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United States
Environmental Protection
Agency

Region V
230 S. Dearborn
Chicago, Illinois 60604

June, 1979

Water Division

EPA

Environmental Impact Statement

Final

Wastewater Treatment Facilities for the Metropolitan Area Columbus, Ohio

VOLUME 3

EPA-5-OH-FRANKLIN-COLUMBUS-WWTP&INT-79

FINAL ENVIRONMENTAL IMPACT STATEMENT
WASTEWATER TREATMENT FACILITIES
FOR THE METROPOLITAN AREA
COLUMBUS, OHIO

Prepared by the

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 5

CHICAGO, ILLINOIS

And

BOOZ, ALLEN AND HAMILTON, INC. With HAVENS & EMERSON, INC.

BETHESDA, MARYLAND CLEVELAND, OHIO

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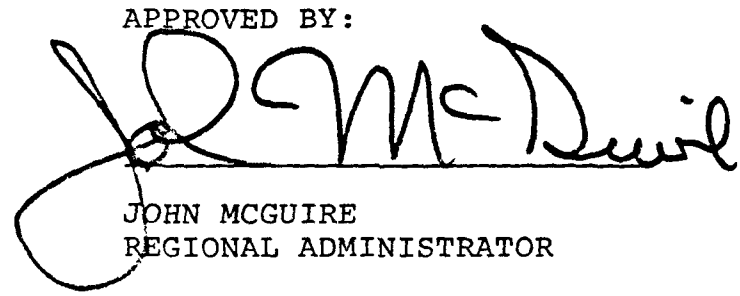

JOHN MCGUIRE
REGIONAL ADMINISTRATOR

JUNE 1979

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PREFACE

The Final Environmental Impact Statement (EIS) for the Columbus, Ohio Wastewater Treatment Facilities consists of the three following volumes:

- Volume I: "Recommended Alternatives, Technical Analysis, and Impacts"
- Volume II: "Response to Comments and Final EIS Appendices"
- Volume III: "The Draft EIS (Edited)"

Volume I discusses the essence and substance of the final collection, treatment, and disposal recommendations, highlighting any recommendations that differ from the Draft EIS. The intent of Volume I is to provide a concise overview of the recommended system, emphasizing areas of significance (e.g., regionalization, pretreatment, sludge disposal). Detailed analyses supporting the conclusions can be found in the Appendices to Volume II and in Volume III.

Volume II contains the written record of public commentary and appropriate responses to the issues raised by this commentary. There are over 330 specific comments by Federal, state and local governments and private concerns for which detailed responses have been developed. Volume II also contains additional appendix material which was developed in response to the comments on the Draft EIS.

Volume III is the Draft EIS edited only for identified omissions and errors. Asterisks in the margins indicate those sections, lines, or words that have been changed, added, or deleted.

Summary Sheet for Environmental
Impact Statement

Columbus, Ohio Facilities Plan

EPA Project No. EPA-5-OH-FRANKLIN-COLUMBUS-WWTP & INT-79

Draft ( )
Final (X)

Environmental Protection Agency
Region V
Chicago, Illinois

1. Type of Action: Administrative (X)
Legislative ( )

2. Brief Description of Proposed Action

The subject action of this Environmental Impact Statement is the Facilities Plan submitted by the City of Columbus to expand and upgrade wastewater collection, treatment, and disposal facilities within the Columbus metropolitan area. The proposed project includes three major actions.

- Selection of addition liquid and solids handling treatment facilities for sewage processing at the Southerly and Jackson Pike sewage treatment plants (STPs).
- Construction of two sludge incinerators and associated dewatering facilities for processing sludge from sewage treatment at Southerly STP.
- Construction of separate sanitary sewer interceptors within the Columbus planning area.

3. Summary of Major Environmental Impacts

The proposed action will have the following beneficial impacts:

(1) Alleviation of existing adverse conditions in the Scioto River caused by law quality wastewater discharges

(2) Improved treatment and disposal of wastewater sludges

(3) Upgraded and integrated treatment facilities to accommodate existing and future sources of wastewater

(4) Elimination of the need for onsite disposal systems and package plants where they are unsuitable.

The proposed action will have the following adverse impacts:

(1) Potential erosion of treatment plant sites and interceptor routes during construction

(2) Temporary noise and odor impacts during construction

(3) Increase traffic activity during construction

(4) Air emmissions from sludge incineration will be minized by offsets from existing incinerators and application of lowest achievable emission rate technology.

4. Summary of Alternatives Considered

Regional wastewater collection alternatives, including the no service alternative, were considered for eleven subareas within the Columbus planning area. Preliminary screening indicated that eight of these were suitable for possible inclusion into a regionalized system. A summary of the alternatives considered, in addition to the no-action alternative, for each of these eight subareas is given below:

Subarea	Number of Alternatives Considered	Alternative Types
West Scioto	2	Two new interceptors
Big Run	1	One new interceptor
Minerva Park	2	One new interceptor Upgrade existing plant
Big Walnut Creek Rocky Fork Blacklick Creek	5	Five new interceptor systems
Groveport	3	Upgrade existing plant Two new interceptors
Rickenbacker Air Force Base	3	Upgrade existing plant Two new interceptors

In addition, four pretreatment alternatives for a major Columbus-area brewery currently discharging to the Southerly Plant were considered. These alternatives ranged from no pretreatment to total on-site brewery waste treatment to Southerly NPDES effluent restrictions.

Treatment plant alternatives considered various ways of utilizing and upgrading the two existing Columbus wastewater treatment plants (Southerly and Jackson Pike). Alternatives for liquid treatment and disposal included: treatment and land application, treatment and reuse, and treatment and discharge.

Alternative disposal concepts considered for the solids produced by the two Columbus plants included: several codisposal opportunities, four resource recovery schemes, and a landfill disposal option. The EIS also examined the resource savings that might be available with the following alternative treatment technologies: phosphorous removal, intermediate sedimentation, oxygen production and dissolution, secondary solids thickening, conditioning and dewatering, recycle management, and pyrolysis. Finally, a variety of process optimization alternatives were analyzed for cost-effectiveness. These were: flow equalization,

reduction of electrical energy charges, the activated sludge system, effluent filtration, and waste solids processing.

5. Federal, State and Local Agencies and Officials Notified of this Action

Federal Agencies

Council on Environmental Quality
Environmental Protection Agency
U.S. Army Corps of Engineers, Huntington District
Department of the Air Force
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Water Resources Council

Members of Congress

Honorable John Glenn U.S. Senate
Honorable Howard G. Metzenbaum U.S. Senate
Congressman Samuel L. Devine U.S. House of Representatives
Congressman Chalmers P. Wylie U.S. House of Representatives
Congressman John M. Ashbrook U.S. House of Representatives
Congressman William H. Harsha U.S. House of Representatives
Congressman Clarence E. Miller U.S. House of Representatives

State

Honorable James A. Rhodes, Governor, State of Ohio
Ohio Environmental Protection Agency
Ohio Department of Natural Resources
Ohio Department of Health

Local

Honorable Tom Moody, Mayor, City of Columbus
Board of Franklin County Commissioners
City of Reynoldsburg
City of Westerville
Grove City
Village of Dublin
Village of Grove Port
Village of New Albany
Mid-Ohio Regional Planning Commission
Mid-Ohio Health Planning Federation
Delaware County Regional Planning Commission
Licking County Regional Planning Commission
Fairfield County Regional Planning Commission

6. Date made available to CEQ and the Public

The Final Statement was made available to CEQ and the public on June 15, 1979.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The subject action of this Environmental Impact Statement is the Facilities Plan submitted by the City of Columbus to expand and upgrade wastewater collection, treatment, and disposal facilities within the Columbus metropolitan area. The proposed project includes five major actions.

- Construction of additional liquid treatment facilities for sewage processing at the Southerly and Jackson Pike sewage treatment plants
- Design and construction of a pilot plant in order to evaluate the effectiveness of the recommended plan to solve the bulking activated sludge problem at Southerly
- Construction of three sludge incinerators and associated dewatering facilities for processing sludge from sewage treatment
- Construction of separate sanitary sewer interceptors within the Columbus planning area
- Selection of a cost-effective and environmentally acceptable system to minimize combined sewer overflows.

The environmental impact analysis of the proposed actions resulted in several key findings and recommendations regarding population projections, primary and secondary impacts, and socioeconomic impacts. These are summarized below.

I. POPULATION PROJECTIONS

A. Existing Projections

The amount of facilities expansion required over the next 20 years in Columbus depends to a great extent on the increase in population over that time period. Facilities' designs must be based on some reasonable estimate of growth for the planning area. Five sets of year-2000 population projections for the mid-Ohio region are currently being evaluated by the region's planning agencies. These projections are shown below in Table 1.

TABLE 1
Population Projections

Projection	Projected Year 2000 population (thousands)	Cumulative projected growth rate (1975-2000)[1]
Battelle/Health Dept.	882	2.3%
Sales and Market Mgmt.	1008	17%
Census 70-75 Estimates Extended	1041	21%
MORPC 70-75 Estimates Extended	1218	42%
Chamber of Commerce	1286	50%
Average	1087	26%

1 Based on 1975 population of approximately 860,000

The wide range in these projections is evident. In recent meetings, regional, state and Federal agency representatives have attempted to come to some agreement upon one set of projections which could be used county-wide. This would assure consistent areawide planning. As this EIS was being written, there was no interagency agreement on the validity of any of these projections or on which ones might be used for planning purposes.

The Facilities Plan used a modified version of the MORPC-extended estimates and projected populations to the years 1995 and 2025. In reviewing the Plan, it was unclear whether these optimistic estimates were reasonable, given the most recent Ohio Health Department year 2000 projections (882,000).

B. "Best Estimate" Projections

In order to assess the soundness of the projections and to come to some conclusions on "best estimate"

projections to be used for this project, the U.S. EPA developed four sets of independent projections based on standard methodologies.

For the year 2000 these projections ranged from approximately 995,000 to 1.11 million. The largest of the projections is greater than three of the five existing projections and is also larger than the average of the five. This 1.11 million figure projects a 1975-2000 cumulative growth rate of 29 percent for the Columbus area which translates to a 1.2 percent average annual growth rate over the planning period. Thus, in the absence of county-wide consensus, selection of this figure would give both a reasonable population estimate for the year 2000 (i.e., avoiding both high and low extremes) and one that is moderately optimistic in its growth predictions based on recent (1970-1975) county trends. For the above reasons this report used the 1.11 million figure in analyzing the need for interceptor and treatment plant expansions.

II. PRIMARY IMPACTS

A. Wastewater Treatment Plants

The proposed improvements will eliminate the discharge of untreated or inadequately treated sewage in most of Franklin County. Minor short-term adverse effects on the natural environment will occur during construction at the treatment plant sites should construction needs dictate the shut down of any process capability.

(1) Water

The occurence of toxic conditions in the Scioto due to releases of either ammonia or chlorine will be essentially eliminated upon implementation of the proposed project plan components. Seasonal chlorination will be used to protect public health, with subsequent dechlorination to protect aquatic life. Enrichment of the Scioto River due to releases of phosphorus will also be reduced to the point of insignificance.

The implementation of the proposed project plan will have its most striking positive impact on the water quality in the Scioto River below the outfall from each wastewater treatment facility. Although

the possibility remains that the stream standard for dissolved oxygen may not be maintained under all flow conditions, the overall improvement in the Scioto River quality will be immense, particularly during periods of low flow.

Short-term adverse impacts on water quality may be experienced during construction activities if and when process capabilities must be shut down. Construction specifications should contain mitigative measures for these short-term impacts, including a definite scheduling of improvements which will minimize bypass of any present or proposed unit processes.

(2) Land

Increased erosion may be experienced during the construction of interceptors and improvements at the treatment plant sites. Since all proposed expansion will take place within the boundaries of the present sites, land related impacts will be minimal. Strip mine restoration by the use of sludge will result in land reclamation as well as improved water quality in strip mined areas.

(3) Air

Emission control standards exist only for particulate matter and mercury emissions from municipal sludge incinerators. A wet scrubber with particulate removal efficiency of 97.2 percent is planned to be used at the proposed incinerators to meet the New Source Performance Standard (NSPS). Since the estimated mercury emissions from the Jackson Pike and Southerly plants under the worst conditions are well below the emission standard for mercury, no special equipment will be required to control mercury emissions.

Additionally, ambient air quality standards have been established for particulate matter to protect both the public health and welfare. The atmospheric modeling study performed by the Ohio EPA to determine the impact on the ambient concentration of particulate matter from existing and proposed incinerators at Jackson Pike and Southerly is inconclusive. Additional modeling by the Ohio EPA is necessary to assess the impact of the proposed incineration facilities and determine if additional incinerators may be built and if offsets will be required. Results of this analysis will be included in the final EIS.

B. Interceptors

The proposed construction of sewer interceptors will have long-term beneficial effects on water quality. Short-term adverse effects on the natural environment during construction will be of minor significance, consisting mainly of traffic disruption, erosion, noise and air pollution due to fugitive dust. The short-term and long-term primary impacts of the eight interceptors are summarized in Table 2.

III. SECONDARY IMPACTS

Many locations within the Columbus planning area are now experiencing water pollution problems because of inadequate septic tank and package plant performance and over-loaded municipal treatment plants. Incorporating these areas into an expanded and upgraded Columbus system could provide a cost-effective and environmentally sound sewage treatment alternative.

In this light, regional interceptor alternatives, including the no-service alternative, were considered for eleven sub-areas within the Columbus planning area. These sub-areas are shown in Figure 1. Preliminary screening indicated that eight of these areas were suitable for possible inclusion into a regionalized system. A summary of the alternatives considered, in addition to the no-service alternative, for each of these eight sub-areas is given in Table 3.

A. Regionalization Recommendations

Construction of the proposed regional interceptors is likely to affect the distribution of the population, with consequent environmental impacts due to changed land use patterns. Recommended revisions to the proposed action will help to mitigate these impacts. The regionalization recommendations for each sub-area are described in Chapter III of the EIS. The recommendations which deviate from the actions proposed in the Facilities Plan by the end of the planning periods (the year 2000) are as follows:

. Southerly Service Area

- Rickenbacker AFB added

- Service only provided to Reynoldsburg in the Blacklick Creek sub-area

TABLE 2

Primary Impacts

Interceptor	Short-term Impacts	Long-term Impacts
West Scioto		
. Low Level	Erosion due to proximity to Griggs Reservoir and crossing of streams and ditches; traverse of wooded area and parkland; noise, air quality, aesthetics during construction	Beneficial: Elimination of septic tanks. Adverse: Purchase of easements, removal of large trees, aesthetic appearance of aerial sewer (5400 feet).
. High Level	Construction in area of steep slopes, stream and ditch crossings, traffic disruption, traverse of parkland, noise, air quality, aesthetics during construction	Beneficial: Elimination of septic tanks. Adverse: Aerial sewer line (1300 feet).
Big Run	Close proximity to Big Run for 25,000 feet; two stream crossings, five highway crossings.	Beneficial: Prevents water quality deterioration due to malfunctioning septic systems. Adverse: Insignificant.
Minerva	Increased water turbidity due to construction along 4,200 feet of stream banks and 3 stream crossings; erosion due to construction through 350 feet of steep slopes	Beneficial: Improvements of water quality due to elimination of Minerva Creek Treatment Plant; improved local aesthetics; decreased manpower, energy and land requirements. Adverse: Adverse impacts would result from retention of treatment plant, including increased manpower, energy and land due to needed expansion; odor, noise and aesthetics.
Big Walnut Creek	Alternatives A, C, and D: Traffic disruption; temporarily severe erosion due to construction on steep slopes and wooded areas near streams and Hoover Reservoir. Alternative B: Same as above except for impact on Hoover Reservoir; temporary adverse impact on Rocky Fork due to construction activities.	Beneficial: Protection of surface and groundwater from degradation due to inadequate onsite and centralized treatment systems. Adverse: Aesthetic impact due to 500 feet of aerial sewer line.
Rocky Fork	Alternative A: Erosion; destruction of trees and vegetation at stream crossings; traffic disruption; steep slopes. Alternative B: Eliminates most of the Alternative A route problems; pump station and force main for subalternative B require short-term commitment of energy, manpower and materials during construction; traffic disruption. Alternative C: Same as Alternative B, except for 4 additional highway crossings, 2 pipeline crossings, 19,300 feet of sewer through open and cultivated areas. Alternative D: Traffic disruption; erosion due to steep slopes; stream crossings.	Beneficial: Central collection of sewage, avoiding use of ineffective onsite disposal systems.

TABLE 2 (Continued)

Primary Impacts

Interceptor	Short-term Impacts	Long-term Impacts
Blacklick Creek	Erosion and turbidity due to construction near streams and at stream crossings; traffic disruption at highway crossings and along highways.	Beneficial: Improvement of water quality in Blacklick Creek resulting from elimination of Reynoldsburg WWTP and other inadequate plants. Adverse: Removal of trees; aerial crossing of ravine north of Route 16.
Groveport	Alternatives A and B: Erosion and turbidity due to stream crossings; traffic disruption at 4 road crossings; noise; air quality; aesthetics. Plant Alternative: Same as for Alternatives A and B.	Beneficial (All alternatives): Improvement of water quality in Little Walnut Creek. Adverse (Plant alternative): The plant alternative will involve an ongoing commitment of manpower, materials, land and energy to upgrade and expand the Groveport WWTP. Also odor, noise, and aesthetic degradation. Adverse (Alternative B): Removal of some large trees.
Rickenbacker AFB	Construction in residential area along Route 665.	Beneficial: Improvement of water quality. Adverse: For plant alternative, commitment of manpower, materials and energy to upgrade and operate the facility. For Alternatives A and B: Insignificant.

