A Study of

Wastewater Discharges from Water Treatment Plants

Ohio River Valley Water Sanitation Commission

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*As of March 15, 1981

A STUDY OF

WASTEWATER DISCHARGES FROM

WATER TREATMENT PLANTS

April, 1981

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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:

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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
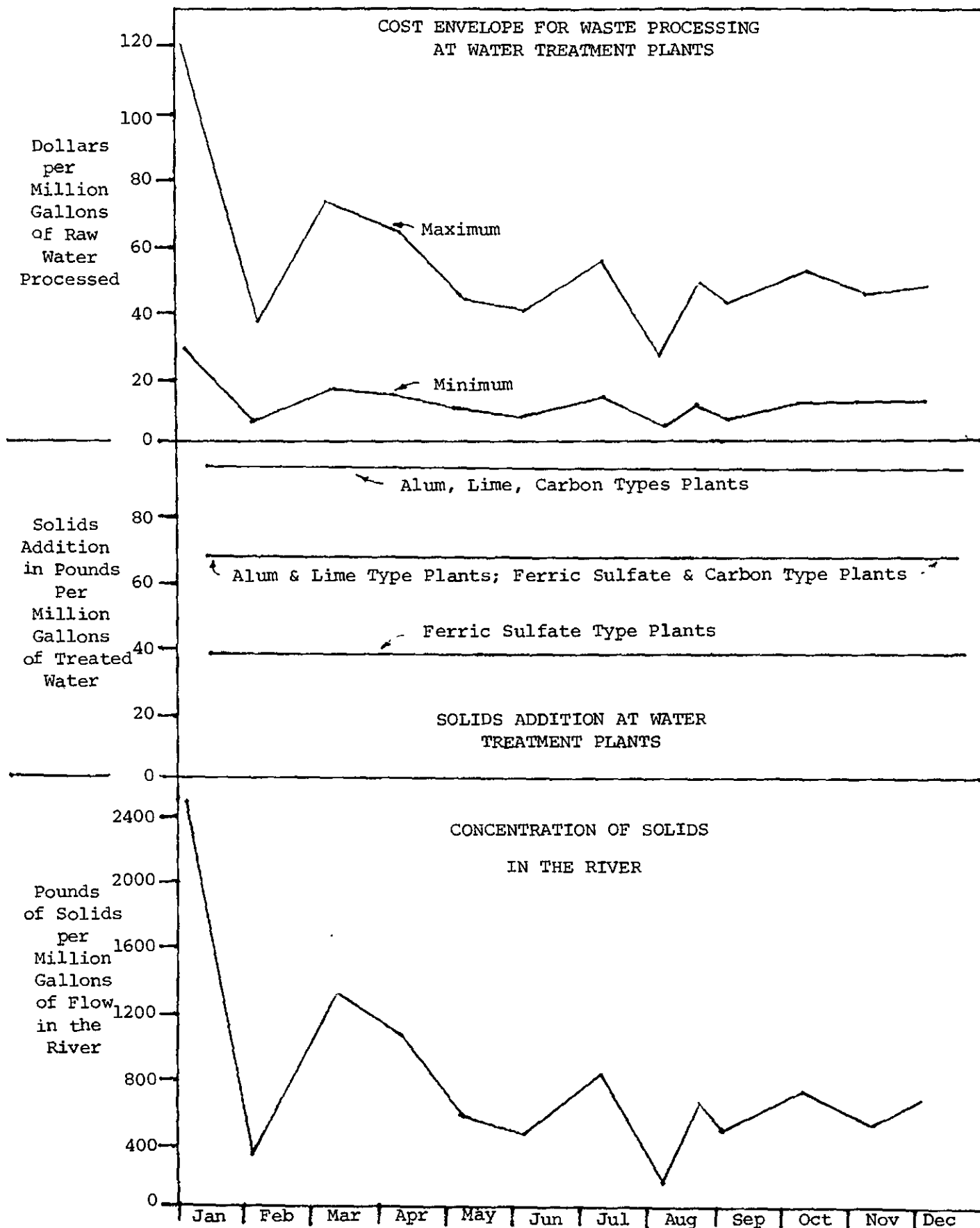
Figure I-1. Generalized Loading and Cost Relationships for Water Treatment Plants
on the Ohio River

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

COST ENVELOPE FOR WASTE PROCESSING
AT A 10 MGD WATER TREATMENT PLANT

(Annual costs based on design/
operation for monthly conditions)

Dollars Per Year

Maximum

Minimum

Alum, Lime, Carbon Type Plant

Solids Addition in Tons per Day

Alum & Lime Type Plants; Ferric Sulfate & Carbon Type Plants

Ferric Sulfate Type Plants

REPRESENTATIVE SOLIDS ADDITION AT A 10 MGD WATER
TREATMENT PLANT

Solids Flow in River in Tons per Day

SOLIDS MASS FLOW
IN THE RIVER

Figure I-2. Loading and Cost Relationships for Representative 10 MGD Water Treatment
Plants on the Ohio River

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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 1-70 and 2-70, the current regulations regarding effluent limitations.

Concurrent with the development of 1-70 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 guide-lines 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 concerni.., 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 pre-pared by a suocommittee of the Water User's Committee. This report summarized the state requirements, presented infor-mation 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 pro-
vide 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 consid-
ered 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. Chlori-
nation is a traditional method for minimizing bacteria and algal growth in the
finished water.

The specific design and operational characteristics of any water treat-
ment 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. Be-
cause 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 spread-
ing, 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 chemi-
cals 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 sul-
fate/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
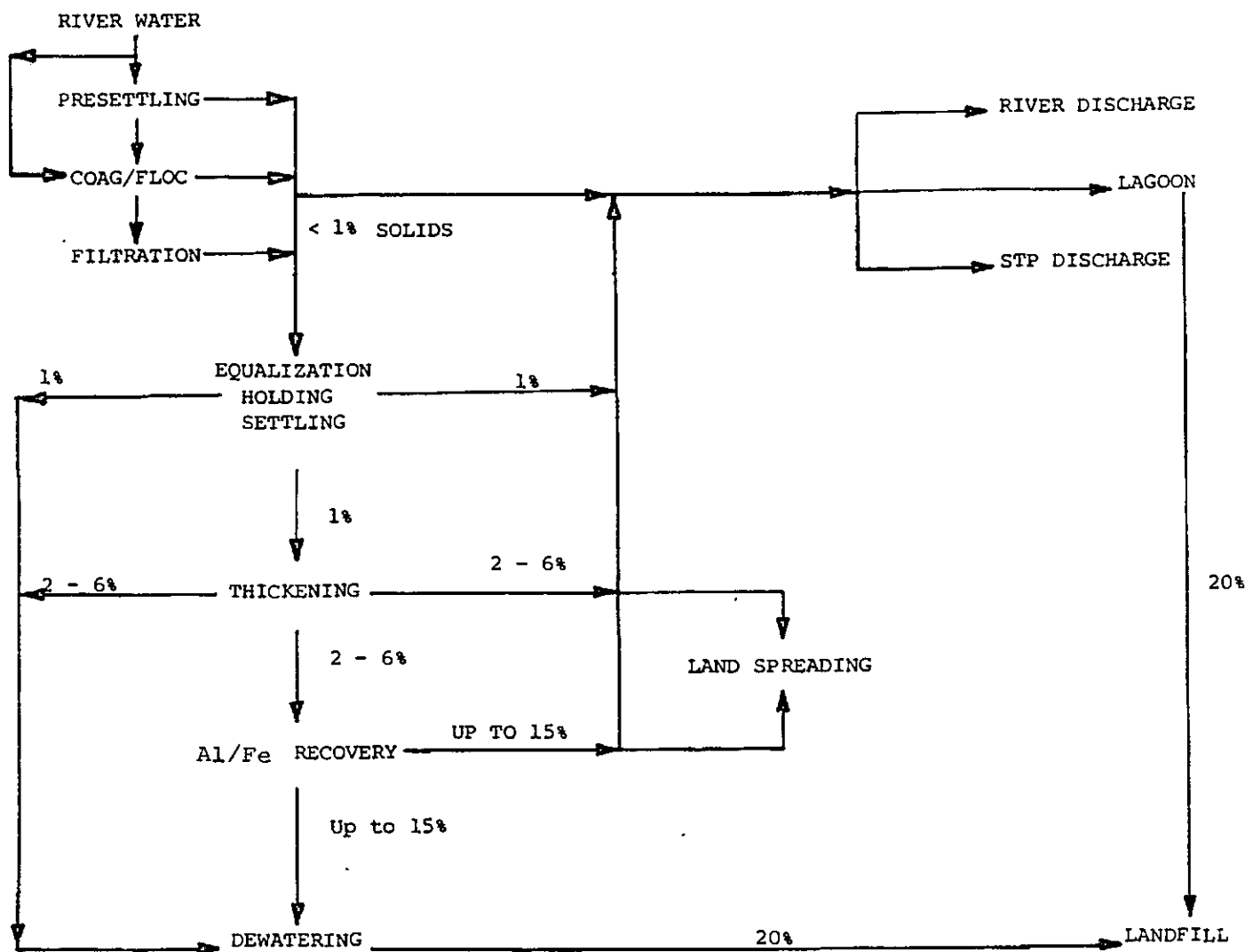
Figure III-1. Waste Treatment Alternatives

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 .o to 0/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 0/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

TOTAL ANNUAL COST[1]

$$\frac{\text{LAGOON}}{\$73,088} + \frac{\text{SLUDGE HAUL}^2}{\$35,156} =$$ $109,244

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{GRAVITY THICKENER}}{\$25,097} + \frac{\text{SAND BED}}{\$95,444} + \frac{\text{SLUDGE HAUL}^2}{\$36,156} =$$ $198,257

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{GRAVITY THICKENER}}{\$25,097} + \frac{\text{FILTER PRESS}}{\$268,359} + \frac{\text{SLUDGE HAUL}}{\$36,156} =$$ $371,172

