | 4.00 |
| Thallium | < 0.001 |

PLANT : LOUISVILLE

DATE : 1980

DESCRIPTION: TRIHALOMETHANES IN LAGOON INFLUENT/EFFLUENTS

| DATE | DESCRIPTION | CONCENTRATION (μg/l) |
|---|---|---|
| June 9, 1980 | Influent Lagoon 3 | < 0.0005 |
| | Influent Lagoon 4 | 0.0017 |
| | Composite Effluent | 0.0005 |
| June 16, 1980 | Influent Lagoon 3 | 0.0 |
| | Influent Lagoon 4 | 0.0 |
| June 30, 1980 | Influent Lagoon 3 | 0.0 |
| | Influent Lagoon 4 | 0.0 |

PLANT : PITTSBURGH

DATE : June, 1980 Composite

DESCRIPTION: HEAVY METALS IN SLUDGE

| | CONCENTRATION | |
|---|---|---|
| Cadmium | < 2.0 | μg/l |
| Copper | 2.0 | μg/l |
| Chromium | 2.0 | μg/l |
| Iron | 14.0 | mg/l |
| Lead | 38 | μg/l |
| Manganese | 3.3 | mg/l |
| Silver | < 2.0 | μg/l |
| Zinc | 14 | μg/l |

PLANT : WILKINSBURG-PENN

DATE : October 1, 1973

DESCRIPTION: FILTER PLANT - SLUDGE CAKE FROM SQUEEGEE

PERCENT

| | Partially Dehydrated | After Ignition | Dried at $103^{o}$ C | From Squeegee |
|---|---|---|---|---|
| $SiO_2$ | 30.40 | 47.68 | 36.16 | 5.88 |
| Carbon | 20.35 | | 24.10 | 3.86 |
| $Al_2O_3$ | 12.70 | 20.0 | 15.18 | 2.40 |
| MnO | 9.60 | 15.0 | 11.39 | 1.80 |
| CaO | 6.40 | 10.0 | 7.59 | 1.20 |
| $Fe_2O_3$ | 3.20 | 5.0 | 3.80 | 0.06 |
| $TiO_2$ | 0.63 | 1.0 | 0.76 | 0.12 |
| MgO | 0.63 | 1.0 | 0.76 | 0.12 |
| SrO | 0.06 | 0.10 | 0.08 | 0.01 |
| NiO | 0.06 | 0.10 | 0.08 | 0.01 |
| CoO | 0.03 | 0.05 | 0.04 | |
| ZnO | 0.02 | 0.03 | 0.02 | |
| $Cr_2O_3$ | 0.01 | 0.02 | 0.01 | |
| ZnO | 0.01 | 0.01 | 0.01 | |
| BaO | 0.01 | 0.01 | 0.01 | |