Figure 1

Planning Area For Metropolitan Columbus

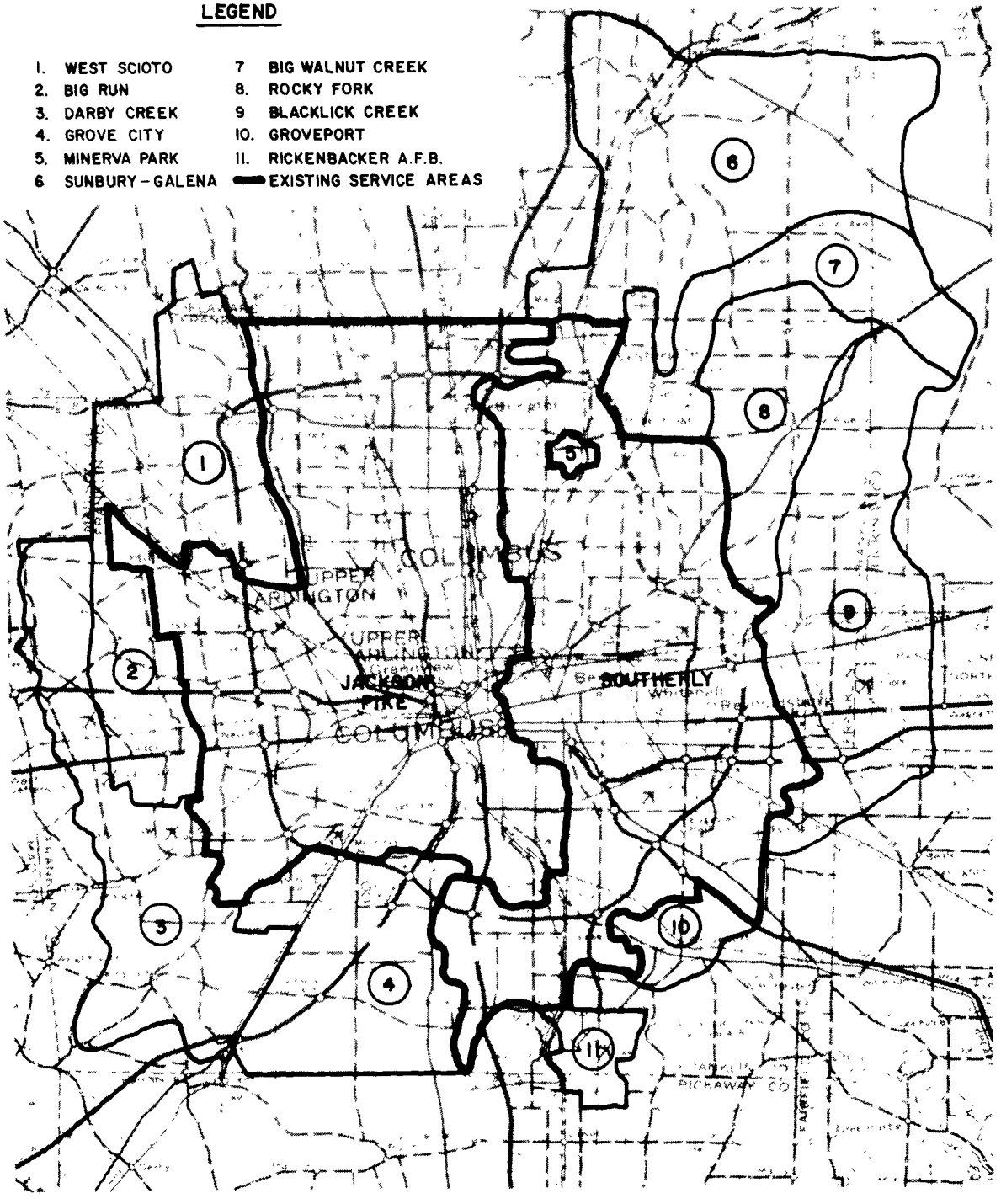

TABLE 3
Regionalization Alternatives

Subarea	Number of Alternatives Considered	Alternative Types
West Scioto	2	Two new interceptors
Big Run	1	One new interceptor
Minerva Park	2	One new interceptor Upgrade existing plant
Big Walnut Creek Rocky Fork Blacklick Creek	5	Five new interceptor systems
Groveport	3	Upgrade existing plant Two new interceptors
Rickenbacker Air Force Base	3	Upgrade existing plant Two new interceptors

- Service only provided to New Albany in the Rocky Fork sub-area

- Partial service to the Big Walnut Creek sub-area may be necessary by 1985.

. Jackson Pike Service Area

- Some portions of Delaware County to be included with the West Scioto sub-area

- Service will not be provided to the Big Run sub-area.

B. Secondary Impact Analysis

While the construction of the proposed action would not be expected to significantly affect total planning area population as compared to expected growth with the no-action alternative, it would be likely to affect distribution of the population, with consequent environmental impacts due to changed land use patterns. Specifically, the impact analysis concluded that the secondary impacts of the action proposed in the Facilities Plan would be:

. Population increase in Franklin County between 1975 and 2000 is likely to be similar with or without the proposed action

. In Big Run, the proposed sewer phasing would have a potential for inducing growth in an area which is primarily agricultural and historically has been considered unsuitable and unattractive for development

. In West Scioto, similar population increase is anticipated with or without the proposed action because of the area's attractiveness; however, the type of development and distribution of the population within the service area's 24,300 acres may differ in each case

. In Big Walnut, the attractiveness of the Hoover Reservoir area may stimulate growth with or without the proposed action; however, the rate of growth with the sewers may exceed the rate without the sewers

- In Rocky Fork and Blacklick, provision of public sewer service has the potential to hasten the existing trend in Franklin County of converting vacant and agricultural land to higher uses

- The ability of the area's economy to support additional population and the adequacy of water supplies may be more significant determinants of population growth and development patterns than availability of public sewer services.

The regionalization changes to the facilities plan proposed by the EIS would provide phased service to certain subareas, and hence will help to preclude the possibility of induced growth where such growth is undesirable. Thus, future growth patterns can be directed and controlled and the potential for adverse secondary impacts will be reduced. Ultimately, however, control and direction over growth will have to come from environmentally and economically sound areawide planning.

All sewer designs in the Facilities Plan were based on an estimate of ultimate population. EPA's cost-effectiveness guidelines require comparing different design periods. An analysis was performed to show the size and cost differences between designs based on ultimate population, on interceptors flowing half full in the year 2000, and on interceptors flowing full in the year 2000. The cost difference between designs using half full by 2000 and full by 2000 vary from 3 percent to 24 percent, with the average and median variation around 18 percent. This demonstrates that, on the average, an 18 percent increase in cost will permit twice as much intercepted flow at design conditions. The comparison of ultimate density to the projected design density for the year 2000 showed that most of the areas are at or less than 25 percent of their ultimate density by the year 2000, making designs based on an ultimate population concept not cost-effective for the Columbus area. The EIS recommends designing most gravity sewers using the half-full, year 2000 criterion.

IV. SOCIOECONOMIC IMPACTS

A. Industrial

The present industrial base of Columbus consists of some 1,000 dischargers of wastewater which collectively

send approximately 15 mgd of wastewater to the two treatment plants. This total industrial release is slightly less than 10 percent of the average daily wastewater flow received at Jackson Pike and Southerly. Of these many and varied industrial releases, only one, that of the Columbus Anheuser-Busch Brewery, presented the opportunity to derive significant changes in the proposed project plan through implementation of an industrial pretreatment requirement. Thus, several pretreatment alternatives for the brewery were considered in the EIS. These alternatives, ranging from no pretreatment to total on-site brewery waste treatment to Southerly NPDES effluent restrictions, are presented below:

1. Brewery wastes without pretreatment (the Facilities Plan assumption)

2. Pretreatment of the brewery wastes to the point that the soluble oxygen demanding load is largely removed (a roughing filter at Anheuser-Busch)

3. Pretreatment of the brewery wastes to remove and handle the large majority of the oxygen demand and suspended solids

4. Total brewery waste treatment to Southerly NPDES effluent restrictions at Anheuser-Busch.

Table 4 summarizes the new capital and entire operating costs for each of the scenarios. Scenarios four, which excludes a joint municipal brewery treatment scheme, was the least attractive. Scenario one, the Facilities Plan Proposal, and scenario three represent nonoptimal alternatives. The best overall brewery waste treatment strategy was found with scenario two, which satisfies the majority of the industrial waste's soluble oxygen demand before release to the city sewer. As shown on the Table, this scenario indicates an overall present worth cost savings of $17 million over the Facilities Plan recommendation at a 60,000 lb/day BOD_5 loading.

Hence, the EIS recommends a revised Facilities Plan that incorporates pretreatment of the brewery waste stream to the level of treatment identified in scenario two. This assumes that the brewery will pretreat its 60,000 lb/day BOD_5 load for control of its soluble oxygen demand and that the previously recommended roughing trickling filter and intermediate sedimentation system at Southerly be eliminated.

TABLE 4

COST COMPARISON OF ALTERNATE BREWERY WASTE TREATMENT SCENARIOS
(Millions of Dollars, 1974/1975 Basis)

	Scenarios							
	100,000 lb/day raw Brewery Load				60,000 lb/day raw Brewery Load			
	1	2	3	4	1	2	3	4
I. Capital Cost Estimate - $								
Brewery	0	4.2	11.4	30.8	0	2.9	7.3	20.3
Southerly	66.4 (2)	48.1 (3)	41.9 (1)	41.9 (1)	66.4 (2)	41.9 (1)	41.9 (1)	41.9 (1)
Total	66.4	52.3	53.3	72.7	66.4	44.8	49.2	62.2
II. Operating Cost Estimate - $/Year								
Brewery	0	0.3	0.9	1.3	0	0.2	0.5	0.8
Southerly	5.5	5.4	5.3	5.3	5.4	5.4	5.3	5.3
Total	5.5	5.7	6.2	6.6	5.4	5.6	5.8	6.1
III. Present Worth Equivalent Estimate - $								
Brewery	0	7	20	42	0	5	12	27
Southerly	120	103	96	96	119	97	96	96
Total	120	110 ★	116	138	119	102 ★	108	123

(1) Unit processes eliminated from Facilities Plan: First stage biological treatment @ $14.1, HVAC, etc. equivalent @ $1.4, new dissolved air flotation units @ $2.3, one additional thermal conditioning system @ $1.8, one dewatering centrifuge @ $0.7, one half of recycle treatment system @ $2.7, and solids handling equivalent contingency @ $1.5. (Total = $24.5 million)

(2) Original Facilities Plan

(3) Unit processes eliminated from Facilities Plan: First stage biological treatment @ $14.1, HVAC, etc. equivalent @ $1.4, new dissolved air flotation uni @ $2.3, and solids handling equivalent contingency @ $0.5. (Total = $18.3 million)

(4) Present worth equivalent at 6-3/8 percent interest and 20 years
= 0.9 (Capital Costs) + (Annual Costs)

B. Capital and Operating Costs

The analysis of the Facilities Plan treatment plant recommendations resulted in various alternative ways of utilizing and upgrading the two existing Columbus wastewater Treatment Plants (Southerly and Jackson Pike). Alternatives for liquid treatment and disposal included: treatment and land application, treatment and reuse, and treatment and discharge. These proposed modifications represent $46 million savings in capital costs and 8 percent savings in annual operating costs.

Alternative disposal concepts considered for the solids produced by the two Columbus plants included: several codisposal opportunities, four resource recovery schemes, and a landfill disposal option. The EIS also examined the resource savings that might be available with the following alternative treatment technologies: phosphorous removal, intermediate sedimentation, oxygen production and dissolution, secondary solids thickening, conditioning and dewatering, recycle management, and pyrolysis. Finally, a variety of process optimization alternatives were analyzed for cost-effectiveness. These were: flow equalization, reduction of electrical energy charges, the activated sludge system, effluent filtration, and waste solids processing.

Based on the alternatives analysis, Figure 2 was developed to describe the recommended facilities for the Columbus wastewater treatment plants. Conceptually, with the exception of the total elimination of the isolated aerobic activated sludge system for stabilization of the broths associated with thermal conditioning, and the addition of dechlorination and post aeration facilities, the proposed Jackson Pike facilities are not uniquely different than the proposed project plan found in the Columbus Facilities Plans. Its uniqueness is found in the recommended sizing of the attendant unit processes. At Southerly, with the abandonment of the first stage pumping station, roughing trickling filter, and sedimentation system made possible by the recommended pretreatment of Anheuser-Busch wastes, a more substantial deviation from the Facilities Plan has occurred.

Table 5 summarizes the changes in unit process sizing derived from the recommended project plan in comparison to the improvements originally proposed in the Columbus Facilities Plan. Where no change from the originally

Figure 2
The Preferred Alternative

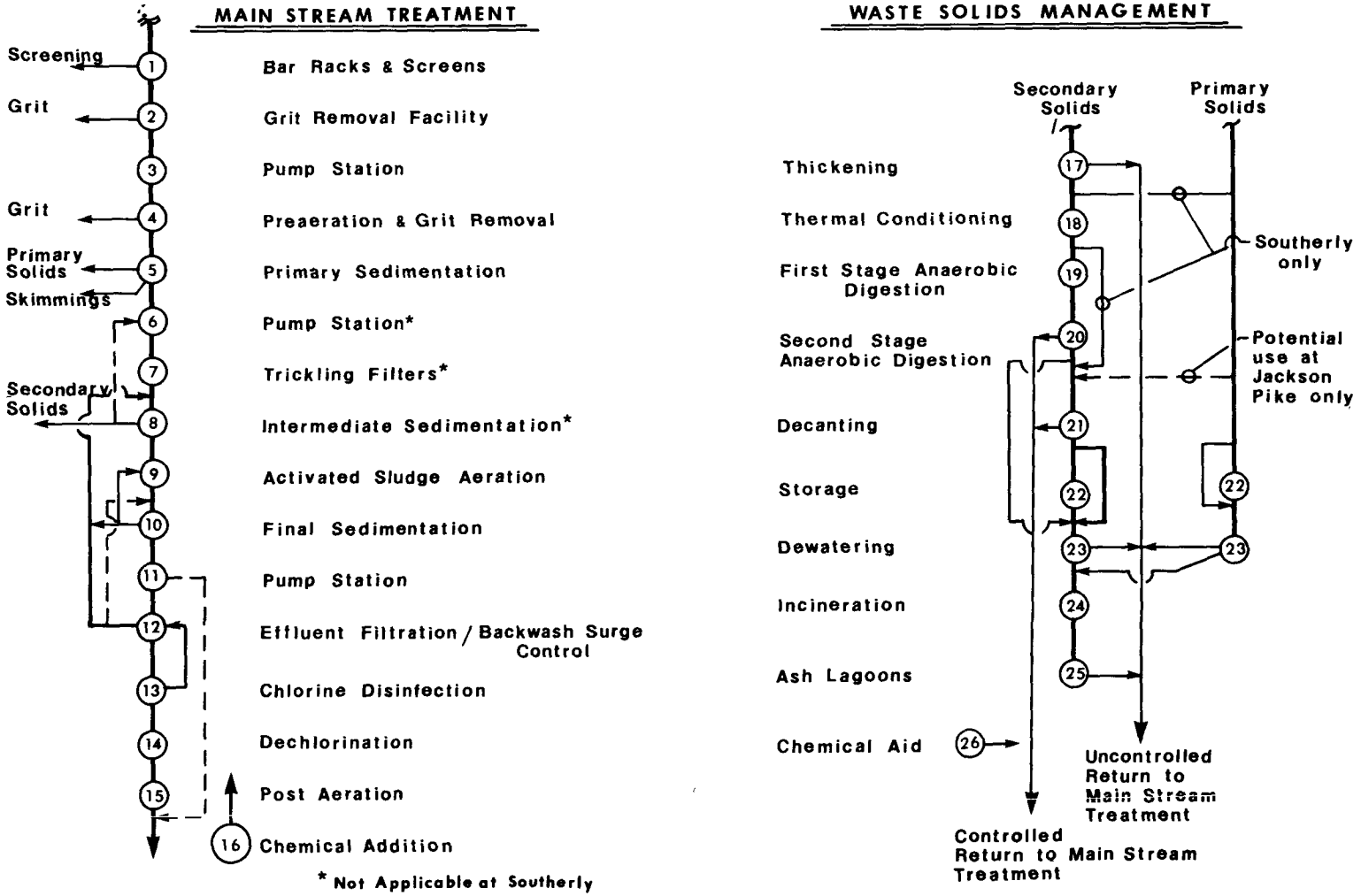

Table 5

Changes Associated with the Recommended Project Plan

Unit Processes (Refer to Figure V-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
1. Bar Racks and Screens	x							x						
2. Grit Removal	x							x						
3. Pump Station	x									x				
4. Preaeration/Grit Removal	x							x						
5. Primary Sedimentation	x							x						
6. Pump Station			x											x
7. Trickling Filters				x										x
8. Intermediate Sedimentation			x											x
9. Activated Sludge Aeration		x		x					x		x			
10. Final Sedimentation				x							x			
11. Pump Station			x							x				
12. Effluent Filtration/Backwash			x		x					x		x		
13. Chlorine Disinfection			x							x				

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Table 5 (Continued)

Changes Associated with the Recommended Project Plan

Unit Processes (Refer to Figure V-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
14. Dechlorination					x							x		
15. Post Aeration					x							x		
16. Chemical Addition					x							x		
17. Thickening				x							x			
18. Thermal Conditioning	x								x		x			
19-20. Anaerobic Digestion						x							x	
21. Decanting	x							x						
22. Storage				x							x			
23. Dewatering	x										x			
24. Incineration		x		x							x			
25. Ash Lagoons	x							x						
26. Chemical Aide					x							x		

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Note: Recommended alternative calls for complete elimination of the proposed isolated activated sludge system for stabilization of the product liquors derived from concentration of the thermally conditioned secondary solids.

proposed project plan is indicated, the reader is referred to Appendix I for the unit process's sizing. Additional discussion of the rationale leading to the final recommendations can be found in Appendix K.