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{BASKET CENTRIFUGE}}{\$204,033} + \frac{\text{SLUDGE HAUL}}{\$36,156} =$$ $281,749

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{DECANTER CENTRIFUGE}}{\$102,050} + \frac{\text{SLUDGE HAUL}}{\$36,156} =$$ $179,766

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{VACUUM FILTER}}{\$270,080} + \frac{\text{SLUDGE HAUL}}{\$36,156} =$$ $347,744

$$\frac{\text{SURGE TANK}}{\$41,560} + \frac{\text{BELT FILTER PRESS}}{\$356,883} + \frac{\text{SLUDGE HAUL}}{\$36,156} =$$ $434,599

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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:

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

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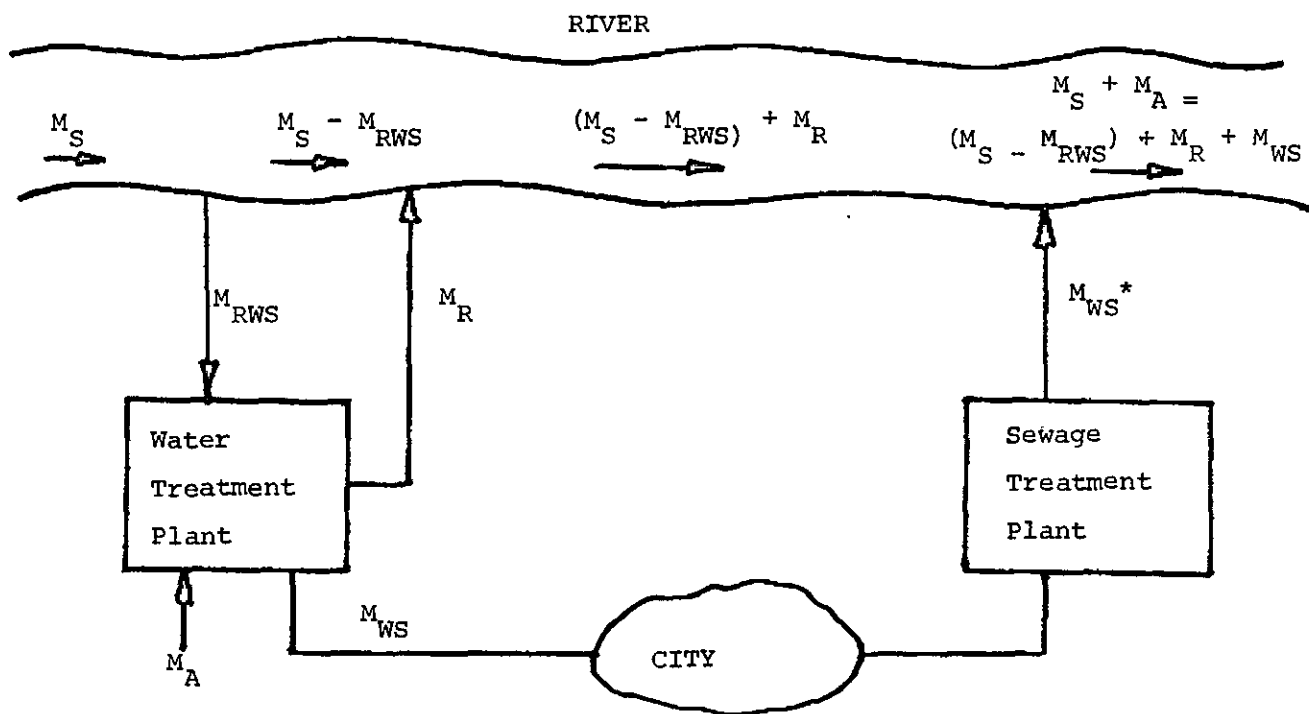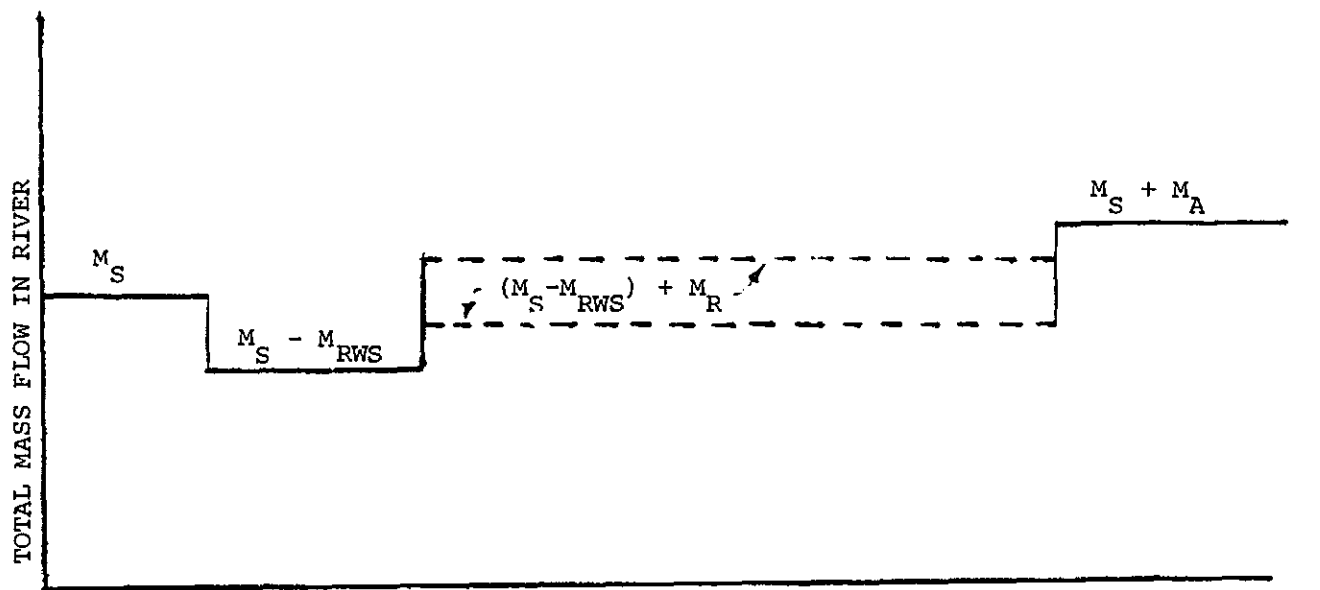
Figure IV-1. Schematic Representation of the Total Mass Perspective of Water Treatment Plant Operation.

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:

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

IV-3
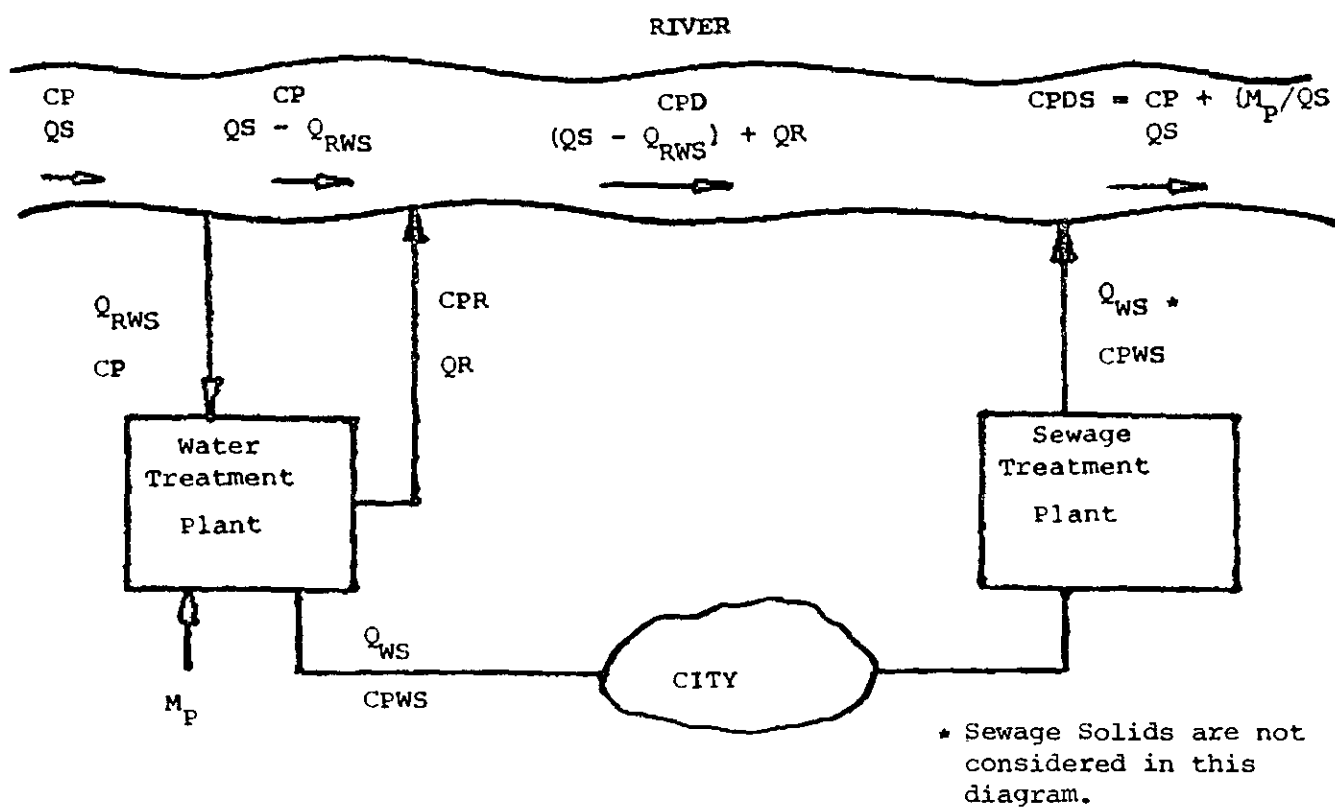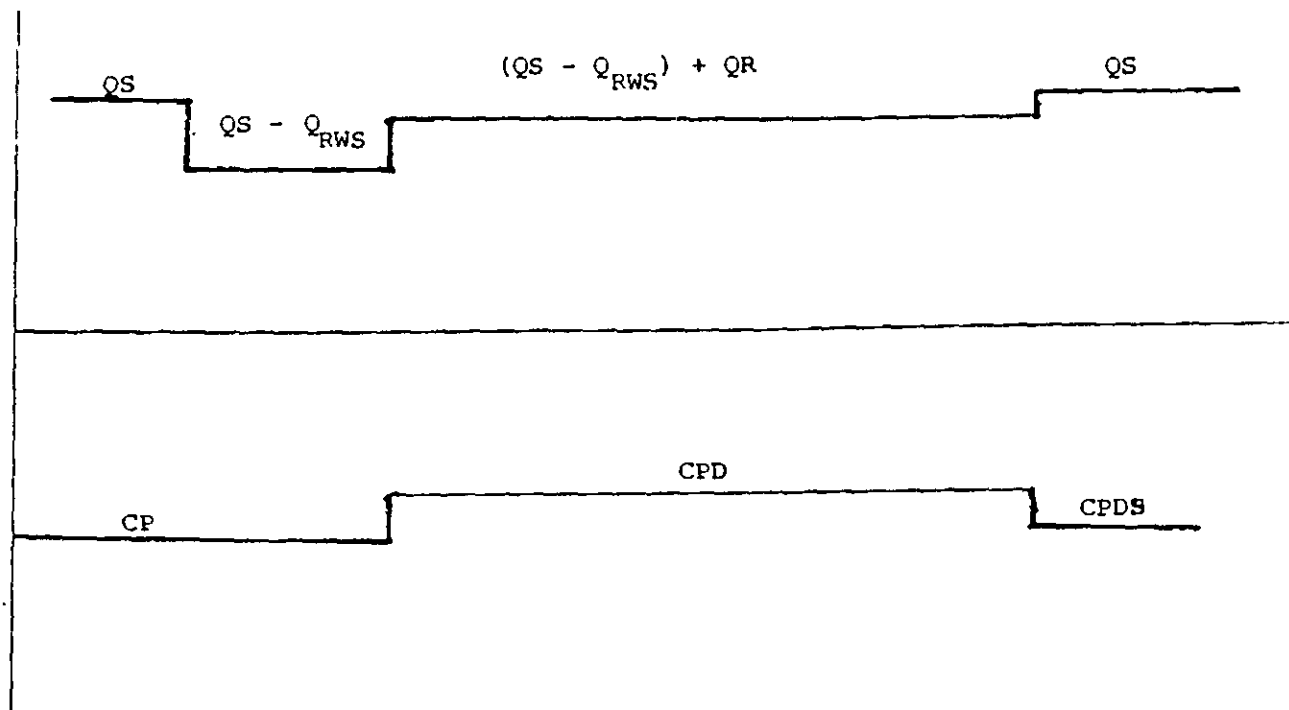
Figure IV-2. Schematic Representation of the Added Pollutant Concentration
Perspective of Water Treatment Plant Operation.