Table 6 compares the first cost of the recommended project plan with the originally proposed project plan for Columbus. The recommended project plan is seen to contain an additional expenditure of some $8 million, the majority of which is associated with the expanded effluent filtration system. It is believed that the recommended improvements are necessary for reliable operation, and are prudently sized. The recommended project plan also offers about $54 million in first cost (capital costs) savings. The majority of these savings are derived by optimal sizing and use of biological reactors and their attendant solids- liquid separation systems, and the economic return derived with pretreatment of the brewery waste applied to Southerly, which allowed the elimination of the originally proposed first stage treatment system. It is believed that the associated recommendations also represent realistically sized alternatives.

Thus, the recommended project plan offers a net capital savings of almost $46 million in comparison to the original project plan. This savings, slightly in excess of 29 percent of the original Facilities Plan's first cost estimate, remains significant even in the context of the costing accuracy normally found in Facility Planning documents. It should also be noted that the recommended project plan offers a wastewater treatment system which integrates the liquid and solids handling capabilities of both plants. This allows a combined hydraulic capacity some 50 mgd more than originally proposed.

The operational costs associated with the recommended project plan were determined by reducing or increasing the costs of the original project plan by the assumed impact of the proposed alternative. This was necessary since the differences in the basis of design for influent flow and pollutant mass would have a rippling impact upon the operating costs for the integrated liquid and solids processing capability of the Columbus plants. Thus, this cost comparison more accurately reflects relative differences rather than true definite costs.

Table 6

First Cost Comparison of Original Project Plan with the Recommended Project Plan
(Millions of Dollars)

Processing Concept	Jackson Pike			
	Original Project Plan	Net Additional Cost	Net Cost Savings	Recommended Project Plan
Pretreatment and Primary Sedimentation	$ 8.6	0	0	$ 8.6
Chemical Addition	2.3	$0.3	0	2.6
First Stage Biological Treatment	16.8	0	$1.1	15.7
Second Stage Biological Treatment	14.8	0	9.1	5.7(3)
Effluent Polishing	13.7	2.8	0	16.5(4)
Subtotal (1)	$56.2	$3.1	$10.2	$49.1
Solids Thickening	$10.5	0	$ 2.7	$ 7.9
Solids Conditioning	4.9	0	0	4.9
Recycle Management	6.8	0	6.1	0.7
Solids Dewatering	1.2	0	0	1.2
Solids Incineration and Transport	12.3	0	3.4	8.9(5)
Ash Disposal	0.6	0	0	0.6
Subtotal (1)	$36.4	$0.0	$12.2	$24.2
TOTAL (1)	$92.6	$3.1	$22.4	$73.3
REVISED TOTAL (2)	-	-	-	$91.6

(1) 1974-1975 Basis
(2) July, 1977 Basis, Factor = 1.25
(3) Reflects installation of Jet Aeration System
(4) Reflects installation of Hydro-Clear Filter
(5) Does not include standby costs

Table 6 (Continued)

First Cost Comparison of Original Project Plan with the Recommended Project Plan
(Millions of Dollars)

Processing Concept	Southerly			
	Original Project Plan	Net Additional Cost	Net Cost Savings	Recommended Project Plan
Pretreatment and Primary Sedimentation	$ 0.1	$ 0.1	$ 0	$ 0.2
Chemical Addition	1.2	0.3	0	1.5
First Stage Biological Treatment	15.5	0	15.5	0
Second Stage Biological Treatment	6.0	0	1.3	4.7 (3)
Effluent Polishing	12.9	4.6	0	16.6 (4)
Subtotal (1)	$34.8	$ 5.0	$16.8	$23.0
Solids Thickening	$ 3.1	$ 0	$ 3.1	$ 0.0
Solids Conditioning	2.2	0	2.0	0.2
Recycle Management	7.0	0	6.3	0.7
Solids Dewatering	7.2	0	0.7	6.5
Solids Incineration and Transport	12.0	0	3.4	8.6 (5)
Ash Disposal	0.1	0	0	0.1
Subtotal (1)	$31.6	$ 0.0	$15.5	$16.1
TOTAL (1)	$66.4	$ 5.0	$32.3	$39.1
REVISED TOTAL (2)	-	-	-	$48.9

(1) 1974-1975 Basis
(2) July, 1977 Basis, Factor = 1.25
(3) Reflects installation of Jet Aeration System
(4) Reflects installation of Hydro-Clear Filter
(5) Does not include standby costs

Table 7 compares the estimated operating costs of the recommended project plan with the original Columbus project plan for the average operating year in the twenty year planning period. On a 1974 to 1975 pricing basis the recommended alternative is seen to offer an operating advantage approaching eight percent. Slight reductions are offered in each costing category, with the reduction in operating power most significant. This is due to the assumed selection of a more efficient oxygen dissolution system and the elimination of the energy intensive isolated activated sludge system for recycle management. At Southerly, it was found that with pretreatment of the brewery waste and the elimination of the trickling filter, the additional aeration horsepower was nearly equivalent to the 1050 horsepower savings derived by eliminating the first stage biological treatment system. As shown at the bottom of the Table, the scenarios which apply waste solids either to the power plant or the strip mines have a relatively small impact upon the total operating budget of the Columbus plants.

Table 7

Operating Cost Comparison of Original Project Plan
with the Recommended Project Plan
(Millions of Dollars)

ORIGINAL PROJECT PLAN

	1974-1975 Basis			Present Day
	Jackson Pike	Southerly	Total	Total
Chemicals	$1.96	$2.01	$ 3.97	$ 5.96
Power	1.38	1.36	2.74	4.93
Personnel	1.29	1.23	2.52	3.35
Maintenance	1.05	0.94	1.99	2.49
Total	$5.68	$5.54	$11.22	$16.73

RECOMMENDED PROJECT PLAN *

	1974-1975 Basis			Present Day
	Jackson Pike	Southerly	Total	Total
Chemicals	$1.98	$1.84	$ 3.82	$ 5.73
Power	1.21	1.07	2.28	4.10
Personnel	1.29	1.16	2.45	3.26
Maintenance	0.97	0.85	1.82	2.28
Total	$5.45	$4.92	$10.37	$15.37 (1)
		Savings	$ 0.85	$ 1.35
		Percent Reduction	7.6	8.1

* Assumes on-site waste solids handling and disposal

(1) Elimination of incineration at Jackson Pike with application of the dewatered solids to the refuse/coal fired power plant will yield about $0.45 million of savings in power, personnel, and maintenance

(2) Application of thermally conditioned solids to strip mine lands will increase net expenditures in power and personnel. With year round hauling, the estimated rise in cost is about $0.6 million.

CHAPTER I

INTRODUCTION, BACKGROUND, AND ISSUES

I. INTRODUCTION, BACKGROUND, AND ISSUES

This chapter defines the legal basis of the environmental impact statement, identifies the grant applicant, presents an overview of the project history and the key environmental impact issues, and briefly describes the proposed action.

1.1 LEGAL BASIS FOR THE EIS

The U.S. Environmental Protection Agency (EPA) is the administering agency for a major Federal environmental program entitled "Grants for Construction of Treatment Works."[1] This program allows the EPA administrator to provide financial aid to any state, municipality, intermunicipal agency, or interstate agency for the construction of publicly owned water pollution control facilities. The program encourages reduction of point sources of water pollution and improvement of national water quality.

The EPA's granting of funds for a water pollution control facility may require an environmental impact statement (EIS). Each proposed water pollution control facility is evaluated on a case-by-case basis by the appropriate EPA regional office to determine whether the proposed facility is expected to have significant environmental effects and whether the system proposed appears to be a cost-effective solution to area water quality problems. In this case, EPA-Region V has concluded, after an environmental review of the proposed actions, that the preparation of an EIS is warranted.

The EIS is being issued pursuant to P.L. 91-90, the National Environmental Policy Act (NEPA) of 1969, and Executive Order 11514, "Protection and Enhancement of Environmental Quality" dated March 5, 1970. Both NEPA and Executive Order 11514 require that all Federal agencies prepare such statements in connection with their proposals for major Federal actions significantly affecting the quality of the human environment.

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(1) Authorized by Title II, Section 201 (g)(1), of the Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 (FWPCA).

This statement has been prepared in accordance with the regulations and guidance set forth in EPA's regulations concerning the "Preparation of Environmental Impact Statements" (40 CFR Part 6; 40 FR 16814, April 14, 1975), the Council on Environmental Quality's Guidelines for the "Preparation of Environmental Impact Statements" (40 CFR Part 1500; 38 FR 20550, August 1, 1973); and 40 CFR Part 35, Subpart E, Appendix A, "Cost-Effectiveness Analysis Guidelines," September 10, 1973.

1.2 GRANT APPLICANT

As shown in Figure I-1 the city of Columbus is located in Franklin County in central Ohio. As of December, 1975 the city comprised 31 percent of the land area and 65 percent of the population of Franklin County. The city of Columbus applied for a Federal grant to expand and upgrade the city's existing wastewater treatment facilities.

Facilities Planning for the city of Columbus was conducted by Malcolm Pirnie, Inc., and Grant, Brundage, Baker & Stauffer, Ltd. The New Albany Facilities Planning was conducted by Evans, Mechwart, Hambleton & Tilton, Inc. Booz, Allen & Hamilton, Inc., and Havens and Emerson, Inc. assisted USEPA in the preparation of the Environmental Impact Statement on the Columbus Facilities Plan.

1.3 PROJECT HISTORY

Since the turn of the century when the city's wastewater treatment facilities were first erected, the demands of increased population and increased water use have contributed to periods of extensive pollution of the natural waterways around Columbus. Continued growth has required continued expansion and upgrading of collection, treatment and disposal facilities.

This section describes the evolution of the most recent facilities planning process, initiated in October, 1974 by the City of Columbus, to further upgrade and expand the system.

The City of Columbus, Ohio, in October, 1974 made known to the State and local clearinghouses its intent to be recognized as the responsible agency for planning, design, construction and operation of wastewater collection and treatment systems within the Columbus Metropolitan Area.

FIGURE I-1
Location of Franklin County and
Columbus Within Ohio

Source: Columbus, Ohio, Department of Development, Division of Planning

Formal initiation of facilities planning for the Columbus Metropolitan Area was on October 3, 1974 when the City entered into contract with Malcolm Pirnie, Inc. for preparation of the Facilities Plan. On December 12, 1974, a Step I grant application to cover seventy-five percent of the facilities planning cost and a Plan of Study were submitted to the Ohio EPA(OEPA). The Plan of Study was subsequently approved and a grant was made to the City from the Region V office of the U.S. EPA by a letter of September 23, 1975.

As delineated in the Plan of Study the facilities plan for the Columbus Metropolitan Area consists of the following reports:

- Cost-Effectiveness Analysis
- Environmental Assessment
- Infiltration/Inflow Analysis
- Facilities Report.

The Infiltration/Inflow Analysis was submitted to the OEPA on July 15, 1975. The analysis contained an identification of those sub-areas of the existing collection system where a Phase II - Sewer System Evaluation Survey was judged cost-effective. Federal EPA concurrence and a grant offer for the Phase II - Evaluation Survey were contained in a June 17, 1976 letter from Region V to the City of Columbus.

The Cost-Effectiveness Analysis and the Environmental Assessment were made available in draft form for public review and comment at a January 15, 1976 public hearing. Following the hearing, appropriate responses to comments made at the public hearing were added to these reports and the reports were submitted to the OEPA. The Facilities Report, made available in October, 1976, is the end product of the Cost-Effectiveness Analysis and Environmental Assessment and established a course of action based on the data presented in both reports as well as the public input obtained through public hearings.

A secondary objective of the Facilities Report was to establish the compatability of ongoing mini or segmental plans with the overall planning effort. Prior to formal initiation of facilities planning by the City of Columbus in October, 1974, several interceptor sewer and wastewater treatment plant improvement projects had been undertaken resulting in completion of required contract documents. In an effort to expedite the implementation of these projects, the City authorized the preparation of mini or segmental facilities plans. A total of six of these plans were completed and are listed below together with the date the public hearing was held to allow the public to comment on the specific segment.

Brookside Estates Area Mini-Facilities Plan	November 19, 1974
Scioto East Area Mini-Facilities Plan	November 19, 1974
Mini-Facilities Plan for Solids Handling Facilities Jackson Pike Wastewater Treatment Plant	November 19, 1974
Columbus Metropolitan Area, Facilities Plan Segment, Jackson Pike Wastewater Treatment Plant, Solids Handling and Disposal	April 24, 1975
Columbus Metropolitan Area, Facilities Plan Segment, Southerly Wastewater Treatment Plant, Solids Handling and Disposal	April 24, 1975
Blacklick Creek Area Mini-Facilities Plan	May 29, 1976

In addition, a facilities plan for sanitary sewers has been prepared independently for New Albany, located in eastern Franklin County.

1.4 KEY IMPACT ISSUES

As with most major metropolitan areas, Columbus has experienced a wide range of air, water, and land pollution problems. The proposed wastewater treatment facilities are expected to correct the major existing water pollution problems in providing sewerage services to a Columbus-area population expected to grow to over one million in the year 2000. Yet, any construction project of this size, even one built with the explicit purpose of improving water quality, has the potential for causing significant adverse environmental impacts. Resolution of the following key issues through the environmental impact statement process would help to assure that construction and operation of the Columbus system would be done in the most cost-effective manner and would result in minimal harm to the environment.

- The potential utilization of the existing Jackson Pike and Southerly Treatment Plants and related facilities

- The cost-effective liquid sewage treatment alternatives that would enable the attainment of water quality standards in the Scioto River

- The cost-effective pretreatment policy for a brewery historically contributing significant loads to the Southerly Plant

- The feasible methods for environmentally acceptable sludge treatment and disposal

- The environmental effects of the construction and operation of the proposed sewage treatment and collection facilities

- The induced growth and secondary environmental effects of building interceptors in and through sparsely developed rural and agricultural areas.

The very magnitude of the proposed project and its attendant impacts suggest that each of these issues be adequately resolved prior to detailed engineering design and construction of the facilities.

1.5 THE PROPOSED ACTION

This section summarizes the action proposed in the Facilities Plan. The following topics are covered:

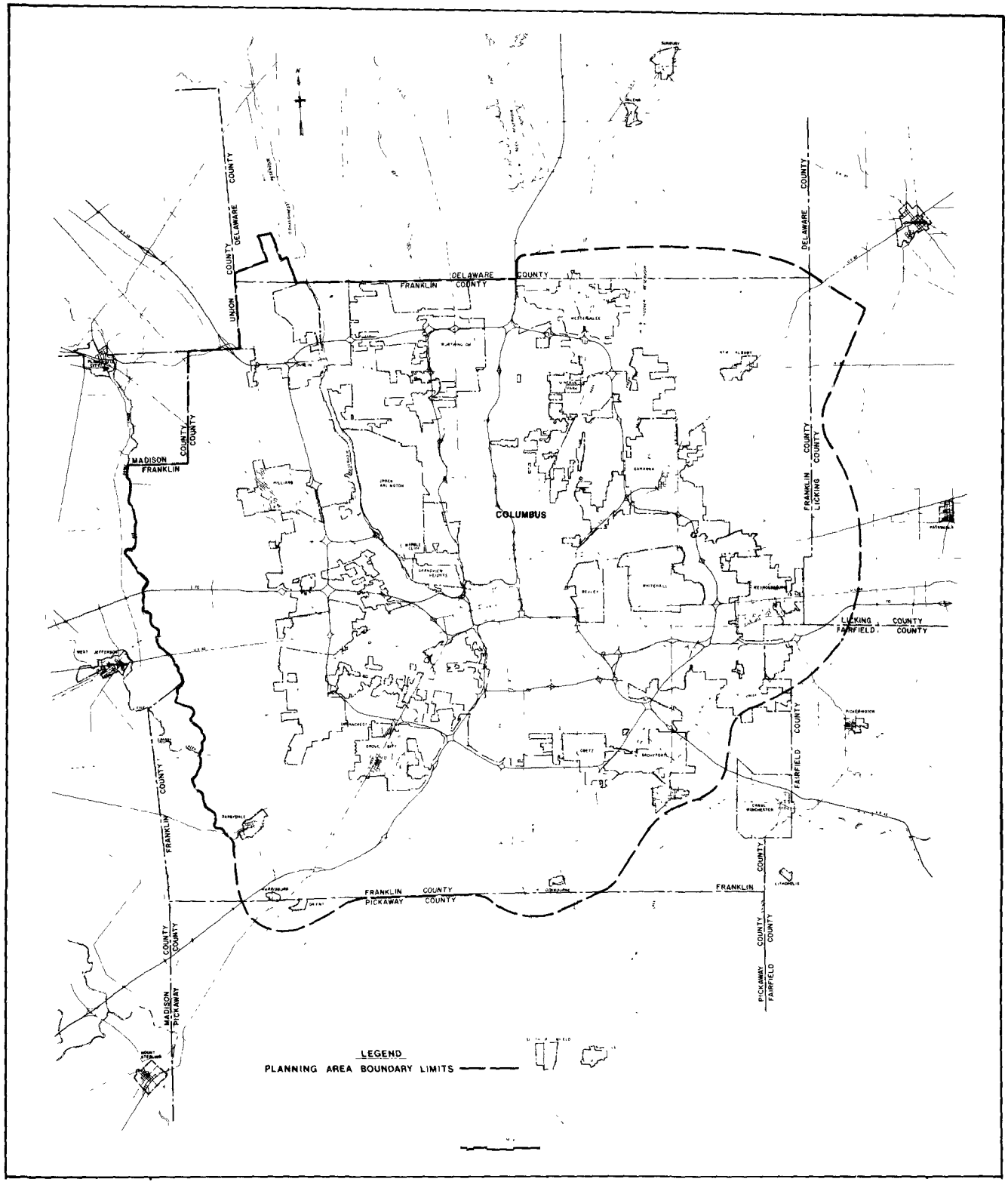
- Planning area delineation
- Overview of existing facilities
- The proposed project
- Costs and financing.

1.5.1 Planning Area Delineation

The planning area delineation process was initiated in the early stages of facilities planning. There has been some disagreement among the City of Columbus, Ohio EPA, and Delaware County on the optimal boundary definition for the area.

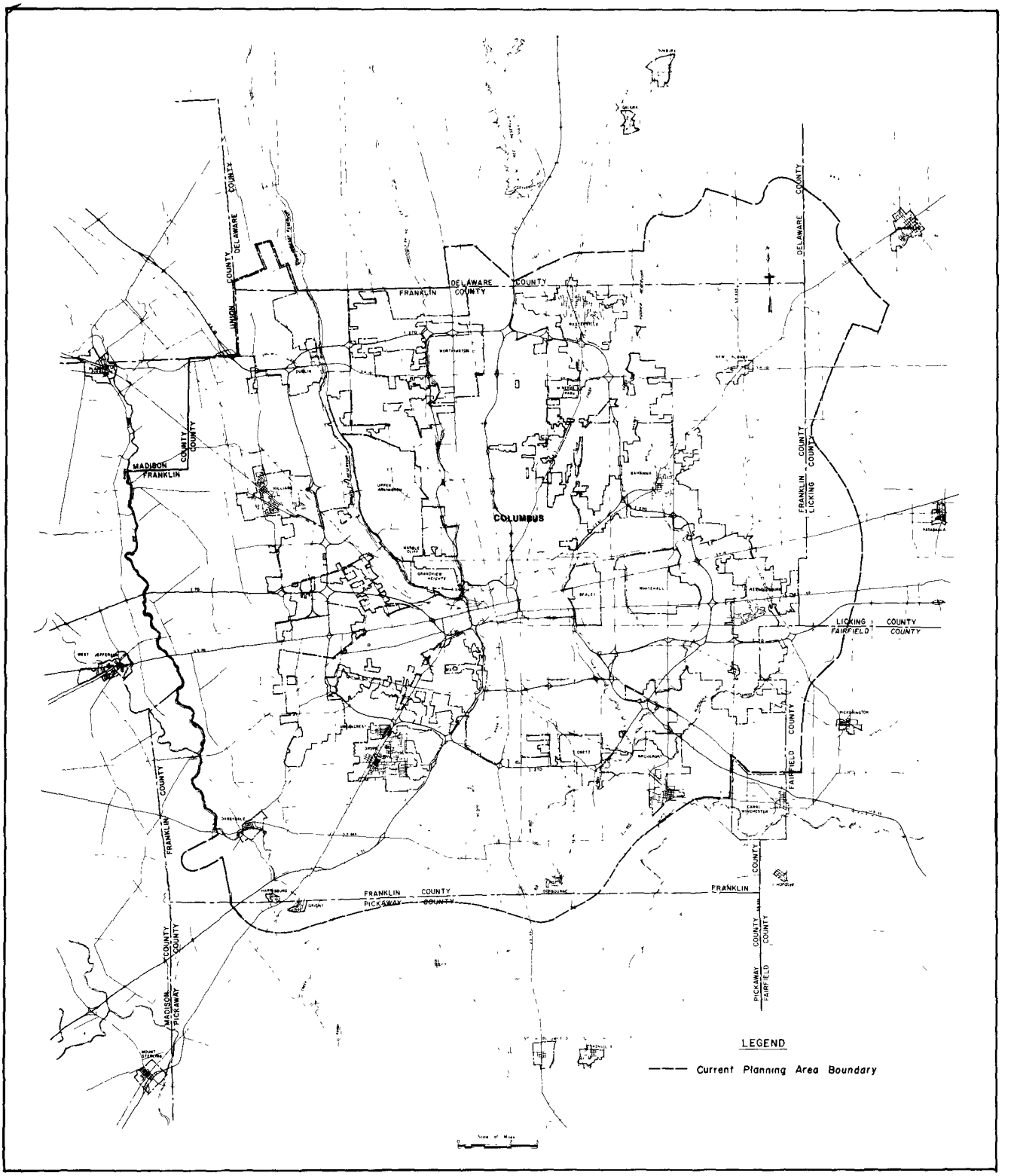
The official (i.e., OEPA sanctioned) planning area under consideration for this grant is shown on Figure I-2. This planning area approximates the boundaries of Franklin County. The facilities plan however, used the larger planning area shown on Figure I-3 in the evaluation of regional

FIGURE I-2
Official Planning Area Boundary



Source: Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976

FIGURE I-3
Facilities Plan
Planning Area Boundary



Source: Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976

service alternatives. This expanded planning area extends further into Delaware County to include the Duncan Run Basin and into Licking County to include the Blacklick Creek Basin. For the purposes of this analysis, the EIS will utilize a roughly equivalent larger planning area to ensure consistency with Columbus Facilities Plan. This is shown on Figure III-4. *

1.5.2 Overview of Existing Facilities

At present, the City of Columbus operates two large activated sludge wastewater treatment plants. The older of the two facilities is the Jackson Pike Wastewater Treatment Plant, located on State Route 104 just south of Frank Road. A portion of the present facilities at Jackson Pike was constructed in 1937. Over the years, several improvements and expansions have been added to the original plant, with present facilities rated at 100 mgd (million gallons per day) hydraulic capacity. The Jackson Pike Wastewater Treatment Plant processed an average daily flow of 72 mgd in 1976.[1]

The second plant, the Southerly Wastewater Treatment Plant, was constructed in 1967 on U.S. Route 23 near Shadesville, south of the Jackson Pike Plant. The capacity of the original plant was 40 mgd. In the early seventies, the hydraulic capacity of the plant was expanded to 100 mgd. The Southerly Wastewater Treatment Plant processed an average daily flow of 46 mgd in 1976. A special problem with the Southerly Plant is the discharge from the Anheuser-Busch Brewery. In recent years, the waste load from Anheuser-Busch has had a progressively greater impact upon the plant.

The Columbus sewerage system occupies some 160 square miles with nearly 2,300 miles of sewers. The 63,000 acre Jackson Pike service area is estimated to contain a population of over 500,000 individuals. The Southerly service area incorporates 40,000 acres with a base population of some 300,000 people.

1.5.3 The Proposed Project

The proposed project calls for an upgrading and expansion of the existing collection, treatment, and disposal facilities. Five major actions have been proposed:

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1 These figures are taken from the Columbus Metropolitan Facilities Plan, Malcolm Pirnie, Inc., July 1976. Ohio EPA suggests that more realistic figures for Jackson Pike and Southerly would be 87 MGD and 50 MGD, respectively.

- Selection of additional liquid treatment facilities for processing sewage at Southerly and Jackson Pike sewage treatment plants (STP's) to enable the treated effluent discharge to attain levels necessary to meet water quality standards for the Scioto River(1)

- Design and construction of pilot plants at the Southerly and Jackson Pike sites to allow for confirmation of design criteria and process effectiveness

- Construction of three additional sludge incinerators (2 at Southerly STP and 1 at Jackson Pike STP) and associated dewatering facilities to process sludge generated during the sewage treatment process

- Construction of separate sanitary sewer inceptors within the Columbus planning area, including the regionalization of Reynoldsburg and New Albany

- Selection of a cost-effective, environmentally acceptable system to minimize discharge of combined sewer overflows.

The proposed project is aimed at meeting the following water quality objectives:

- To produce an effluent which will help meet the water quality standards of the Scioto River adopted by the Ohio Environmental Protection Agency

- To produce an effluent from the wastewater treatment works which will meet the NPDES permit requirements.

Meeting these objectives requires extensive treatment of the sewage discharged from both plants because the plants are located on a critical water-quality limited segment of the Scioto River.

The effluent limitations contained in the National Pollutant Discharge Elimination System (NPDES) permits

(1) The Scioto River is classified as "water quality limited", meaning that water quality standards can be achieved only with the application of greater than secondary treatment.

issued by the OEPA for Jackson Pike and Southerly do not reflect the stringent levels required to meet water quality standards in this reach of the Scioto River. Both plants are limited to BOD and suspended solids levels of 8.0 mg/l on a 30-day average basis, as well as phosphorous removal.

1.5.4 Costs and Financing

Table I-1 identifies the capital costs of the facilities proposed for construction. As indicated, the total estimated capital cost of immediate planning and facilities construction is approximately $174,000,000. This estimated cost is not an estimated construction cost, as the costs were developed in accordance with cost-effectiveness analysis guidelines. Realistic schedules for plan review, design, and construction would extend the immediate period to approximately five to seven years. With various facilities not bid for several years, inflation could increase the actual construction cost significantly.

In November, 1975, the citizens of the City of Columbus voted the passage of a bond issue totalling $98,800,000. It was anticipated that the bond issue monies would, when combined with Federal funds, finance approximately $227,000,000 for wastewater treatment works, an amount well above the anticipated costs.

* * * *

The remainder of this EIS begins by examining the existing environment in the Columbus metropolitan area in terms of natural features, such as geology and wildlife, and socioeconomic features, such as schools and employment (Chapter II). For ease of reference, regionalization alternatives and their primary effects are discussed separately in Chapter III. Treatment plant alternatives and the final selected treatment plan are presented in Chapters IV and V. The primary effects of the construction and operation of the treatment plant recommendations are described in Chapter IV. The secondary or growth-related effects of the entire collection, treatment, and disposal facilities are described in Chapter VII. Finally measures to mitigate primary and secondary environmental effects are discussed in Chapter VIII.

TABLE I-1
Columbus Metropolitan Area Facilities Plan
Facilities Report
Financing

Item	Capital Costs		
	Federal	Local	Total
Facilities Planning	816,700	272,200	1,088,900
Sewer System Evaluation Survey - Phase II	1,578,400	526,100	2,104,500
Interceptor			
. Big Walnut Basin	6,548,400	2,182,800	8,731,200
. Scioto River Basin	1,500,000	500,000	2,000,000
. Minerva Park Creek Basin	116,300	38,700	155,000
. Brookside Estates Creek Basin	300,000	100,000	400,000
Southerly Wastewater Treatment Plant			
. Wet Stream	26,092,600	8,697,500	34,790,100
. Solids Handling	21,675,000	7,225,000	28,900,000
Jackson Pike Wastewater Treatment Plant			
. Wet Stream	43,617,800	14,539,200	58,157,000
. Solids Handling	25,833,000	8,611,000	34,444,000
Laboratory, Metering and Sampling Surveillance	2,175,000	725,000	2,900,000
Pilot Plant	705,000	235,000	940,000
TOTAL	130,958,200	43,652,500	174,610,700

Source: Facilities Report, Columbus Metropolitan Area Plan, Malcolm Pirnie, Inc., October 1976

CHAPTER II

ENVIRONMENTAL SETTING

II. ENVIRONMENTAL SETTING

The environmental setting, for purposes of description and analysis, can be defined as the natural environment and the man-made environment. The natural environment includes the land and underlying geologic structure; the air, water, and mineral resources; and the naturally occurring vegetation and animal life. The man-made environment includes the structures man has built for shelter, transportation, industry, commerce, and recreation. In describing the man-made environment certain characteristics are important, such as: land use patterns, demographic and economic characteristics, the exploitation of natural resources and the degradation of air and water quality that has been encouraged by technology, urbanization, and an aggressive attitude toward the natural environment. *

The determination of the impacts of proposed waste water treatment alternatives in the study area requires a thorough analysis of the total physical environment, emphasizing those characteristics of the environmental setting that are most affected by the alternatives. Since much of this information has been documented in other works,[1] the EIS will summarize the data from these studies consistent with EPA and CEQ guidelines to avoid repetition and unnecessary length of the statement. This document focuses on the development and analysis of alternatives and the assessment of the primary and secondary effects of these alternatives. Descriptions of the existing environment are given in sufficient detail for decisionmakers to understand the significant environmental impacts relative to the proposed actions.

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1 Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976.

Cost Effectiveness Analysis, Vols. One and Two, Columbus Metropolitan Area Facilities Plan. Malcolm Pirnie, Inc., July 1976.

Environmental Assessment of Sludge Handling Facilities for the Columbus, Ohio, Southerly Wastewater Treatment Plant, Ecol Sciences, Inc., March 31, 1975.

Environmental Assessment of Sludge Handling Facilities for the Columbus, Ohio, Jackson Pike Wastewater Treatment Plant, Ecol Sciences, Inc., March 31, 1975.

2.1 THE NATURAL ENVIRONMENT

The discussion of the physical and biological aspects of the natural environment in the Columbus metropolitan area is organized as follows; *

- Physical characteristics
- Atmosphere
- Hydrology
- Biotic characteristics. *

2.1.1 Physical Characteristics

Located in central Ohio, the study area includes the city of Columbus, Ohio, most of the 552 square mile area of Franklin County, including numerous satellite communities, and a portion of Delaware County near the Hoover reservoir. Columbus, the capital of Ohio and a major commercial and industrial center, is located in the central portion of the county. This urban area accounts for twenty percent of Franklin County and contains over one-half of the Scioto River Basin population. The remaining, primarily rural, land is utilized mainly for agriculture, including the grazing of cattle. *

In this section, the following physical characteristics are described: *

- Topography and drainage
- Glacial and alluvial deposits
- Geology
- Soils.

(1) Topography and Drainage

The topography of the study area is level to rolling, with altitudes ranging from a high of 1,130 feet above sea level in the northeast to a low of 665 feet in the south. Valley floors range from 670 to 840 feet above sea level, while hilltops range from 690 to 1,130 feet. * *

Major stream valleys in the northern portion of Franklin County are almost parallel in alignment. They converge in the middle and southern portions of the county towards a center line created by the Scioto River. Minor lateral valleys developed by subsequent

streams join each major valley. The Scioto River, in the study area, has a channel gradient of about 4.4 feet per mile on the average.

Runoff rates and volumes are affected by the increase in impervious surface area as a result of urbanization and by the extensive network of multipurpose reservoirs that serve the water-related needs of the Columbus area.

(2) Glacial and Alluvial Deposits

There is evidence that the Illinoian and Wisconsin glaciers once covered Franklin County. The resulting glacial deposits, rich in clay and silt-size materials, rise to over 300 feet in thickness above the bedrock formations. On the basis of surface features and material composition, the glacial deposits are classified as general moraine, end moraine, eskers and kames, outwash or valley train, and lake clays. Most of the county is ground moraine characterized by a gently rolling land surface underlain by glacial till.

Buried valleys of pre-pleistocene rivers in Franklin county are believed to be major potential aquifers. End and ground moraines are possible sites for drilled wells, while eskers, kames, and outwash gravel terraces may serve to recharge the underlying deposits. Since contamination of the ground water in these aquifers may result unless unfavorable development is guided away from such areas, they must be given consideration in the alternatives analysis.

(3) Geology

From an escarpment of north-south scarps and terraces, the Appalachian Plateau rises eastward from an elevation of 800 feet near Big Walnut Creek, constituting about one-fifth of Franklin County. The Till Plains section of the Central Lowlands physiographic province constitutes the remainder of the county. The Till Plains, formed when preglacial features were buried by glacial deposits, are flat except in areas adjacent to streams, but lack the lakes and swamps often found in glaciated areas.

The bedrock formations are stratigraphic sequences of dolmitic limestone, black shale, and alternating shales and limestones, most likely deposited when much of central Ohio was covered by a shallow inland sea. Silvrian and Devonian limestone developed from the hardening of calcerous muds. Devonian shale, as well as Mississippian sandstone and shale, developed from clay and sand deposits. A more detailed description of the location and characteristics of each rock type can be found in other documents.[1] As mentioned in the previous section, glacial deposition has covered the bedrock formations under as much as 300 feet of clay, silt, sand and gravel in some areas. In other areas bedrock outcrops are common.

The geologic characteristics of the planning area will significantly influence the evaluation of sewer interceptor alternatives. The importance of geologic formations with regard to ground water is well known. Permeability, fissures, and other hydraulic-related characteristics of concern in geologic formations are included in the alternatives analysis. *

(4) Soils

Soil characteristics influence the design and location of septic tank systems and landfills as well as the suitability of sites for land application of sewage sludge.

Soils in Franklin County have developed from glacial till and alluvium on almost level terrain. The depth to bedrock is 50 feet on the average. Detailed agricultural and engineering properties of the major soils in the planning area are described in other sources.[1]

Soil infiltration rates under different cover conditions, permeability, land slopes, depth to bedrock and water table and the relation of these factors to the ground water system determine the suitability of a site for solid or liquid waste disposal.