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/l

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

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 afore-mentioned 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 poten-tially 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
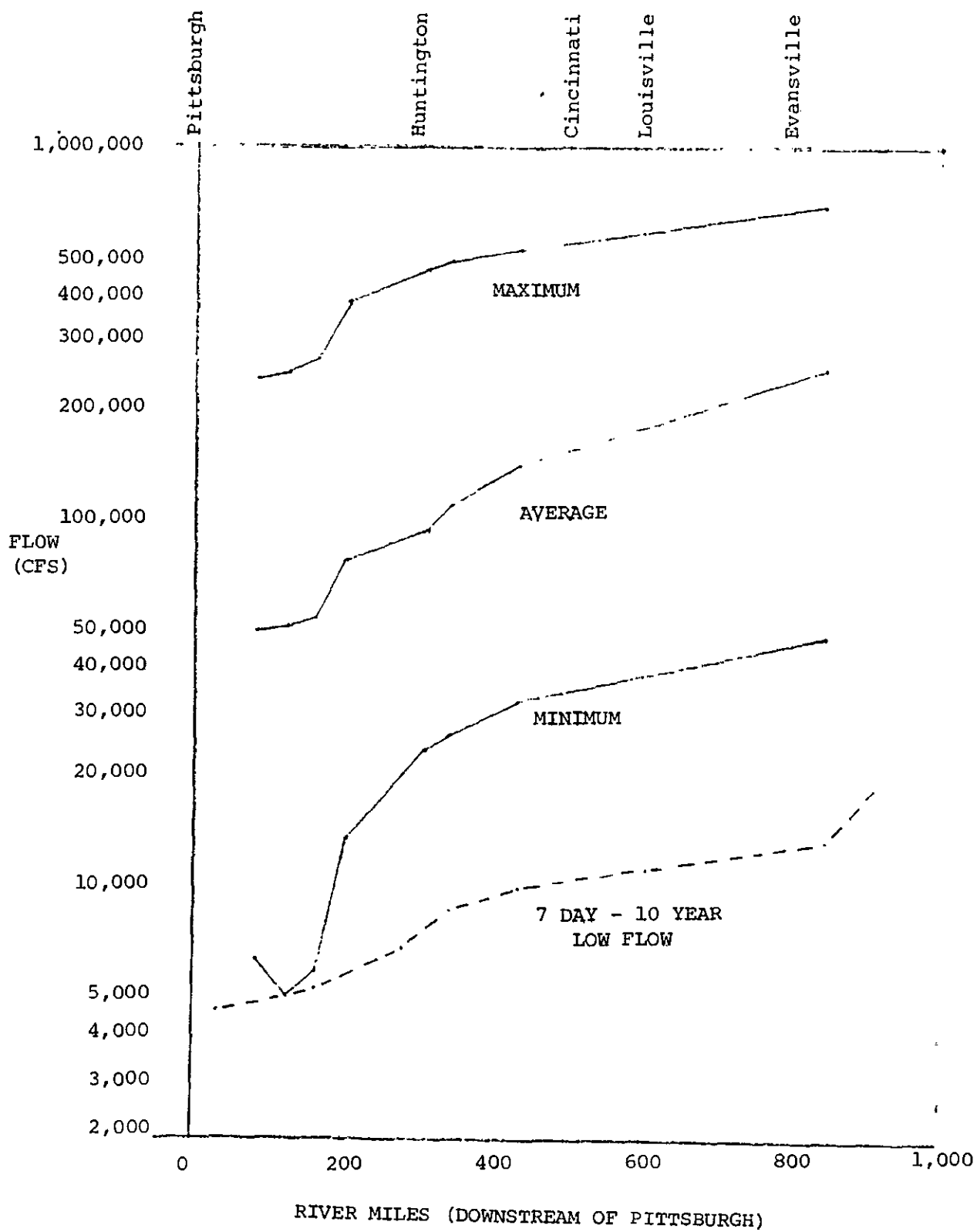
Figure V-1. Profile of Flow in the Ohio River for 1979.
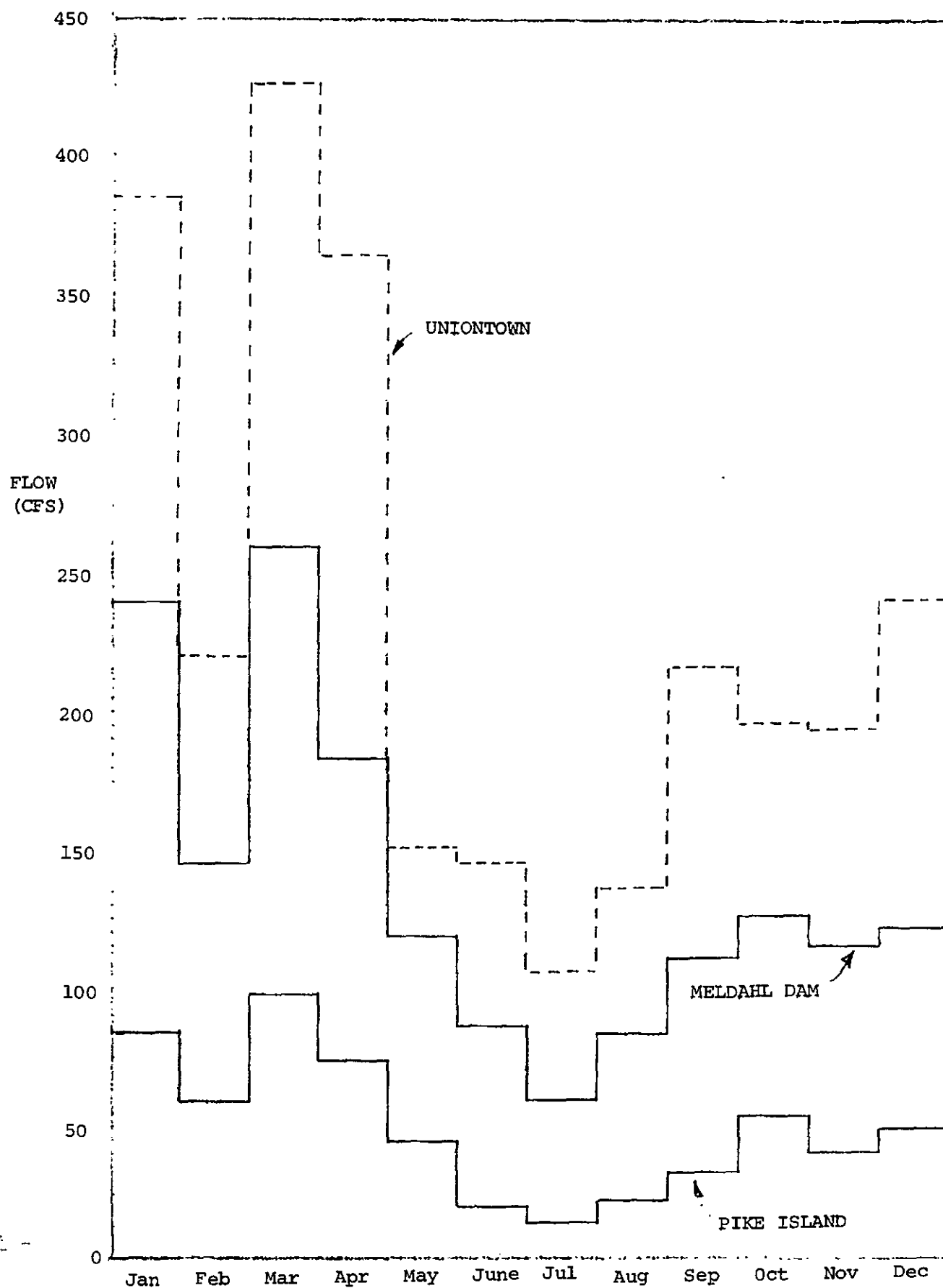
Figure V-2. Average Monthly Flow during 1979 for Selected Locations on the Ohio River