More than one-half of the county consists of soils of the Crosby-Brookston-Celina association with low to

1 Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976.

moderate susceptibility to erosion and with poor to moderate drainage characteristics. Soils in the flood plains of the streams are well drained and exhibit erosion susceptibility ranging from low in flat terrain areas to severe on steep slopes. Figure II-1 is a map of the major soil associations in Franklin County, and Table II-1 presents a summary description of the soils in the facilities planning area.

2.1.2 Atmospheric Characteristics

The climate and air quality of the Columbus Metropolitan Area are described in this section. The degradation of air quality is caused principally by human activities. It then permeates the environment to such an extent that other aspects of the natural setting are adversely affected.

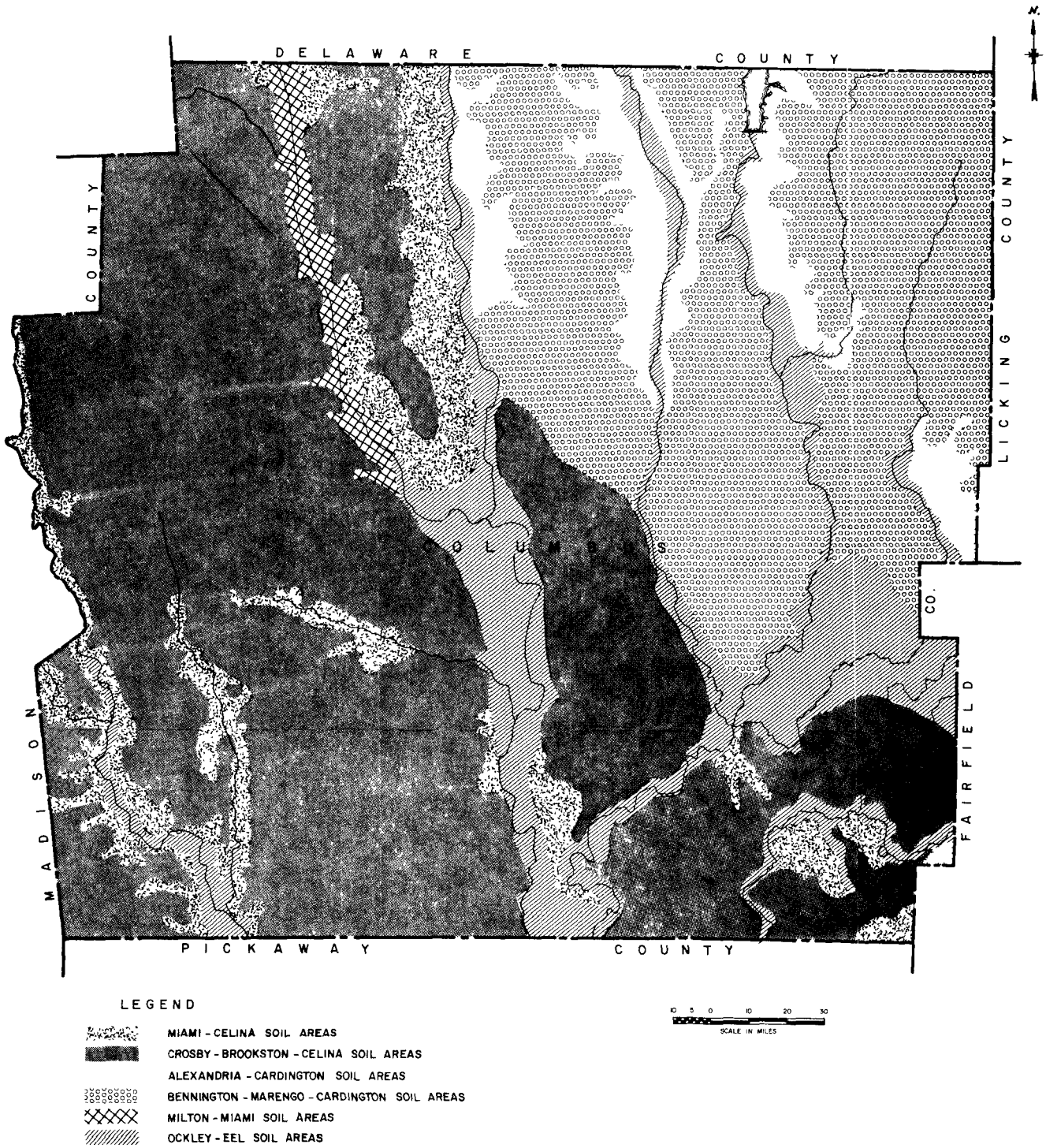
(1) Climate

Franklin County lies in the region of temperate, continental climate characterized by moderate extremes of temperature and of wetness and dryness. The area is subjected to both polar and maritime tropical air masses and to rapid changes in weather due to the movement of low pressure areas. Weather variations on a local scale are associated with narrow stream valleys. The prevailing winds from the south-southwest at about 4 to 10 miles per hour are conducive to relatively slow dispersion of air pollutants.

Moderately warm summers and fairly cold winters are characteristic of this region, with mean monthly temperatures ranging between 74.7°F. in July and 30°F in January. The usual frost free growing season is 196 days, from April 17 to October 30, with the most rainfall occurring during the spring months and the least in the fall.

The average annual precipitation is 36.5 inches. Snowfall is about 21 inches. Thunderstorms, prevalent during winter and spring as well as during the summer, are often the cause of flooding in the area.

FIGURE II-1
Soil Associations of Franklin County



Source: Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc. July 1976

TABLE II-1
Soils in the Columbus Metropolitan Facilities Planning Area

SOIL TYPE	DRAINAGE	PARENT MATERIAL	pH	LOCATION	PROFILE	SUBSTRATUM	PRODUCTIVITY	REQUIREMENTS FOR AGRICULTURAL USES
Miami-Celina								
Miami	Well-drained	Highly calcareous loam till	Medium to strongly acid	Steeper slopes	0-11 silt loam 11-32 silty clay loam	Highly calcareous loam till	Moderately high	Erosion control, lime, fertilizer, organic matter
Celina	Moderately well-drained	Highly calcareous loam till	Medium to strongly acid	Uplands	0-11 silt loam 11-36 silty clay loam	Highly calcareous loam till	Moderately high	Erosion control, lime, fertilizer, organic matter
Crosby-Brookston-Celina								
Crosby	Imperfect, needs drainage	Highly calcareous loam till	Medium to strongly acid	Level areas	0-12 silt loam 12-36 silty clay	Highly calcareous loam till	Moderately high	Drainage, lime, fertilizer, organic matter
Brookston	Very poorly drained	Highly calcareous loam till	Slightly acid to neutral	Slightly depressed areas	0-57 silty clay loam	Highly calcareous loam till	Very high	Drainage, lime, fertilizer, organic matter
Alexandria-Cardington								
Alexandria	Well-drained	Moderately calcareous clay loam till	Strongly acid	Steeper slopes	0-12 silt loam 12-36 silty clay loam	Moderately calcareous clay loam till	Moderate	Erosion control, lime, fertilizer, organic matter
Cardington	Moderately well-drained	Moderately calcareous clay loam till	Strongly acid	Gentle slopes	0-12 silt loam 12-42 silty clay loam	Moderately calcareous clay loam till	Moderate	Erosion control, lime, fertilizer, organic matter
Bennington-Marengo-Cardington								
Bennington	Imperfectly drained	Moderately calcareous clay loam till	Strongly acid	Nearly level	0-12 silt loam 12-42 silty clay loam	Moderately calcareous clay loam till	Moderate	Drainage, lime, fertilizer, organic matter
Marengo	Very poorly drained	Moderately calcareous clay loam till	Slightly to medium acid	Slightly depressed areas	0-12 silty clay loam 12-60 silty clay	Moderately calcareous clay loam till	High	Drainage, lime, fertilizer, organic matter
Milton-Miami								
Milton	Well-drained	Highly calcareous clay loam till	Medium acid	Gentle to steep slopes	0-10 silt loam 10-40 silty clay loam	Limestone at 3 feet or less	Moderate	Erosion control, lime, fertilizer & organic matter - where shallow to limestone; soils are droughty
Ockley-Eel								
Ockley	Well-drained	42 inches or more silt over calcareous sand and gravel	Medium to strong acid	Nearly level	0-14 silt loam 14-66 silty clay loam	Clean loose calcareous sand and gravel	High	Lime, fertilizer, organic matter
Eel	Moderately drained but subject to flooding	Nearly level first bottoms	Slightly acidic	Nearly level	0-9+ silt loam	Acid silt loam	High	Flooding - needs protection by levees

Source: Environmental Assessment of Sludge Handling Facilities for the Columbus, Ohio, Jackson Pike

(2) Air Quality

Based on ambient air quality conditions, the City of Columbus has been designated a Class I area for particulates, nitrogen oxides (NO_x), and photochemical oxidants ($P_{ht}O_x$) and Class III for sulfur dioxide (SO_x) and carbon monoxide (CO). These priority numbers indicate the sensitivity of the area to future degradation.[1] Further increases in the levels of particulates, NO_x and $P_{ht}O_x$, must be limited in order to avoid exceeding state standards for these pollutants.

Data collected from air quality monitoring stations in Franklin County in 1974 are presented in other sources.[2] The data for 1976 for particulates, sulfur dioxide and nitrogen dioxide are summarized in the following paragraphs. Information on these pollutants, plus ozone and nonmethane hydrocarbons, is summarized in tabular form in Appendix E.

State standards for particulates require that the annual geometric mean not exceed 60 micrograms per cubic meter ($\mu g/m^3$) and that the 24-hour concentration not exceed 150 $\mu g/m^3$ more than once per year. During 1976 the geometric mean for the various monitoring stations ranged from a high of 92.48 $\mu g/m^3$ in the urban area to a low of 53.36 $\mu g/m^3$ in the outlying suburbs. The data indicated that the 24-hour standard was exceeded at the Washington Boulevard, Fairgrounds, Cheasapeak Avenue and Windsor Avenue stations with maximum readings of 238, 204, 168 and 226 $\mu g/m^3$ respectively.[3]

For sulfur dioxide, state standards require that the annual arithmetic mean not exceed 60 $\mu g/m^3$ more than once a year. During 1976 the arithmetic mean ranged from a high of 30.90 $\mu g/m^3$ at the State Fairgrounds to a low of 14.39 $\mu g/m^3$ at Grandview Avenue monitoring station. At no time were the maximum readings in excess of maximum standard values.

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1 Priority I Region indicates that the pollutant concentration is greater than the federal primary air quality standard. Priority III region indicates that the outdoor concentration of a pollutant is presently less than the secondary air quality standard.

2 Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976.

3 OEPA computer data.

Standards for nitrogen dioxide require that the annual arithmetic mean not exceed 100 $\mu g/m^3$. Nitrogen dioxide levels in 1976 ranged from a high arithmetic mean of 53.00 at the Washington Boulevard station to a low of 32.23 at Windsor Avenue, with no readings exceeding the maximum standard values.

2.1.3 Hydrology

The Central Scioto River Basin, of which Franklin County forms a part, is a flat glacial till plain with streams that flow in a north-south direction. Three sub-drainage areas are the western, central, and eastern sub-areas.

The main stem of the Scioto drains the central sub-area along with the Olentangy River, which joins the Scioto at Columbus. The flood plains of both rivers are relatively narrow north of Columbus. Below the mouth of the Olentangy, the floodplain widens, measuring up to a mile or more in width.

Big Darby Creek is the major stream in the Western sub-drainage area, draining the far western portion of the county. Its tributaries are Little Darby Creek and Hellbranch Run.

The eastern subarea is drained by Big Walnut Creek. It has a relatively steep gradient and a broad floodplain, as have Alum Creek and Blacklick Creek, its two main tributaries. Rocky Fork is also a tributary of Big Walnut Creek.

Reservoirs control the flow of most of the streams in Franklin County. These are described in another report.[1] Table II-2 shows the flow characteristics of major streams in the County and Table II-3 presents a summary of existing and proposed reservoirs in the area.

(1) Water Quantity

Surface water is the major source of water supply in the Columbus Metropolitan Area, with approximately 90 percent of municipal supplies derived from surface sources. While less than 10

[1] Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976.

TABLE II-2
Flow Characteristics of Streams
in the Franklin County Area

Stream and Location	Drainage Area sq. mi.	Average Flow mgd	10-year Frequency 7-Day Duration Average Low Flow (mgd/sq mi.)
Scioto R. near Prospect	571	287	0.00458
Scioto R. near Dublin	988	472	0.00268
Scioto R. near Circleville	2,635	1,428[a]	0.02170[a]
Olentangy R. at Stratford	438	246	0.00136[a]
Alum Crk. at Columbus	190	106	0.00296
Big Walnut Crk. near Central College	190	123	0.00017[b]
Big Walnut near Reese	544	305 (319)[b]	0.00832[b]
Blacklick Crk. at Mouth	63	35	0.0491[c]
Walnut Crk. at Franklin-Pickaway County Line	194	116	0.0446[c]
Darby Crk. near Darbysville	533	276	0.00748

a. Prior to regulation by Delaware Lake.

b. Prior to regulation by Hoover Reservoir.

c. Figure represents flow equaled or exceeded 90 percent of time.

Source: Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976

TABLE II-3
Reservoirs in the Franklin County Area

Reservoir	In Operation Since	Stream	Drainage Area (sq. mi)	Storage Capacity (acre-ft) Total	Usable	Primary Purpose[1]
Delaware	1951	Olentangy R.	386	132,000	24,500	Flood Control
Griggs	1905	Scioto R.	1044	4,450	3,700	Water Supply
O'shaughnessy	1924	Scioto R.	979	16,980	14,500	Water Supply
Bellepoint	proposed	Scioto R.	770	121,230		Flood Control
Mill Creek	proposed	Mill Crk.	181	89,560		Flood Control and Low flow augment'n
Alum Creek	*	Alum Crk.	123	133,200		Water Supply and Flood Control
Hoover	1955	Big Walnut Crk	190	86,090	60,130	Water Supply & Flood Control
Upper Darby Creek	proposed	Big Darby Crk.	244	40,200		Water Supply & Flood Control
Lower Darby Creek	**	Big Darby Crk.	451	197,650		Flood Control

1. Most of the existing reservoirs are used also for recreation.

* Completed; reservoir is in the process of filling up.

** Project is no longer proposed.

Source: Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976

percent of the county's municipal supply comes from ground sources, private industrial supplies are almost totally dependent on wells. Extensive use is also made of ground water in rural areas of the County for domestic and agricultural purposes.

By the year 2000 it is estimated that water demand within the Columbus system will be 230 to 270 mgd for a population equivalent of 1.58 to 1.86 million.[1] Developable sources to meet this demand include about 70 mgd, or 20 percent, from ground sources. As discussed earlier, pre-Pleistocene river valleys, buried by glacial deposites, are important potential surces of ground water. Limestone aquifiers in the County also have the potential for high yield wells. The maximum yield from ground sources is believed to be 105 mgd. Of the 352 mgd total safe yield considered developable within the county, about 248 mgd is from surface sources.

(2) Surface Water Quality

Both point and nonpoint sources contribute to water pollution in the study area. Generally, the northern portions of the streams are of higher quality than the portions south of Columbus. Water supply impoundments take advantage of this cleaner water upstream on several streams. The Scioto River, Alum Creek and Blacklick Creek have the greatest dissolved oxygen problems, while the Scioto River and Big Walnut Creek have the highest concentrations of heavy metals.

Fecal bacteria problems are common to all of the streams, with the Scioto River, the Olentangy River, and Blacklick Creek having the highest counts.

Water quality measurements show that the southern portions of the Scioto River and Blacklick Creek are severely polluted. At least two fish kills have been reported in the Scioto and Olentangy Rivers. Shad kills have occured in the Big Walnut due to temperature changes and nonpoint runoff following rain storms.

1 Habig, William C., et. al., 1972, Water Supply Plan (Revised) for Columbus-Franklin County, Ohio, Prepared for the mid-Ohio Regional Planning Commission.

Fairly extensive sampling programs have been undertaken in the planning area by various entities. All persons or groups engaging in such sampling activities have been requested to submit their results in a form suitable for inclusion in the Federal EPA-maintained STORET system. Although compliance with this request is not universal, STORET is a reliable source of water quality data for the Scioto River and its tributaries in the Columbus area.

Significant sampling results have been included in the STORET system for 15 points in the area: seven on the Scioto River; three on Big Walnut Creek; two each on Alum Creek and the Olentangy River; and one on Blacklick Creek. The following sections will provide a short discussion of quality results for each stream. Tabulated data summarized in terms of the various flow regimes which occurred at or near the point sampled are provided in Appendix C, along with a condensed summary of Ohio water quality standards. Figure C-1 provides site locations and names along with the Appendix C callout for the appropriate summary table.

1. Blacklick Creek

Blacklick Creek was sampled on twelve occasions at a single point during 1974 and 1975. Violations of a dissolved oxygen (DO) level of 5.0 mg/l occurred on nine of the twelve sample days, with lower flows generally exhibiting greater DO depressions. BOD_5 and suspended solids levels were relatively high, with median values of 5.6 and 25 mg/l, respectively. Nutrient values were also elevated, with median values of 1.27 mg/l measured for both ammonia nitrogen (NH_3-N) and total phosphorus (P_{tot}). A variety of poorly or partially treated domestic wastewater releases above this sampling point is no doubt the major cause of the degraded conditions evidenced. The facility plan, as presently constituted, would consolidate those dischargers into the Columbus releases to the Scioto.

2. Alum Creek

Two points have been monitored on Alum Creek: the USGS gage at Columbus, and the Williams Road crossing below the gage. Quality appears to be generally good at the gaging station, and exhibits little flow dependency. Only one DO reading less than 5.0 mg/l was observed, despite BOD_5 levels as high as 6.5 mg/l. A single nitrate nitgrogen (NO_3-N) reading of 14.0 mg/l is likely due to analytical or reporting error. Total iron values are consistently greater than 1 mg/l with a high value at the Williams Road station of 11.4 mg/l. These concentrations are most likely due to a variety of industrial releases above the Williams Road sampling point.

3. Big Walnut Creek

Big Walnut Creek has been sampled at three points: at Central College, the USGS gage at Reese, and at U.S. 23. The first point is a good indication of overflow quality from Hoover Reservoir; the second should demonstrate any impact due to Alum Creek; and the third is just above the confluence of Big Walnut and the Scioto River.

The few significant samples at Central College demonstrate uniformly excellent quality, with high DO's and low BOD_5's and nitrogen forms. Perhaps the most striking observation at this point is the small flow variation noted; a demonstration of the degree of regulation exerted on the stream.

General quality at Reese becomes somewhat poorer although only a single, relatively low flow, violation of a 5.0 mg/l stream DO is noted. BOD_5 values up to 5.4 mg/l are reported (3.5 mg/l median), while suspended solids are never lower than 16 mg/l (30 mg/l median).

Readings at U.S. 23 indicate about the same level of quality as evidenced at Reese. Again, flow levels are the important observation here. Although taken on different days than the first

two points, they demonstrate the outflow characteristics of the Big Walnut channel for much of its length. The Ohio EPA has indicated that most of this "lost" flow returns to the stream at or near its confluence with the Scioto River.[1]

4. Olentangy River

The two points sampled on the Olentangy River should effectively bracket the effect of the River's passage through the City of Columbus. The upper station of Worthington shows high DO's coupled with a median BOD_5 of 1.7 mg/l. Nitrate nitrogen levels are somewhat elevated, with median and high values of 2.58 and 5.58 mg/l, respectively. These readings are possibly due to the residual effects of several upstream releases of treated domestic wastewater. Little flow dependency is evidenced for any parameter examined.

Oxygen demanding loads increased significantly at the Goodale Street station, with BOD_5 levels ranging up to 14.8 mg/l and TKN's up to 5.5 mg/l. DO violations are noted at the lowest flows, and consistently improve as flows increase.[2] * This trend will most likely reverse itself at still higher flows due to the impact of combined sewer overflows and urban runoff on the Olentangy. Overflow problems may contribute to elevated instream oxygen demands at this point even at fairly low background flow levels.

5. Scioto River

Water quality problems in the Scioto River have been the impetus for the facilities planning work in the Columbus area. Heavy instream pollution loads and low DO's have been observed as far below Columbus as Circleville. The seven sampling stations summarized in Appendix C demonstrate the impact of the two major wastewater releases on the resources and quality of the Scioto.

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1 Personal Communication, George Garrett, Chief, Water Quality Standards, Ohio EPA.

2 The low ratings may no longer be valid. At the time of the sampling the old main sewer was completely blocked (plugged by grease) causing continuous overflow to the river. The condition has since been relieved by the installation of a temporary pump station which intercepts flow and force mains it to the OSIS.

The three stations tabulated which are above the Jackson Pike release (Greenlawn Dam, Frank Road, and the USGS gage at Columbus) demonstrate fair quality characteristics for an urban stream such as the Scioto. Occasional severe DO depressions are evidenced at low flows, with scattered high BOD_5 readings appearing in all flow ranges. Suspended solids levels are relatively high on all samples, with greater flows producing some extremely high readings (373 mg/l maximum). Some impact of bypassing from the sewer system may be evidenced at these stations.

Quality of the three stations below Jackson Pike (at I-270, and at and below Shadeville), and one below Southerly (Ohio Rt. 762), does demonstrate the impact of these wastewater releases, particularly at low flows. DO violations are noted at all except the highest flow regimes tabulated. Instream BOD_5 values are at higher levels than those evidenced upstream; but the parameters showing the most marked increases are NH_3-N and fecal coliform. Median ammonia nitrogen levels exceed the recommended 96 hour TLM wherever tabulated, with only the high flow regimes again escaping toxicity impacts. Fecal coliform levels exceed water quality standards at all downstream points which report this parameter at all flow regimes. Overall median fecal coliform values of 19,000; 9,300; and 6,300 No/100ml were reported at I-270, Shadeville, and S.R. 762, respectively.

(3) Ground Water Quality

Ground water pollution is most likely to occur in areas using water from shallow aquifiers and such recharge sites as eskers, kames, and outwash gravel terraces. Wells located close to streams and having hydraulic connections to the streams are vulnerable to pollutants. Although ground water quality analyses have been conducted by the U.S. Geological Survey and Ohio Department of Health, these analyses were limited to the inorganic chemical characteristics of the water. Tests are needed to determine the bacteria content of ground water taken from the areas described above.

(4) Flood Control

The Columbus area has a record of flood disasters dating back to 1871. Flooding has usually resulted from several days of heavy rainfall during the months of January through April. Greater storm runoffs due to frozen ground have often aggravated flooding problems. Reservoirs on the major streams provide some flood control protection. Flood profiles for the record 1913 and 1959 floods are available in the Flood Plain Information Report by the U.S. Army Corps of Engineers. Maps are also available showing the extent of the 20- and 100-year frequency floods. These profiles and maps indicate that the Jackson Pike Wastewater Treatment Facilities and most of the major components at the southerly plant are protected against a 100 year flood.

The city of Columbus has enacted into law a "Comprehensive Zoning Code" defining flood areas and spelling out activities that may be permitted in these areas. Flood insurance, used as a tool to encourage positive methods of preventing flood damage, is now available to all communities in Franklin County, according to the Ohio Insurance Institute.

2.1.4 Biotic Characteristics

The living species in the area constitute an important aspect of the environmental setting and may be used as indications of environmental quality. They include the natural vegetation, the wildlife and the aquatic life that inhabit the natural environment.

(1) Vegetation

Franklin County lies within the Temperate Deciduous Forest Biome. Climax beech forests once covered most of Franklin County.

Today, however, most of the land has been cleared for agriculture, and native forest is now limited to scattered woods and areas along stream banks and floodplains. Only about 5 percent of the County, today, is in forest. Table II-4 identifies several natural terrestrial areas that have unique natural vegetation.

TABLE II-4
Noteworthy Natural Terrestrial Areas

Area	Location	Description
Blacklick Woods Metropolitan Park	Southwest of Reynoldsburg	One of the finest unspoiled woodlands of central Ohio. A beech-maple to elm, ash, oak swamp-forest. Dedicated as a State Nature Preserve, April 1973.
Blendon Woods Metropolitan Park	Northeast of Columbus, along Route 161	An area of rough terrain and second growth timber, much kept as wilderness area. Upland and swamp forests.
Darby Creek Metropolitan Park	East side of Darby Creek, on Koebel-Suydam Road	An upland area of primarily oak-hickory forest. Eroded hillsides along the creek provide suitable habitat for prairie species vegetation.
Highbanks Metropolitan Park	Sharon Twp. and also Orange Twp., Delaware County	Ohio shale bluff and oak forest along the East bank of the Olentangy River. Dedicated as a State Nature Preserve, April 1973.
Sharon Woods Metropolitan Park (Spring Hollow)	Sharon Twp.	A good beech-maple forest containing large white oaks.
Flint Ravine	Sharon Twp. crosses Rt. 23 to the Olentangy River.	A terrain rich in fauna and flora that has been kept in a wild state.
Gahana Woods State Nature Preserve (Dehlendorf Woods)	Jefferson Twp. Gahanna, 1/2 mi. south of Haven Corners Rd., on the west side of Taylor Station Road.	A beech-maple and ash forest with mixed mesophytics, and pin oak, silver maple and buttonbush swamp in lower regions. Dedicated January 1974. *
Rocky Fork Natural Area	Rocky Fort Creek vicinity	A rugged ravine on Rocky Fork Creek, a tributary of Big Walnut Creek.
Scioto River Bank at Dublin	Extends south from Dublin Bridge and west of U.S. Rt. 33 ca 1 mile, including an old limestone quarry	The type locality of Trillium nivale, and also contains one of the best colonies of Thuja occidentalis in its native habitat in central Ohio.
Welch's Beech Woods	Washington Twp. and Also Concord Twp., Delaware County.	Mature beech woods of exceptional quality on the Powell Moraine.

Source: Environmental Assessment, Columbus, Ohio, Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976

(2) Wildlife

Suitable habitat for wildlife requires a terrain capable of providing both mobility and protection. Farm woodlots and vegetation along streams provide the principal wildlife habitat in the facilities planning area. Farm fields provide adequate forage for farm land species, while nearby woods provide protective cover and nesting sites. These species are abundant; especially the cottontail rabbit, fox squirrel, red fox, and woodchuck. Raccoon, weasel, opossum, muskrat, and mink inhabit the marshes and wooded areas along the streams, lakes and ponds. Forest species, including white-tailed deer, gray squirrel, and gray fox are also found in many parts of the county.

Many species of field and woodland birds as well as several game bird species inhabit the area. Occurring in medium to low densities are bob-white quail and ring-necked pheasant. Birds of prey included several species of hawks and owls. The bald eagle and the sharp-shinned hawk, designated as endangered species, occur as migrant species and are not known to nest in the area. Waterfowl, including several species of ducks and geese, are plentiful on the streams and reservoirs. Common inhabitants along the shores of streams and lakes are great blue herons, green herons, and kingfishers.

(3) Aquatic Life

Aquatic organisms are excellent indicators of water quality. Depending on their tolerance to organic pollution, these organisms can be divided into pollution-sensitive, pollution tolerant, and facultative (adaptable to a wide range of conditions) types. The diversity of species and abundance of individual organisms are indicative of environmental quality.

Pollution sensitive invertebrates include gill breathing-types such as stonefly and mayfly larvae; pollution tolerant types include worms, leeches and pulmonate snails; and facilitative forms are immature bettles, dragonflies, blackflies, craneflies, gilled snails and fingernail clams.

Extensive studies of invertebrate communities and mussel populations in the Columbus area streams have been conducted by various investigators.[1] Their findings are summarized in a prior study on a stream-by-stream basis.[2]

The streams in Franklin County are classified as "warm water" fishery streams by the Ohio Department of Natural Resources. The quality of the water in each stream determines the species and the abundance of fish found there. The major area streams are considered separately in the following discussion.

- Big Walnut Creek - Of the 74 species of fish that occur in Big Walnut Creek, six, including the endangered muskellunge, are introduced species. Two other endangered species listed by Ohio DNR that occur in Big Walnut are the blacknose shiner and the American brook lamprey. The large population of minnows in the stream serves as a source of food for other fish.[3]

- Alum Creek - Alum Creek, near the Franklin County line supports 51 species of fish. Minnows, including the rosyface shiner,

1 Olive, J.H., 1971, A Study of Biological Communities in the Scioto River as Indices of Water Quality, U.S. Office of Water Resources Research, U.S. Department of Interior, Washington, D.C.

Phinney, G.J., 1967, An Ecological Comparison of Two Streams in Central Ohio, Ph.D. Dissertation, Ohio State University, Columbus Ohio.

Stansbury, D.H., 1972, "An Evaluation of the Naiad Mollusk Fauna of Big Darby Creek in Central Ohio", The Ohio State University Museum of Zoology, Columbus, Ohio.

Stansbury, D.H., 1974, "The Naiad Mollusks of Alum Creek and Big Walnut Creek Between Alger Road Bridge and the Scioto River", The Ohio State University Museum of Zoology, Columbus, Ohio. *

2 Environmental Assessment, Columbus Metropolitan Area Facilities Plan Malcolm Pirnie, Inc., July 1976

3 Cavender, T.M. 1974, "Checklist of Fishes for the Big Walnut Creek Drainage," Ohio State University Museum of Zoology, Columbus, Ohio.

bluntnose minnow and the stoneroller minnow are the most abundant. Also found in large numbers is the orangespotted sunfish.[1]

- Hellbranch Run - Nine of the 47 species of fish in Hellbranch Run are found along the entire length of the stream. Several of the species occurring in this stream, including shiners and minnows, are characteristic of prairie streams such as Hellbranch Run that are frequently turbid, rich in organic matter, and have a low gradient.[2]

- Rocky Fork Creek - Several species in the stream, including the northern hog sucker and blacknose dace are characteristic of streams like Rocky Fork Creek that have a moderate to high gradient and clear waters. Two species have been designated as endangered by the Ohio Department of Natural Resources: the blacknose shiner and bigeye shiner. Fish that are tolerant to siltation have to some extent replaced those that cannot tolerate siltation caused by land use practices.[2]

- Big Darby Creek - Due to its high water quality and diversity of aquatic habitats, Big Darby Creek supports an unusually large variety of fish. The Scioto madtom, a small catfish, is found only in Big Darby. It has been designated as an endangered species by the Ohio Department of Natural Resources and the U.S. Department of Interior. Other endangered species found in Big Darby Creek are the bigeye shiner, river redhorse, tippecanoe darter, and the sand darter.[3]

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1 U.S. Army Engineer District, Huntington, W.V., 1973, Alum Creek Lake, Alum Creek, Scioto River Basin, Ohio, Final Environmental Statement.

2 Phinne, G.J. 1967, An Ecological Comparison of Two Streams in Central Ohio, Ph.D. Dissertation, Ohio State University, Columbus, Ohio.

3 Gordon, R.B., 1969, "The Natural Vegetation of Ohio in Pioneer Days," Bulletin Ohio Biological Survey, Volume III, No. 2.

- Blacklick Creek - Thirty-six species of fish occur in Blacklick Creek. No endangered species are known to occur here.[1]

- Scioto River - A twenty-year old inventory of fish in the Scioto River indicates that at that time 58 species of fish lived in the Franklin County portion of the river, including 32 species below the City of Columbus. The species composition probably has been altered since that time due to changes in water quality.[1]

- Olentangy River - Thirty-four species of fish occur in the Franklin County segment of the Olentangy River. These are listed in an appendix to the previously cited Environmental Assessment.[2]

2.2 MAN-MADE ENVIRONMENT

The objective of this section of the environmental setting chapter is to discuss present and anticipated socioeconomic characteristics of the planning area and its subdivisions which are essential for identifying and assessing primary and secondary impacts of the proposed action. Therefore, the description of the man-made environment focuses on the following factors:

- Demographic Characteristics
- Demographic Projections
- Economic Characteristics
- Economic Projections
- Existing Land Use Controls and Patterns
- Present Land Use
- Community Facitilities and Services
- Municipal Fiscal Capabilities
- Resource Use.

These factors provide a basis for comparing the attractiveness of development in the region's subareas, a key step in conducting the secondary impact analysis.

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1 Trautman, M.B., 1957, The Fishes of Ohio, Ohio State University Press, Columbus, Ohio.

2 Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie, Inc., July 1976.

Additional man-made environmental factors which are less critical to an impact analysis are summarized. These factors are other major projects and archeological and historical sites.

2.2.1 Demographic Characteristics

This section discusses three demographic characteristics of the planning area:

- Population
- Employment
- Income.

These characteristics were selected for discussion and analysis for three reasons. First, they provide a baseline for the demographic projections. Second, these characteristics shape the level and type of demand for development. Third, they are socioeconomic characteristics which developers are likely to consider in arriving at development decisions.

(1) Population Profile

The population profile identifies past population trends of the overall planning area as well as the present population of both the planning area and the proposed interceptor areas. It develops the baseline data for evaluating the population projections and for estimating the relative development attractiveness of various communities within the planning area.

- Regional Context - This section presents trends in Franklin County. Table II-5 compares population trends in the Franklin County/Columbus area with those in the Columbus SMSA, the State of Ohio, and the U.S. A presentation of this perspective is important because the present relationship among growth rates of various jurisdictions provides one means for estimating and evaluating future growth trends.

TABLE II-5
Population Trends 1950-1970
Comparison of U.S., Columbus SMSA,
Franklin County and City of Columbus

	1950	1960	1970	Percent Change 1950-60	Percent Change 1960-70
United States (in 1000's)	150,697	179,323	203,213	18.9	13.3
Ohio	7,946,627	9,706,397	10,652,017	22.1	9.8
Columbus SMSA	637,470	845,290	1,017,847	32.6	20.4
-minus Franklin County	134,060	162,328	184,598	21.0	13.7
Franklin County	503,410	682,962	833,249	35.7	22.0
Columbus	375,901	471,316	539,667	25.4	14.5

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

All jurisdictions grew faster between 1950-60 than during the 1960-70 decade. The two principal trends in the planning area during 1950-60 were that:

- Growth rates in Ohio, Franklin County, and Columbus all exceeded the national growth rate
- While Franklin County increased its share of the state of Ohio population, the City of Columbus decreased its share of the Franklin County population.

These trends reflected an in-migration to Ohio but within Franklin County the beginning of a redistribution of population to suburban areas.

Between 1960 and 1970, the following growth patterns occurred:

- The state of Ohio growth rate fell below that of the national rate

- However, the growth rates of both Franklin County and the City of Columbus continued to exceed the national rate.

- Franklin County continued to increase its share of the state population while Columbus continued to decrease its share of the county population.

These growth patterns reflected a shift in the U.S. population from the northern urban areas to the southern sunbelt, and a continuation of the redistribution of Franklin County population from Columbus to suburban areas. Tables II-6 and II-7 document this shift in the county's population. Table II-6 shows that suburban areas of the county grew faster than Columbus, and Table II-7 shows the decline in Columbus' share of the county population.