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 dis-
played 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 concen-
tration yields the following relationships and coefficients of determination
(R^2):

South Heights, Pennsylvania

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

Greenup Dam

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

Cincinnati, Ohio

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

Louisville, Kentucky

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

The strong correlation between flow and TSS concentration leads to a
large variability in the mass flux of suspended solids due to the multi-
plicative effect of flow and concentration in calculating flux. This variability
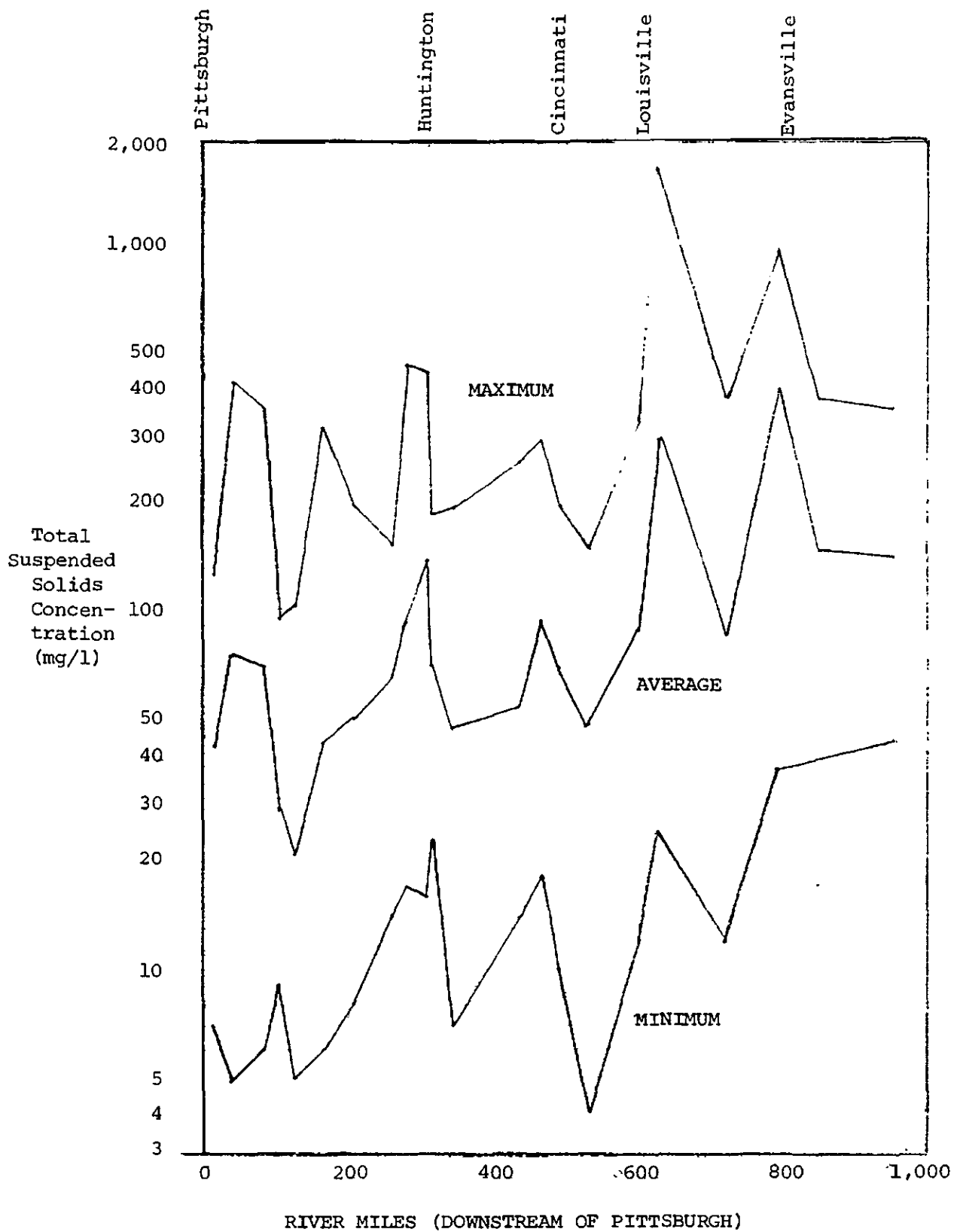
Figure V-3. Profile of Total Suspended Solids Concentration in the Ohio River for 1979.
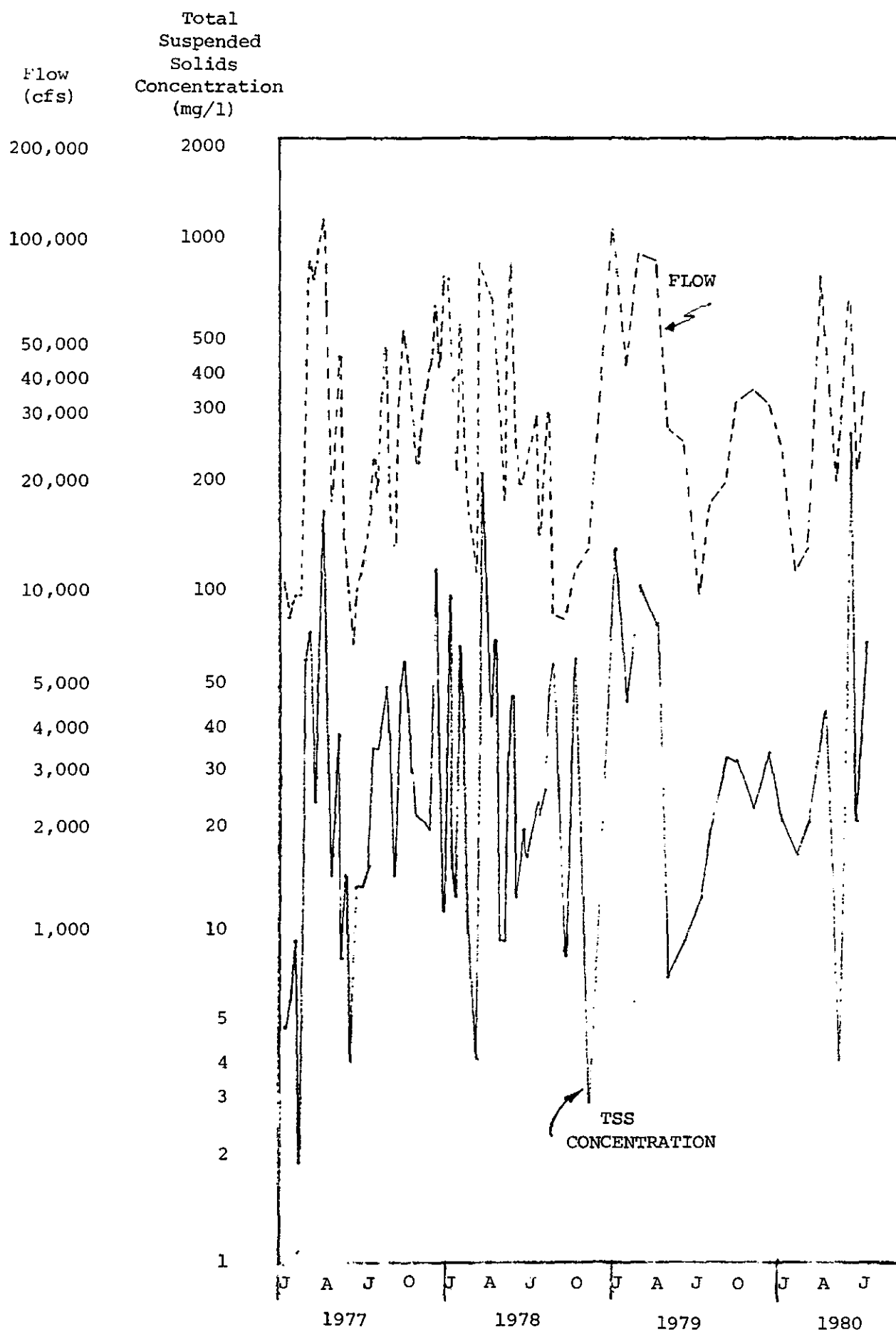
Figure V-4. Flow and Quality Measurements on the Ohio River at South Heights, Pennsylvania.
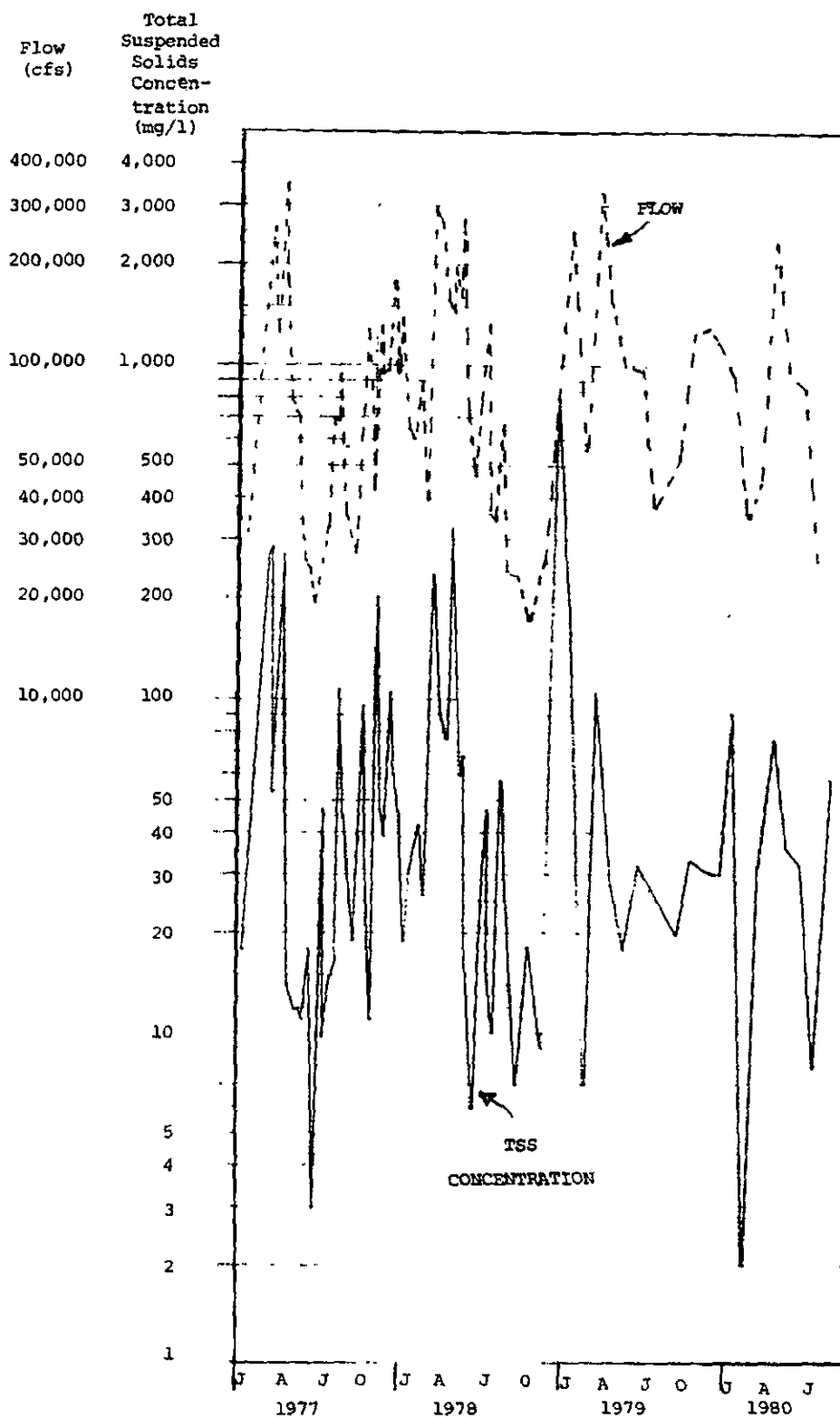
Figure V-5. Flow and Quality Measurements on the Ohio River at Greenup Dam
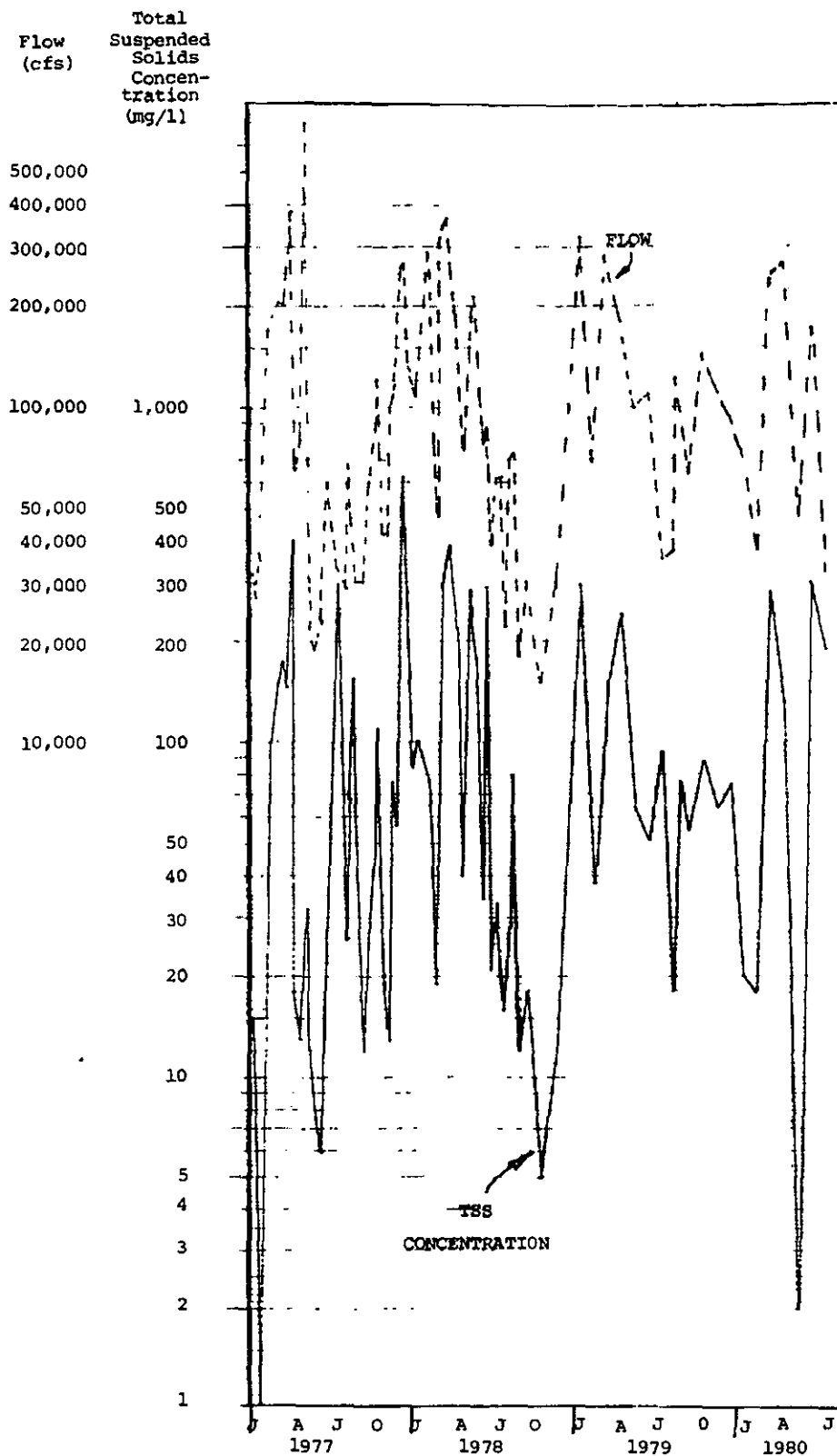
Figure V-6. Flow and Quality Measurements on the Ohio River at
Cincinnati, Ohio

Flow (cfs) | Total Suspended Solids Concentration (mg/l)

Flow (cfs)	Total Suspended Solids Concentration (mg/l)
600,000	6,000
500,000	5,000
400,000	4,000
300,000	3,000
200,000	2,000
100,000	1,000
50,000	500
40,000	400
30,000	300
20,000	200
10,000	100
	50
	40
	30
	20
	10
	5
	4
	3
	2
	1

FLOW

TSS CONCENTRATION

J A J O J A J O J A J O J A J
1977   1978   1979   1980
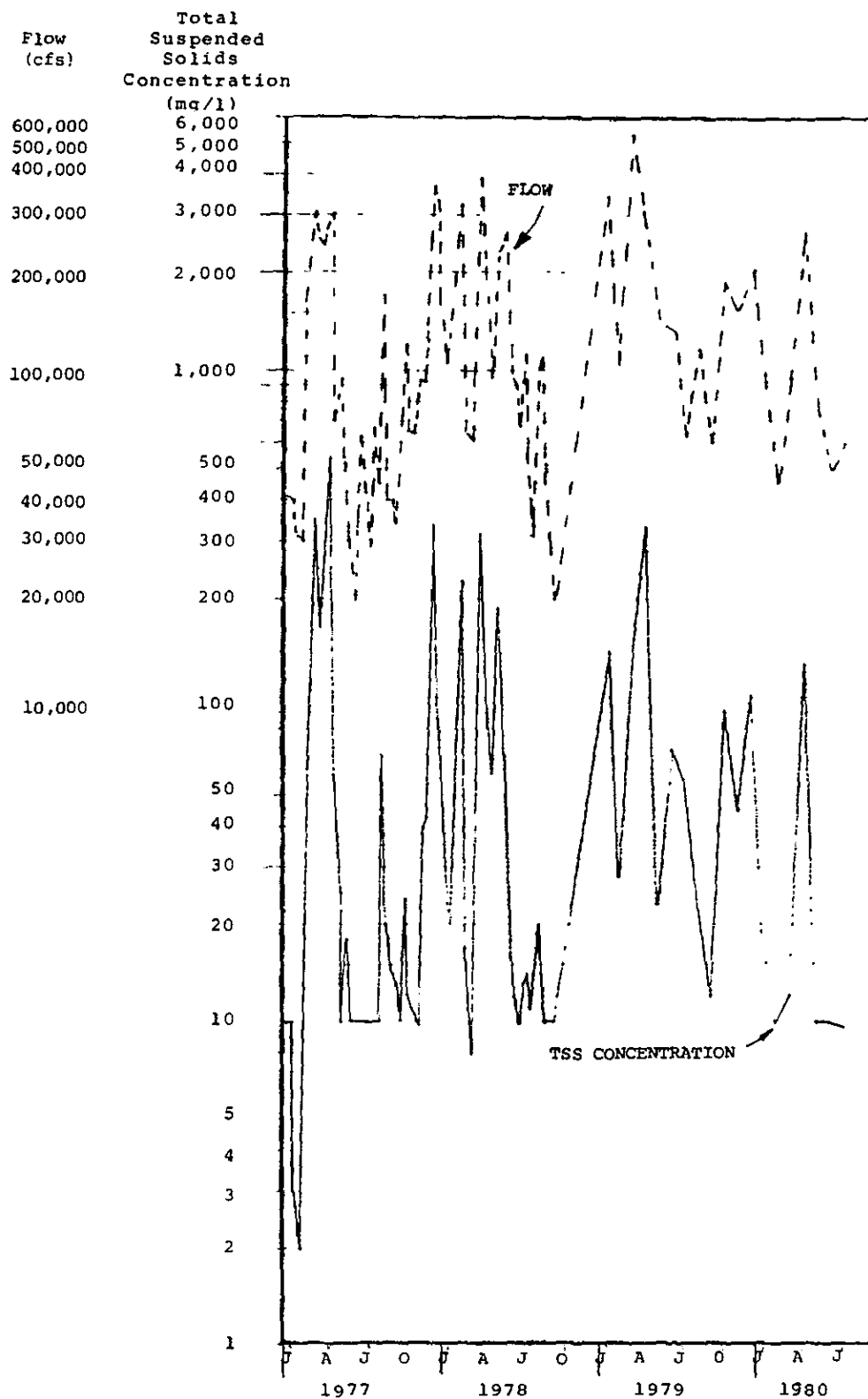
Figure V-7. Flow and Quality Measurements on the Ohio River at
Louisville, Kentucky