TABLE II-6
Population Trends in Columbus and Suburbs
1950-1970

	1950	1960	1970	% Change 1960-1970
Franklin County	503,410	682,962	833,249	22.0
Columbus (City)	375,901	471,316	539,667	14.5
Bexley	12,378	14,319	14,888	3.9
Gahanna	596	2,717	12,400	356.4
Grandview Heights	7,659	8,270	8,460	2.3
Grove City	2,339	8,107	13,911	71.5
Hilliard	610	5,633	8,369	46.6
Reynoldsburg	724	7,793	13,921	78.6
Upper Arlington	9,024	28,486	38,360	34.6
Westerville	4,112	7,011	12,530	78.7
Whitehall	4,877	20,818	25,263	21.4
Worthington	2,141	9,239	15,326	65.9

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

TABLE II-7
Columbus Share of Franklin County
Population 1950-1970

	1950	1960	1970
Franklin County Population	503,410	682,962	833,249
Columbus Population	375,901	471,316	539,667
Columbus Percent of Franklin County Population	74.7	69.0	64.7

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

Table II-8 shows the recent trends for 1970-1975 within the Columbus SMSA. During this period, the other four counties in the SMSA have grown at faster rates than Franklin County. The Mid-Ohio Regional Planning Commission has attributed this reduced growth rate to declining family size and fertility rates, shifts in the U.S. population, and a net out-migration. The out-migration has been facilitated by the construction of I-270, I-70, and I-71 which permits people to live in adjacent counties and work in Franklin County.

TABLE II-8
Population Trends in Columbus SMSA 1970-1975

County	1970	1975	Percent Change	Net Migration	Percent
Delaware	42,908	50,800	18.4	6,200	14.5
Fairfield	73,301	84,900	15.8	8,800	12.1
Franklin	833,249	866,100	3.9	-8,700	-1.0
Madison	28,318	31,400	10.8	1.700	5.9
Pickaway	40,071	43,800	9.4	1,800	4.6
TOTAL SMSA	1,017,847	1,077,000	5.8	9,900	1.0

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

- Proposed Interceptor Service Area Population - Table II-9 presents the 1975 population estimates for the five proposed interceptor service areas: Big Run, Scioto West, Big Walnut, Rocky Fork, Blacklick. These population figures will serve as a baseline for estimating the growth which would be likely to occur without the construction of the interceptors and the growth which is anticipated if the interceptors are built.

TABLE II-9
1975 Population Estimates for
Proposed Interceptor Service Areas

Service Area	1975 Population
Big Run	1,500
Scioto West	13,500
Big Walnut	6,000
Rocky Fork	4,300
Blacklick	27,700

Source: Based on Mid-Ohio Regional Planning Commission Year 2000 *Population Estimates*

(2) Employment

A discussion of employment trends in the planning area provides a basis for evaluating the extent to which present and projected employment opportunities are sufficient to support the present population and anticipated growth. Tables II-10, II-11, and II-12 show that the occupational characteristics of the Columbus/Franklin County area reflect its position as a state government and regional services center. Table II-10, for example, shows that between 1971 and 1976 Franklin County maintained a constant share of the number of people employed in Ohio. Tables II-11 and II-12 show that manufacturing, services, and wholesale/retail trade have been the three largest employment sectors for Franklin County and the City of Columbus. However, while employment manufacturing declined 4.7% in the county as a whole between 1950-70, employment in the services sector rose 7.6%.

TABLE II-10
Franklin County Percentage of
Employment in Ohio 1970-1976

Year	Ohio Employment	Franklin County Employment	Franklin County Employment
1970	4,143,000	347,458	8.3%
1971	4,142,000	359,679	8.7%
1972	4,273,000	381,461	8.9%
1973	4,416,000	396,168	9.0%
1974	4,479,000	417,175	9.3%
1975	4,296,000	385,747	9.0%
1976	4,361,000	391,483	9.0%

TABLE II-11
Major Employment Sectors in Franklin County
1950, 1960, 1970

Employment Sector	Percent of Total Employment		
	1950	1960	1970
Manufacturing	25.5	26.7	22.7
Transportation and Utilities	10.0	7.1	6.4
Wholesale and Retail Trade	22.0	19.4	21.2
Finance, Insurance, and Real Estate	5.2	5.3	6.8
Services	21.0	24.7	28.6
All Other	16.3	16.8	14.3
TOTAL	100%	100%	100%

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

TABLE II-12
Changes in Employment of the Columbus Work Force
1969-1975

Sector	Employment		Percent Change
	1969	1975	
Public Sector[a]	44,213	52,371	18.4
Manufacturing[b]	103,439	92,500	-10.6
Non-Manufacturing[b] (excluding government)	291,546	370,900	27.2
Wholesale Trade	17,660	22,900	29.1
Finance, Insurance and Real Estate	24,482	31,800	29.9
Retail Trade	64,209	89,900	40.0

[a]Includes changes in aggregated employment for the City of Columbus, State of Ohio in Franklin County, Franklin County, and Ohio State University for the period 1969-1975. Based on data from Table III-62 in the Appendix.

[b]Ohio Bureau of Employment Services, Annual Average Nonagricultural Wage and Salary Employment in the Columbus SMSA, and Monthly Report on Nonagricultural Wage and Salary Employment for December 1975.

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

In the City of Columbus, manufacturing employment experienced a decline of 10.6% between 1969 and 1975. However, wholesale and retail trade and the public sector expanded during that period. Table II-13 shows that the occupational characteristics of Columbus reflect its regional role. The percentage of white collar workers in the labor force of Columbus and Franklin County is 54.1% and 57.3% respectively, above the State of Ohio figure of 45.4% and the national figure of 40%.

TABLE II-13
Occupational Characteristics of the Labor Force

	Total Employed	White Collar Workers				Blue Collar Workers			
		Skilled		Unskilled		Skilled		Unskilled	
		No.	%	No.	%	No.	%	No.	%
Columbus	218,683	52,731	24.1	65,533	30.0	61,293	28.0	39,126	17.9
Franklin County	336,132	90,724	27.0	100,677	30.3	91,173	27.1	53,558	15.9
Ohio Metro.	3,202,598	711,310	22.2	821,606	25.6	1,121,254	35.0	548,428	17.1
Total	4,063,780	864,599	21.3	981,763	24.1	1,477,327	36.4	740,091	18.2
U.S.A.	47,623,754	12,116,322	25.4	6,946,216	14.6	19,397,898	40.7	9,163,318	19.2

a White Collar Skilled - Professional, technical, and kindred workers, managers and administrators, except farm
b White Collar Unskilled - Sales workers, clerical and kindred workers
c Blue Collar Skilled - Craftsmen and kindred workers, operatives, transport equipment operatives
d Blue Collar Unskilled - Laborors, farmers and farm managers, farm laborors and farm foremen, service workers, private household workers

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

The employment profile can be summarized as follows:

- Franklin County is retaining its share of State-wide employment
- Services, trade, and manufacturing have been the three largest sectors
- The national economic recession significantly affected the local manufacturing sector
- Growth in the services and trade sectors is indicative of the area's importance as a regional service and administrative center
- Except for a sharp decline in 1975, due to reduced revenues, public sector employment has continued to increase steadily.

(3) Income

The objective of discussing income levels in the planning area is to provide information about a demographic characteristic which may influence both consumer demands for and developers' decisions on development type. For example, the income level of residents in a particular area may influence whether the market demand is for residential versus commercial development and in residential development for multi-unit dwellings or single family homes.

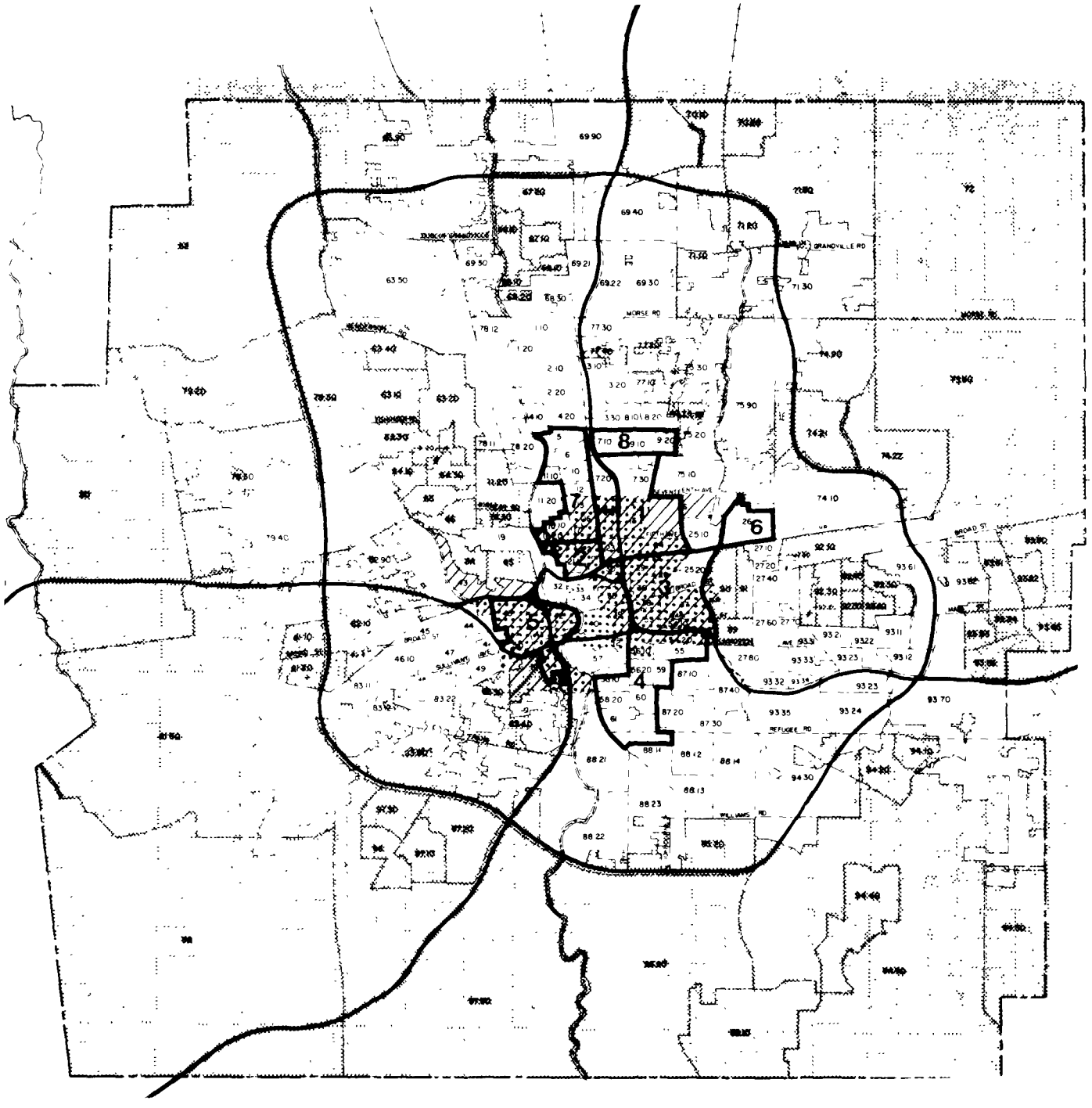
Table II-14 portrays the relative 1970 median family incomes for the U.S., Ohio, Franklin County, and the City of Columbus. It shows that the median national family income in the state was 7.5% above the median nation family income. Furthermore, the median family income in Franklin County is 2.6% above the state income and 8.0% below the median county income. This reflects a concentration of higher income, white collar households in the suburban areas. Figure II-2 portrays the concentration of low income families in particular neighborhoods of the city.

TABLE II-14
Median Family Income for U.S., Ohio, Franklin County, and Columbus (1970)

Place	Median Income	Black	White
U.S.A.	9,586	6,063	9,957
Ohio	10,309	7,763	10,521
Franklin County	10,579	7,648	10,920
Columbus	9,729	7,552	10,134

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

FIGURE II-2
Special Low Income Areas



Census tract boundary	
Major freeways	
Columbus corporation limits	
EDA Impact Areas	
Census Low Income Areas	
CDA Program Areas	

1	South Linden
2	Near North
3	Near South
4	Near East
5	Franklinton
6	Stelzer - Cassady
7	University - Clintonville
8	North Linden

Source: Columbus, Ohio, Department of Development, Division of Planning

2.2.2 Demographic Projections

The objective of this section is to estimate the population, employment, and income characteristics of the planning area in the year 2000. These three factors are important in shaping both the market demand and the decisions of developers. The projections presented here will contribute to the comparison in the secondary impact analysis chapter of the degree of growth likely to occur in the absence of the new facilities versus that likely to occur with the availability of the proposed facilities. To the extent that data is available for evaluation, the analysis will cover both the region in general and the five proposed interceptor service areas in particular.

It is important to realize that projecting population for a specific geographic area involves a variety of factors. The margin for error is large given the potential fluctuations in economic conditions and changes in life style. The margin increases for each succeeding data included within the span of the projections. Similar difficulties arise in projecting employment and income and in assessing whether employment opportunities are sufficient to support the estimated population.

(1) Population Profile

This section discusses estimated future population growth trends in the planning area. Five sets of population projections currently exist for the mid-Ohio region for the year 2000. These include (in thousands):

Battelle/Health Department (1977)	881.8
Sales & Market Management (1976)	1,007.5
Census 70-75 estimates extended (1977)	1,040.8
MORPC 70-75 estimates extended (1977)	1,217.9
Cols. Area Chamber of Commerce (1977)	1,286.1

(average - 1,086.8)

In recent meetings, State and Federal agency personnel have attempted to come to some agreement over one set of projections which could be used county-wide. This would assure consistent areawide planning. As this EIS was being written, there was no interagency agreement on the validity of any of these projections or on which ones might be used for planning purposes. In order to assess the reasonableness of these projections

and to come to some conclusions on projections to be used for this project, the EPA has developed 4 sets of independent projections based on standard projection methodologies. The results are shown in Table II-15. Note that these projections range from approximately 995,000 to 1.11 million.[1] This range fits within that of the five existing, but unapproved, projections. Note that the largest of these projections (1.11 million) is greater than 3 of the five existing projections and is also larger than the average of the five. Thus, selection of this figure would give a reasonable population estimate for the year 2000 (i.e., avoiding both high and low extremes), yet one that is optimistic in its growth predictions. For the above reasons, this report will use the 1,110,251 figure in its analysis of the sizing of interceptors and treatment plant design. *

- Regional Context - A discussion of trends in the State of Ohio and Franklin County provides a context for the subsequent discussion of population trends in the proposed interceptor service areas. Development of this perspective is necessary for the secondary impact analysis which must assess the relative attractiveness of the region's sub-areas.

- OBERS projections for the State of Ohio show continued growth through 2020. However, according to Table II-16 the rate of growth will decline gradually from 9.0% between 1970-80, to 8.0% between 1980 and 1990 to 6.0% between 1990 and 2000. Between 1970 and 1974, the county experienced an average annual growth rate of 1.3%. The projected 1985 county population of 963,336 represents a 11.2% increase over the 1975 population or a 1.0% annual increase. By 2000 the county population is expected to increase 15.4% above the 1985 figure, or an average annual increase of .96%. *

- Proposed Interceptor Service Area Populations - Table II-17 displays the estimated population changes in the proposed interceptor service areas between 1975 and 2000. The figures presented in this table will form the baseline in the secondary impacts chapter for an evaluation of the relative degree of growth to be expected with or without the proposed facilities.

[1] For the year 2000.

TABLE II-15
Franklin County
Population Projections
1970-2000

Year / Method	1970	1975	1980	1985	1990	1995	2000
1. P-25 Extrapolation	833,249	858,239	883,978	910,490	937,796	965,922	994,891
2. P-25 County Share	833,249 7.818%[a]	858,239 7.995%[a]	892,230 8.171%[b]	944,516 8.347%[b]	994,782 8.523%[b]	N.A.	1,069,966 8.875%[b]
3. P-26 Extrapolation	833,249	866,100	900,246	935,739	972,630	1,010,976	1,050,834
4. P-26 County Share	833,249 7.818%[a]	866,100 8.050%[a]	904,342 8.282%[b]	963,336 8.513%[b]	1,020,666 8.745%[b]	1,065,000	1,110,251 9.208%[b]

a County portion of State - Census estimates

b Projected county portion of State - BEA projections

- - - - - - - - - - -

1. Straight-line extrapolation of the 1970 - 1975 growth rate (3.0%) and estimates shown by P-25 implies a 1970 to 2000 growth of 19.4% and a year 2000 projection of 994,891.

2. Using P-25 as a base to establish 1970 and 1975 percent share of the county in State estimates, an increasing percentage share was projected to the year 2000. The Franklin County proportion (8.87%) of the EEA year 2000 projection would lead to a projection of 1,069,966. This reflects an increased growth rate over recent trends and a 1970 to 2000 growth of 28.4%.

3. A straight line extrapolation of 1970 to 1975 estimates and growth rate (3.9%) shown by P-26, implies a 1970 to 2000 growth of 26.1% and a year 2000 projection of 1,050,834.

4. Using P-26 as a base to obtain county share of 1970 to 1975 estimates for the State population, a year 2000 percentage share of the State population was projected at 9.21%. This proportion of the BEA year 2000 projection results in 1,110,251. This shows an increased growth rate over recent trends and a 33.2% growth from 1970 to 2000.