V-9
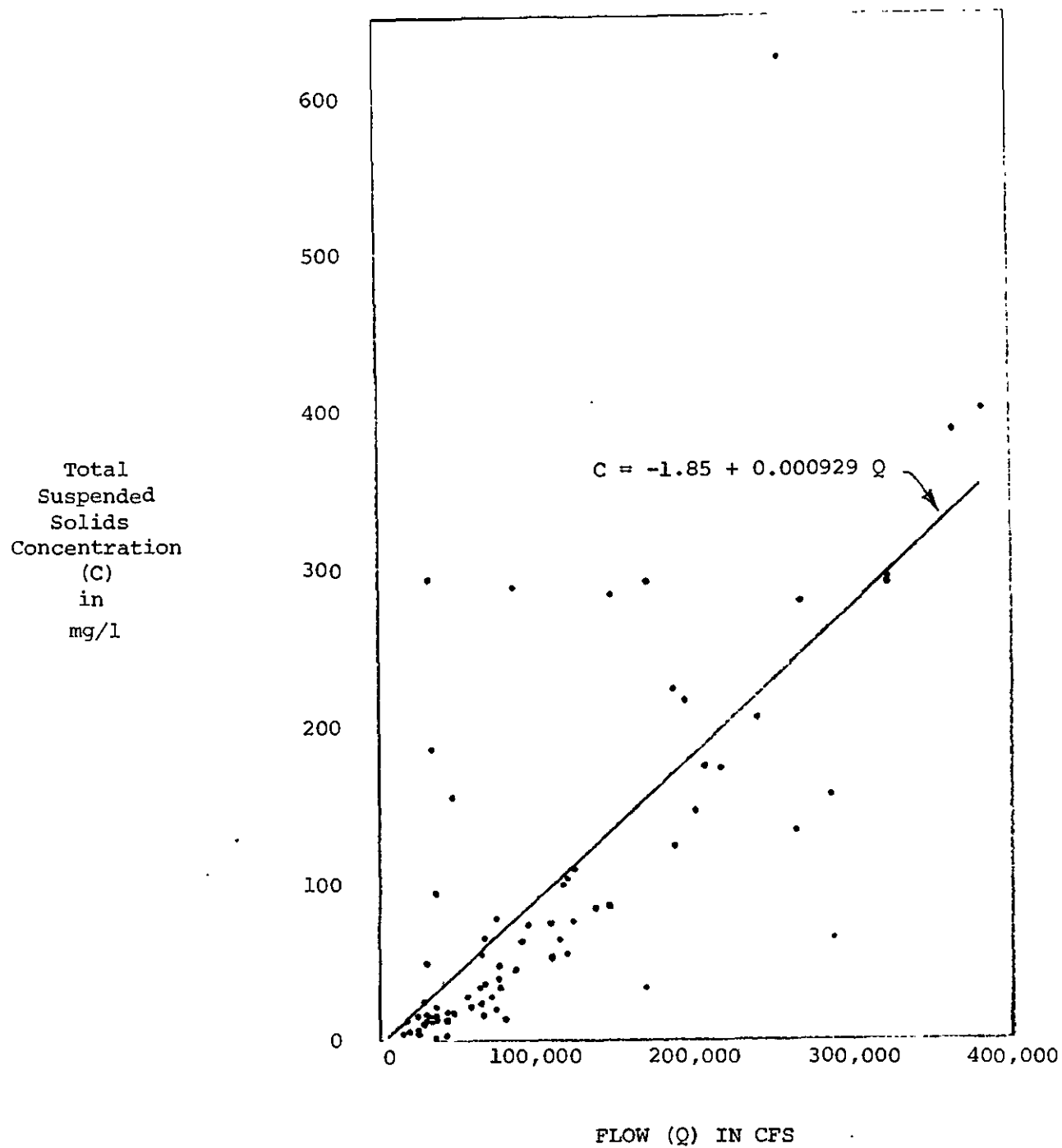
Figure V-8. Relationship between Flow and Total Suspended Solids Concentration in the Ohio River at Cincinnati, Ohio.
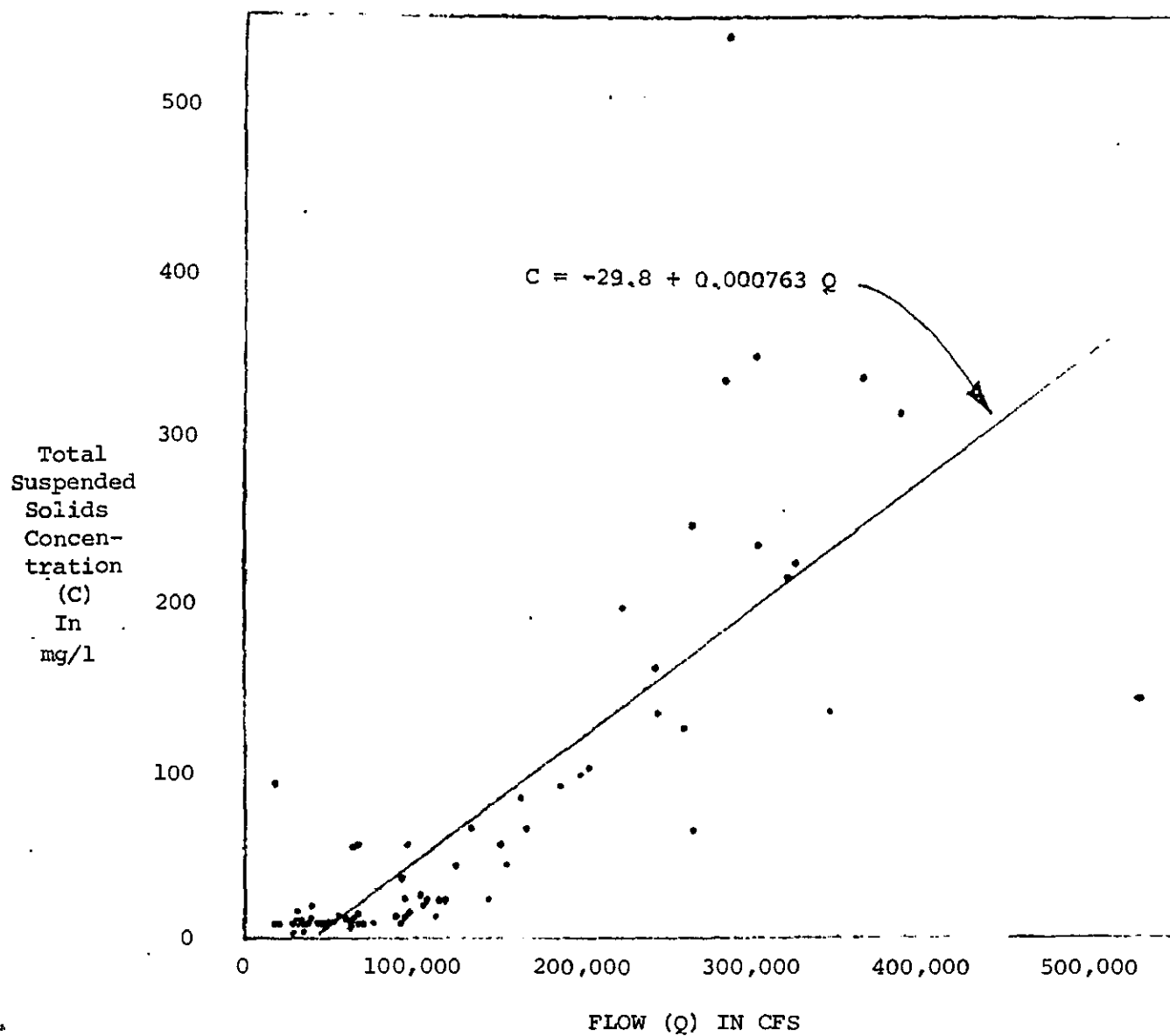
Figure V-9. Relationship between Flow and Total Suspended Solids Concentration
in the Ohio River at Louisville, Kentucky.

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

Mass
Flow
of
Total
Suspended
Solids
in
Tons/
Day

500,000
400,000
300,000

200,000

100,000

50,000
40,000
30,000

20,000

10,000

5,000
4,000

3,000

2,000

1,000

500
400

300

200

100

J A J O   J A J O   J A J O   J A J
   1977   1978   V-24   1979   1980
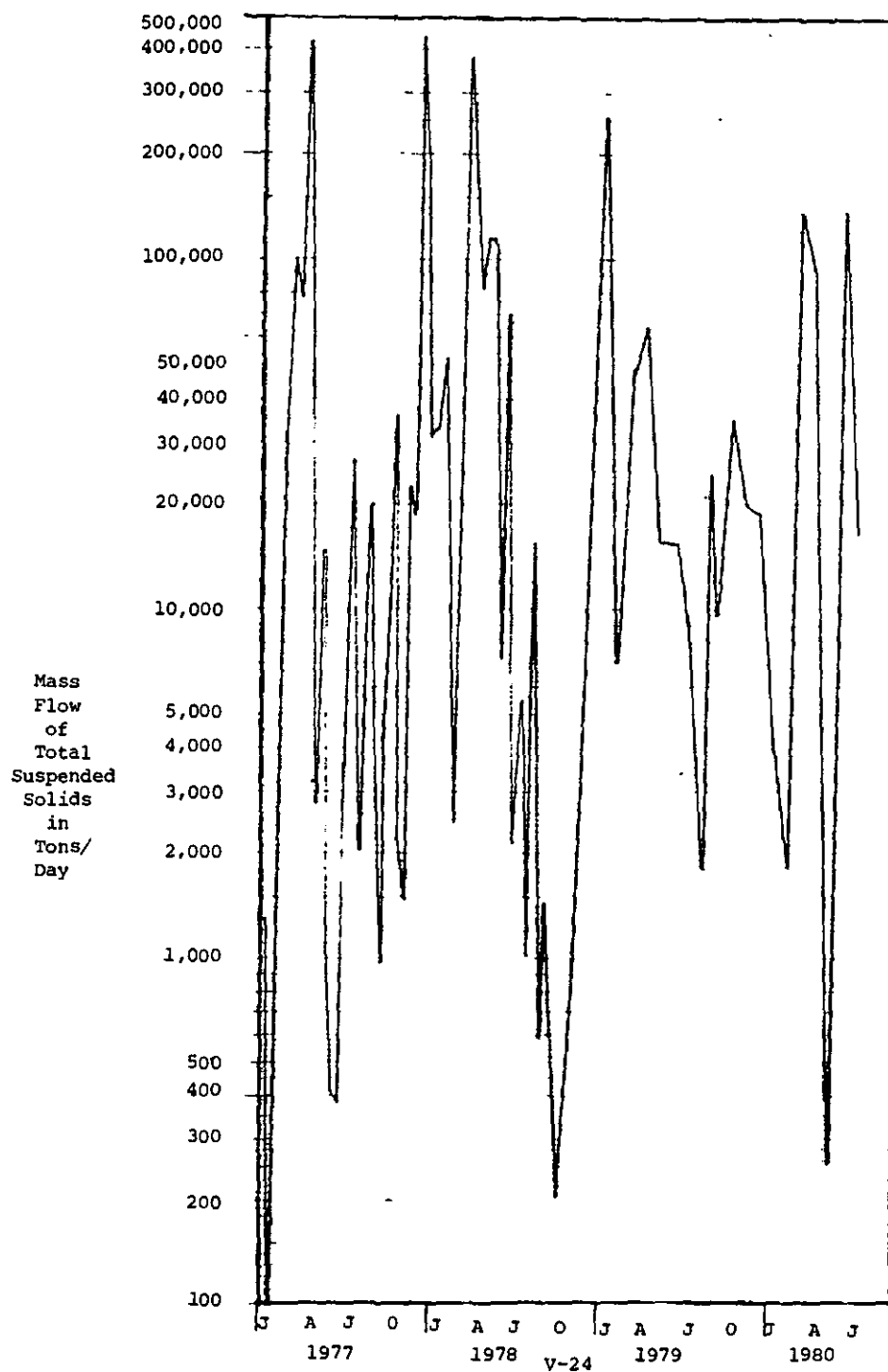
Figure V-10.   Total Mass Flow of Suspended Solids in the Ohio
                River at Cincinnati, Ohio

V-13

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 POLYMER SETTLING GAC FILTRATION	LAGOON SUPERNATE	2 LAGOONS UNDER CONSTRUCTION SOME BACKWASH RECYCLING 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 KMnO4 GAC FILTRATION	BACKWASH 40,000 gpd	NONE
CORAOPOLIS BOROUGH	PA	10.2	GROUND WATER						
SEWICKLEY	PA	11.4	60% GROUND WATER 40% OHIO RIVER						

V-16

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	12.0	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	21.8	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	WASTE 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 FERRIC CHLORIDE LIME $KMnO_4$ GAC FILTRATION	7.25 mgd/MO. 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 PAC $FeSO_4$ + LIME FILTRATION		2 GRAVITY THICKENERS 2 BELT FILTER PRESSES 5 TONS SLUDGE PER 10 MGD PER DAY BACKWASH WATER RECYCLED 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						NONE
SISTERSVILLE	W. VA.	137.1	OHIO RIVER	OHIO RIVER		0.23 - 0.26	ALUM/LIME SODA ASH R.S. FILTRATION	BASIN DRAINED ANNUALLY BACKWASH AS REQUIRED	NONE
ST. MARYS	W. VA.	155.5	GROUND WATER						
BELMONT	W. VA.	158.0	GROUND WATER						NONE
PARKERSBURG	W. VA.	182.2	OHIO RIVER (RANNEY COLLECTOR)	OHIO RIVER		6.5	ALUM/POLYMER KMnO$_4$ FILTRATION		
HUNTINGTON	W. VA.	304.2	OHIO RIVER	LAGOON DISCHARGE TO OHIO RIVER		17.6	FeSO$_4$ LIME POLYMER	3 mgd SLUDGE 14.8 mgd BACKWASH LAGOON EFFLUENT 24.9 mg/l SS 1.13 mg/d Fe	2 LAGOONS SAND BEDS SLUDGE SOLIDS TO LANDFILL
HAVERSON HEIGHTS	W. VA.	70.6	GROUND WATER						NONE
EAST LIVERPOOL	OHIO	40.2	OHIO RIVER	OHIO RIVER		3.2	ALUM/LIME PAC FILTRATION	BACKWASH 60,000 gpd BASINS 1 mg/yr ONCE A YEAR	

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 KMnO4 R.S. FILTRATION	BACKWASH 60,000 gpd BASINS DRAINED EVERY 4 to 5 MO. 10,000 GAL.	
TORONTO	OHIO	59	OHIO RIVER	OHIO RIVER	2		ALUM/LIME PAC R.S. FILTRATION	BASINS DRAINED EVERY 3 MO. 500,000 gal.	
STEUBENVILLE	OHIO	65.2	OHIO RIVER	STP		5 - 5.5	ALUM/LIME PAC KMnO4 R.S. FILTRATION		STP 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	38	0.5 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 CHARACTLRIZATION
MAYSVILLE	KY	408.5	OHIO RIVER	OHIO RIVER	2.4	1.304	ALUM/LIME PAC R.S. FILTRATION	BACKWASH-DAILY SLUDGE 2X/YR	NONE
NEWPORT	KY	463.5	OHIO RIVER	CREEK TO OHIO RIVER	10.5	8.5	2 RESERVOIRS ALUM/LIME FILTRATION	SLUDGE 10 M. GAL/YR 1400 mg/d SS BACKWASH 93 M. GAL/YR 400-800 MG/l. SS	
OLDHAM CO.	KY	582	OHIO RIVER (RANNEY COLLECTOR)		2.8	2.2	C/2 SODIUM TRI-POLY PHOSPHATE	NO DISCHARGE	
LOUISVILLE CRESCENT HILL PLANT	KY	600.6	OHIO RIVER			120 GMD	PRESETTLING ALUM/POLYMER LIME/SODA ASH SOFTENING FILTRATION	LAGOON SUPERNATE 4.3 MGD	1 LAGOON SYSTEM SERVES BOTH PLANTS 75 ACRES 30-40 YR STORAGE CAPACITY BACKWASH WATER RECYCLED
LOUISVILLE B.E. PAYNE PLANT	KY	594.5	OHIO RIVER			15 MGD	ALUM/POLYMER LIME/SODA ASH SOFTENING FILTRATION	"	"
HAWESVILLE	KY	723.0							
OWENSBORO	KY	753.5	GROUND WATER			10 MGD	AERATION LIME SOFTENING FILTRATION	LAGOON SUPERNATE	20 ACRE LAGOON 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					STP
MORGANFIELD	KY	839.9	OHIO RIVER	STP	6	4.5	ALUM/LIME $KMnO_4$ FILTRATION	BACKWASH 203,100 gpd	NO CHARGE TO WATER COMPANY
UNIONTOWN	KY	842.5	OHIO RIVER		4	1.5 to 2	RESERVOIR ALUM/LIME PAC R.S. FILTRATION	50,000 gpd	STP
MORGANFIELD	KY	843.0	OHIO RIVER (KANNEY 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					
EVANSVILLE	IN.	791.5	OHIO RIVER	OHIO RIVER		24	ALUM/LIME PAC R.S./GAC FILTRATION	24,000 gpd 10,000 PPMSS	EQUALIZATION TANK
MOUNT VERNON	IN.	829.3	OHIO RIVER	OHIO RIVER	2	28	ALUM /LIME PAC CLARIFIERS FILTRATION		
					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	BACKWASH AS REQUIRED	NONE
GOLCONDA	ILL	902.3	OHIO RIVER	LUSK CREEK UPSTREAM OF OHIO RIVER		0.13 - 0.18	ALUM/LIME PAC R.S. FILTRATION	SLUDGE EVERY 3 MONTHS	
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 treat-
ment plants are presented below:

Water Treatment Plant Capacity	Diffuser Costs
(Million Gallons Per Day)	(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

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, com-

mercial, 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:

Inorganic chemicals	Limiting concentration (mg/l)
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.

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)

$$62.4 \times \text{river flow (cfs)} \times (T_1 - T_{tt}) \times 90\%$$

Where:

T_1 - 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_{tt} 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[c]
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.

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 promul-
gated 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/1.

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:

Type of Plant (1)	Parameter	Min.	LIMIT 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.

<u>USEPA Region V</u>

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	MAX/MIN	DATE 1979	TOTAL[1] SOLIDS GENERATED LBS./10 mgd	LIME + ALUM CAPITAL COST $/10 mgd	O & M COST $/10 mgd	TOTAL[2] ANNUAL COST $/10 mgd	TOTAL COST $/LB.	TOTAL[1] SOLIDS GENERATED LBS./10 mgd	LIME + ALUM + PAC CAPITAL COST $/10 mgd	O & M COST $/10 mgd	TOTAL[2] ANNUAL COST $/10 mgd	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 PRESS	-MAX	4 JAN.	24,990	2,142,000	154,700	356,890	14.281		2,142,000	154,700	356,883	14.123
	-MIN	7 AUG.	2,140	249,900	22,610	46,198	21.588		261,800	23,800	48,511	20.046
GRAVITY THICKENER	-MAX	4 JAN.	24,990	214,200	4,879	25,097	1.004		214,200	4,879	25,097	0.993
	-MIN	7 AUG.	2,140	73,780	2,023	8,987	4.20		77,350	2,142	9,443	3.902
FILTER PRESS	-MAX	4 JAN.	24,990	952,000	178,500	268,359	10.739		952,000	178,500	268,359	10.62
	-MIN	7 AUG.	2,140	428,400	101,150	141,587	66.162		452,200	101,150	143,833	59.435
VACUUM FILTER	-MAX	4 JAN.	24,990	654,500	202,300	264,078	10.567		654,500	208,250	270,028	10.686
	-MIN	7 AUG.	2,140	238,000	38,080	60,545	28.292		249,900	41,650	65,238	26.958
DECANTER CENTRIFUGE	-MAX	4 JAN.	24,990	476,000	54,740	99,670	3.988		476,000	57,120	102,050	4.038
	-MIN	7 AUG.	2,140	214,200	17,850	38,068	17.789		214,200	19,040	39,258	16.222
BASKET CENTRIFUGE	-MAX	4 JAN.	24,990	952,000	111,860	201,719	8.072		963,900	113,050	204,033	8.074
	-MIN	7 AUG.	2,140	226,100	19,040	40,382	18.87		226,100	19,040	40,382	16.687
SURGE TANK $/10 MGD	-MAX	4 JAN.	24,990	440,300	NA	41,560	1.663		440,300	NA	41,560	1.645
	-MIN	7 AUG.	2,140	440,300	NA	41,560	19.421		440,300	NA	41,560	17.174
SLUDGE HAUL 10 MGD 5 MI	-MAX	4 JAN.	24,990	130,900	23,800	36,156	1.447		130,900	23,800	36,156	1.431
	-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

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

UNIT PROCESS		DATE 1979	TOTAL[1] SOLIDS GENERATED LBS./10 mgd	FERRIC SULFATE				FERRIC SULFATE + PAC				
				CAPITAL COST $/10 mgd	O & M COST $/10 mgd	TOTAL[2] ANNUAL COST $/10 mgd	TOTAL COST $/LB.	TOTAL[1] SOLIDS GENERATED LBS./10 mgd	CAPITAL COST $/10 mgd	O & M COST $/10 mgd	TOTAL[2] ANNUAL COST $/10 mgd	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 PRESS	-MAX	4 JAN.		2,142,000	154,700	356,883	14.437		2,142,000	154,700	356,883	14.275
	-MIN	7 AUG.		226,100	21,420	42,762	22.867		249,900	22,610	46,198	21.487
GRAVITY THICKENER	-MAX	4 JAN.		214,200	4,879	25,097	1.015		214,200	4,879	25,097	1.004
	-MIN	7 AUG.		71,400	1,904	8,643	4.622		73,780	2,023	8,987	4.180
FILTER PRESS	-MAX	4 JAN.		952,000	178,500	268,359	10.856		952,000	178,500	268,359	10.734
	-MIN	7 AUG.		404,600	99,960	138,150	73.877		428,400	101,150	141,587	65.854
VACUUM FILTER	-MAX	4 JAN.		654,500	202,300	270,028	10.923		666,400	208,250	271,152	10.846
	-MIN	7 AUG.		232,050	34,510	56,413	30.167		238,000	38,080	60,545	28.160
DECANTER CENTRIFUGE	-MAX	4 JAN.		476,000	57,120	102,050	4.128		476,000	57,120	102,050	4.082
	-MIN	7 AUG.		214,200	16,660	36,878	19.721		214,200	17,850	38,068	17.706
BASKET CENTRIFUGE	-MAX	4 JAN.		952,000	110,670	200,529	8.112		952,000	110,670	200,529	8.021
	-MIN	7 AUG.		226,100	17,850	39,192	20.958		226,100	17,850	39,192	18.229
SURGE TANK $/10 MGD	-MAX	4 JAN		440,300	NA	41,560	1.681		440,300	NA	41,560	1.662
	-MIN	7 AUG.		440,300	NA	41,560	22.225		440,300	NA	41,560	19.330
SLUDGE HAUL 10 MGD	-MAX	4 JAN.		130,900	23,800	36,156	1.463		130,900	23,800	36,156	1.446
	-MIN	7 AUG.		64,260	3,332	9,398	5.025		65,450	3,570	9,748	4.534
SMI												

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

C-2

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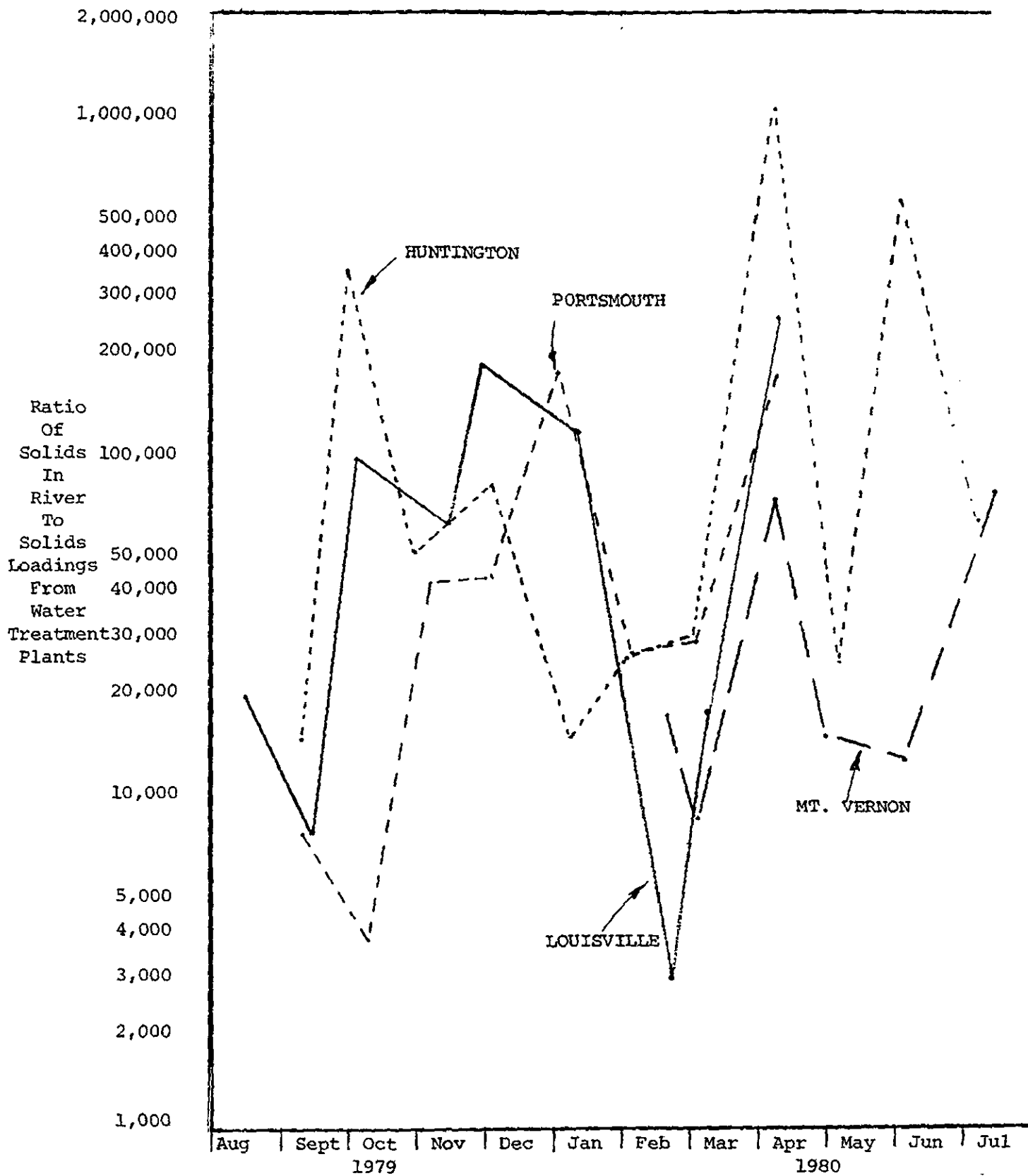
Figure E-1.   Comparison of Solids Flow in the Ohio River to Loadings from
Representative Water Treatment Plants

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 (μq/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

<u>PERCENT</u>

	Partially Dehydrated	After Ignition	Dried at 103° 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	