TABLE II-16
OBERS Population Projections
for Ohio 1970-2020

Year	Population, Midyear
1970	10,688,000
1980	11,650,600
1990	12,609,400
2000	13,382,200
2020	14,767,000

Source: OBERS Projections, Regional Economic Activity in the U.S., series E Population, Volume 4: States, U.S. Water Resources Council, Washington, D.C.

TABLE II-17
Population Projections 1975 - 2000
for Proposed Interceptor Service Areas[1]

Interceptor Service Area	Acres	1975 Pop.	1985	% Increase 1975 - 1985	2000	% Increase 1985 - 2000	% Increase 1975 - 2000
Big Walnut	24,300	6,000	14,100	135%	21,296	51%	255%
Rock Fork	11,400	4,300	9,118	112%	17,776	95%	313%
Blacklick	32,700	27,700	30,362	10%	41,800	38%	51%
Big Run	12,900	1,500	4,606	207%	10,384	125%	592%
Scioto West	24,300	13,500	31,866	136%	42,680	34%	216%

[1] These estimates are based in part on MORPC's disaggregated traffic zone/district projections for 1985 and 2000.

The table indicates that all areas will experience significant growth during the approximate 25 year period. Big Run, which presently is sparsely populated, is expected to experience the largest percentage increase. The smallest percentage increase is anticipated in the Blacklick Interceptor Area which serves Reynoldsburg. This area already has considerable population and has proposed connecting to the City of Columbus facilities in order to shutdown the outdated Reynoldsburg wastewater treatment plant.

The projections displayed in the table are based on the most recent traffic zone figures available from MORPC. MORPC assigned population to each zone on the basis of assumptions regarding availability of transportation, sewer, and government services.

(2) Employment

A discussion of employment projections is presented because the availability of employment opportunities is a key factor in determining the amount of population growth which an area can support. Employment projections for both the state of Ohio and Franklin County are favorable, and the number of job openings is likely to be sufficient to support the modest rate of growth anticipated.

Total employment in the state is expected to increase 13% or 546,000 jobs to 4,964,000. In addition, replacement needs are expected to total 1,558,400 bringing the total statewide job openings to 2,135,000 during the 1970's. Declines are expected to occur primarily in farm employment and crafts; while growth is expected in professional and technical occupations, managerial positions, sales, clerical and service openings.

In Franklin County, the trends exhibited during the 1970's are expected to continue into the 1980's. For example, although manufacturing will continue to have an important role in the regional economy, particularly due to its increasing output, employment in this sector will remain stable or experience slight declines. On the other hand, both the services and public sector will expand. The Chamber of Commerce anticipates over a 40% increase in public employment between 1974 and 1985.

(3) Income

An analysis of future earnings trends provides a basis for assessing the likely market demands and decisions of developers. For example, the income of residents may influence whether developers concentrate on multi-unit or single-family dwellings.

Earnings trends exhibited during the 1970's should continue during the 1980's with some improvement as general economic conditions improve. In the manufacturing sector, continued high wage levels are expected. In the wholesale/retail trade sector, average weekly earnings have increased since 1972, although inflation has resulted in a decline in real earnings. Future changes in real earnings, therefore, are largely dependent on the rate of inflation in relation to wage increases. Similarly, total earnings in the services sector have increased steadily although real earnings have increased only slightly.

2.2.3 Current Economic Characteristics

The objective of this section is to describe the major sectors of the planning area's economy and to lay a foundation for an assessment of the ability of the economy to support different degrees of population growth. The economic health of a region contributes to its attractiveness relative to other regions.

(1) Principal Trends

During the past two decades, the Franklin County/Columbus region has exhibited two different economic patterns. First, during the 1960's and early 1970's its continued growth was a sharp contrast to the slow growth or actual population loss of several other Midwestern cities. The Columbus area avoided this decline primarily because of its position as a regional center and because the service sector expansion which kept the city's unemployment rate below that for the state and the nation (Table II-18).

However, in the mid-1970's, the Columbus/Franklin County economy exhibited an increased vulnerability to the vacilations of the national economy. As the recession deepened, the area's manufacturing sector

TABLE II-18
Unemployment Rates, U.S., Ohio, and Franklin County
1965-1976

Year	U.S.[a]	Ohio[b]	Franklin County[b]
1965	4.5	3.6	2.7
1967	3.8	3.2	2.4
1969	3.5	2.8	2.2
1971	5.9	5.2	3.4
1972	5.6	4.3	3.0
1973	4.9	4.3	2.9
1974	5.6	4.8	3.7
1975 Average	8.5	9.1	7.3
March	8.5	9.4	7.3
December	8.3	7.8	6.2
1976 (March)	7.6 (Feb.)	8.2	7.3

[a] Economic Indicators, Council of Economic Advisers, Washington, D.C., January, 1973; January, 1976; March, 1976.

[b] "Labor Force Estimates in Ohio, By County", Labor Market Information, Ohio Bureau of Employment Services, Columbus, Ohio, for respective years 1965-1976 (March).

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

declined significantly. As out-migration from the Midwest continues, the regional demand for goods and services may decline. Therefore, the health of the Franklin County economy will depend on its ability to shift from functioning as a regional economic center to a national one.

(2) Major Economic Sectors

The present strength of the Columbus economy reflects its diversified services sector supplemented by manufacturing, retail/wholesale trade, financial and real estate activities, and government. Agriculture is neither a major source of employment nor a major source of output.

- Manufacturing - The Columbus manufacturing sector focuses on durable goods. Several areas of manufacturing experienced moderate growth until 1975, reflecting population growth and the area's attractiveness as a distribution center. Other sectors, however, such as fabricated metal products and machinery have declined as mechanization increases.

- Wholesale Trade--Table II-19 shows the changes which occurred in the wholesale trade sector between 1958 and 1972. This sector has expanded rapidly, largely as a result of Columbus' central location and excellent transportation network. In addition the large amount of land available provides the space required for the handling and storage of durable goods.

TABLE II-19
Wholesale Trade Changes in Number of Establishments, Total Sales, Employment, Franklin County and Columbus 1958-72

	Franklin County						Columbus					
Year	No. of Estab.	% Change	No. Empl.	% Change	Sales (in 1,000s)	% Change	No. of Estab.	% Change	No. Empl.	% Change	Sales (in 1,000s)	% Change
1958	969	--	13,275	--	1,095,153	--	835	--	11,533	--	886,130	--
1963	1,068	10.2	14,958	12.7	1,430,717	30.6	888	--	12,675	9.9	1,140,169	28.7
1967	1,126	5.4	17,779	18.8	2,044,568	42.9	873	--	14,097	11.2	1,465,594	28.5
1972	1,422	26.3	20,627	16.0	3,011,770	47.3	980	--	15,177	7.7	1,945,003	32.7

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

- Retail Trade—Table II-20 shows that between 1967 and 1972, the number of retail establishments, employment in the retail sector and total retail sales had increased. During this period, spatial redistribution of the retail trade sector occurred. The number of retail establishments within the city has declined with the emergence of regional shopping malls which serve the increasingly decentralized population. The principal malls are Eastland, Westland, Northland, and Sawmill.

TABLE II-20
Retail Trade Changes in Number of Establishments
Total Sales, Employment Franklin County and Columbus, 1958-72

	Franklin County						Columbus					
Year	No. of Estab.	% Change	No. Empl.	% Change	Sales (in 1,000s)	% Change	No. of Estab.	% Change	No. Empl.	% Change	Sales (in 1,000s)	% Change
1958	5,373	--	36,314	--	852,653	--	4,500	--	31,683	--	734,214	--
1963	5,227	-2.7	39,043	7.5	1,074,802	26.0	3,836	--	29,490	-6.9	790,375	7.6
1967	5,496	5.1	43,242	10.7	1,406,170	30.8	3,832	--	31,534	6.9	1,003,177	26.9
1972	6,620	20.4	57,606	33.2	2,218,312	57.8	4,403	--	47,017	49.0	1,539,564	53.5

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

- Financial Services—Columbus has become a financial center served by several major bank holding companies, smaller banks, and insurance companies. The Bank Ohio Corporation, the First Bank Group of Ohio and Huntington Bankshares which together have assets exceeding $6 billion dollars are the major banks. Columbus also is becoming a major insurance center. Recently, Nationwide Insurance Company built its national headquarters in Columbus.

- Selected Services—Between 1967 and 1972 the selected services sector, which includes hotels, personal services, repair services, and recreation, increased markedly. It provided 12,000 new jobs and doubled its receipts. Within the Columbus SMSA., services are concentrated in Franklin County. Within the county, the City of Columbus' share of the services sector is declining.

- Agriculture and Mining—These two sectors of the regional economy continued to decline in importance. Although Ohio continues to be an agricultural state, the percent of land and share of

the work force devoted to farming has decreased both statewide and in Franklin County. Between 1954 and 1970 agricultural land decreased from 50 percent of the total county land to 35 percent. However, both the average value of farms and the value of total agricultural output has been rising. Major crops are soybeans, corn, wheat, and hay.

2.2.4 Projected Economic Characteristics

This section discusses the projected trends of the regional economy and the principal constraints upon incentives for economic development.

(1) Projected Trends

Both the growth and spatial redistribution trends of the 1970's are likely to continue in the foreseeable future. Manufacturing is likely to remain stable or decrease slightly. The trade sector will increase its number of establishments, employment, and output. Agriculture will continue to decline in importance. Most of the economic expansion will occur in the Franklin County portion outside the City of Columbus. However, plans to revitalize the downtown area may reduce the decentralization trend of the 1960's and 1970's.

(2) Incentives and Constraints

This discussion shows that the Columbus/Franklin County area has several advantages which are conducive to simulating the area's economic recovery. The major ones are;

- Central location from both a regional and national perspective
- Excellent surface transportation facilities
- Available land for commercial development.

These three factors combine to make the region attractive for trade, storage and distribution, finance, and services.

The region faces the following three constraints:

- Inadequacy of water supply
- Linkage of regional economy
- Vulnerability to vacillations in national economy.

The first one appears to be the most difficult to overcome because it is a physical one. The second two constraints could be somewhat alleviated with a decreased emphasis on manufacturing and public sector employment and continued development of services, storage and distribution, finance and banking, and trade.

Water supply availability potentially poses a constraint on the type of economic development in Franklin County. Section 2.2.7 which discusses the county's water sources in detail notes that sufficient water is available at least through the year 2000. This estimate, however, takes into consideration the development of deep water wells and the possible damming of Big Darby Creek.[1] Therefore, the siting of manufacturing units requiring large quantities of water is constrained. Provided the economic growth continues to be focused on the trade and service sectors, water supply problems may not develop.

The potential constraint posed by the area's linkage to the state and Midwestern economies results from two factors. First, as the state capital, the city of Columbus is dependent on state government employment and expenditures. In 1974, for example, the State of Ohio and Ohio State University were the two largest sources of employment. The downswing in economic conditions during 1974-1975 was a contributing factor to reduced state revenues and in turn reduced

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1 Big Darby Creek is the only remaining free flowing creek in Central Ohio. Construction of a Dam on Big Darby would have an adverse effect on the natural aquatic life of the stream, which due to its high water quality supports an unusually large variety of fish. One species, the Scioto madtom, a small catfish, is found only in Big Darby Creek. It has been designated an endangered species by the Ohio Department of National Resources and the U.S. Department of Interior. *

expenditures and employment. Although the opportunities for public sector employment are expected to increase with the improvement of economic conditions, continued dependence on that sector poses a potential constraint. In addition, economic expansion may be constrained by the net out-migration of people from the Mid-west. The resulting reduction in demand for goods and services could curb economic growth.

A third potential constraint is the nature of the linkage between the Franklin County/Columbus economy and the national economy. In general, the linkage has occurred with respect to the manufacturing sector of the economy. As the 10% decline in manufacturing employment during the recent recession illustrates, that sector is particularly susceptible to overall economic conditions. While an increased emphasis on providing national rather than just regional financial and storage/distribution services would relieve the economy's vulnerability to regional trends, it would reinforce dependence on national trends. However, the nature of that dependence would change.

2.2.5 Existing Land Use Controls and Patterns

The utilization of land is affected by market demands, local land use policies and controls, and natural environmental constraints. This section describes existing land uses as well as the policies and regulations which have shaped and will continue to shape those uses. It provides a baseline for estimating future land uses with or without the proposed interceptor facilities.

(1) Land Use Planning

Comprehensive land use planning efforts are undertaken by the Mid-Ohio Regional Planning Commission (MORPC) which conducts planning for 21 townships adjacent to Franklin County as well as for the county. MORPC has been responsible for projecting population and land use, for developing transportation plans, and participating in 701 and 208 planning.[1] However, like most regional planning agencies, MORPC has no enforcement powers.

1 MORPC is supposed to have a contract with the State of Ohio to do 208 planning for Ohio's "non-designated" areas.

Planning for the City of Columbus occurs within the Planning Division of the city's Department of Development. This division published a Developmental Policies document in 1973[1] which specified some of the city's previously unstated land use policies. The major ones are:

- Annexation
- Extension of utilities including water supply and sewers
- Transportation planning

(2) Land Use Controls

At the present time, there is no mechanism in the Franklin County/Columbus region for comprehensive land use planning and growth management. Land use planning and control occurs at three levels:

- Incorporated area (city, town, village)
- Township
- County.

Within Franklin County, all of the cities, including the City of Columbus, and most of the major villages, have enacted zoning codes. Of the 17 townships, 3 have adopted such codes. They are Jefferson, Washington, and Plains Townships. The remaining unincorporated area is subject to the Franklin County Zoning Resolution. The major principles of the city and county zoning codes are summarized below.

- Columbus Zoning Code—The complex zoning code is administered by the Division of Zoning. Its principal objectives are to regulate the location of buildings, the amount of open space, the heights of structures, and to provide for minimum off-street parking in all districts.

  However, the city does not have pre-zoning. Essentially, this means that when the zoning code was enacted, all tracts were zoned according to existing uses. Undeveloped land was placed in a holding category. Land in the holding category is zoned at such time as an application is made for a specific use.

1 Development Policies Statement, Department of Development, City of Columbus, December 1973.

The Columbus zoning code is extended to annexed areas in the following manner. Land owners have 30 days after annexation in which to apply for zoning according to existing or new uses. Land for which no application is made goes into the holding category.

As of January 1976 many zoning functions were transferred to the planning division of the Department of Development (DOD). The Code Enforcement Division of the Department is responsible for zoning enforcement. The result of this transfer was to concentrate all planning services of the Department in one division.

The zoning services section of the Planning Division reviews all plans submitted to the Building Regulation Division. Except for one and two family residences, all construction must receive permits to insure its compliance with minimum zoning code requirements. The zoning staff reviews requested changes to the official zoning map and makes recommendations to the Development Commission and City Council. It reviews all proposed subdivisions, lot splits,[1] utility and street improvement plans.

The Board of Zoning Adjustment receives all variance applications. The variance may be granted if certain characteristics of the land prevent the owner from using his land reasonably for some other purpose. The zoning staff advises the Board of Zoning Adjustment.

Columbus has encouraged the Planned Unit Development District (PUD) in order to facilitate flexibility in land and site design. Each PUD District is analyzed by the Planning Division prior to submittal to the City Council for approval.

. Franklin County Zoning—Franklin County does not have a comprehensive land use plan to provide a context for zoning decisions.[2] In the mid to late 1960's comprehensive development plans were

1 Lots may be split without going through subdivision proceedings.

2 MORPC is preparing a year 2000 Land Use Plan for the County and adjacent townships.

prepared for Franklin County. These plans however, showed concentrations of development types rather than site specific plans. County zoning, which applies to all unincorporated areas not subject to township zoning, was enacted in 1948. At that time, existing land uses were identified and the county zoned according to those uses. In 1966, the zoning code was changed so that land not already zoned residential was automatically zoned rural/agricultural. A developer then had to go through a rezoning process in order to file subdivision plans. This involves hearings held by both the Regional Planning Commission and the Rural Zoning Commission. The final decisions rest with the County Commissioners.

(3) Existing Land Use

Land use patterns in Franklin County strongly reflect the growth, development, and land use policies of the City of Columbus. The general patterns are as follows. The city center is characterized primarily by commercial development and public and quasi-public areas. Development outward from the center follows the major throughfares to the east, north, northeast, and southeast. Retail facilities are concentrated along these throughfares. Manufacturing and storage activities within the city are concentrated on the eastern side of the city along 5th Avenue, Route 62, and in the airport vicinity. Additional storage and distribution facilities are interspersed at various locations around the Outer Belt. The Anheuser-Busch Brewery, a major water user, occupies 155 acres in the northern part of the city near Worthington.

Development to the south and west of the city limits has been slow. In the south, except for Grove City on the southwest, odor emissions from the rendering and treatment plants, poor soils, and geological conditions have constrained development. To the West, just south of Hilliard in the proposed Big Run Interceptor Service Area, drainage and soil problems together with the absence of public utilities has resulted in slow development. A proposed General Land Use Plan (1973)[1] identified the area as an agricultural one not recommended for urban development.

1 Land Use Study, Columbus Department of Development December, 1973.

The completion of the Outer Belt (I-270) has opened up new areas for development. In general, this new development is characterized by spatial decentralization. The specific trends are discussed in 2.2.6, Projected Land Uses, and in the Secondary Impacts Analysis chapter.

- Residential Patterns—Residential development is scattered throughout the planning area. It is characterized primarily by single or two family homes. Apartment developments, many of which are garden apartments, are concentrated outside the city limits in proximity to the outer beltway. Residential land increased from 14.58 percent to 21.95 percent of land usage between 1954 and 1970. Demand for single family homes is strong, since dwellings in this category did not increase as rapidly as did apartment dwellings during the early 1970's.

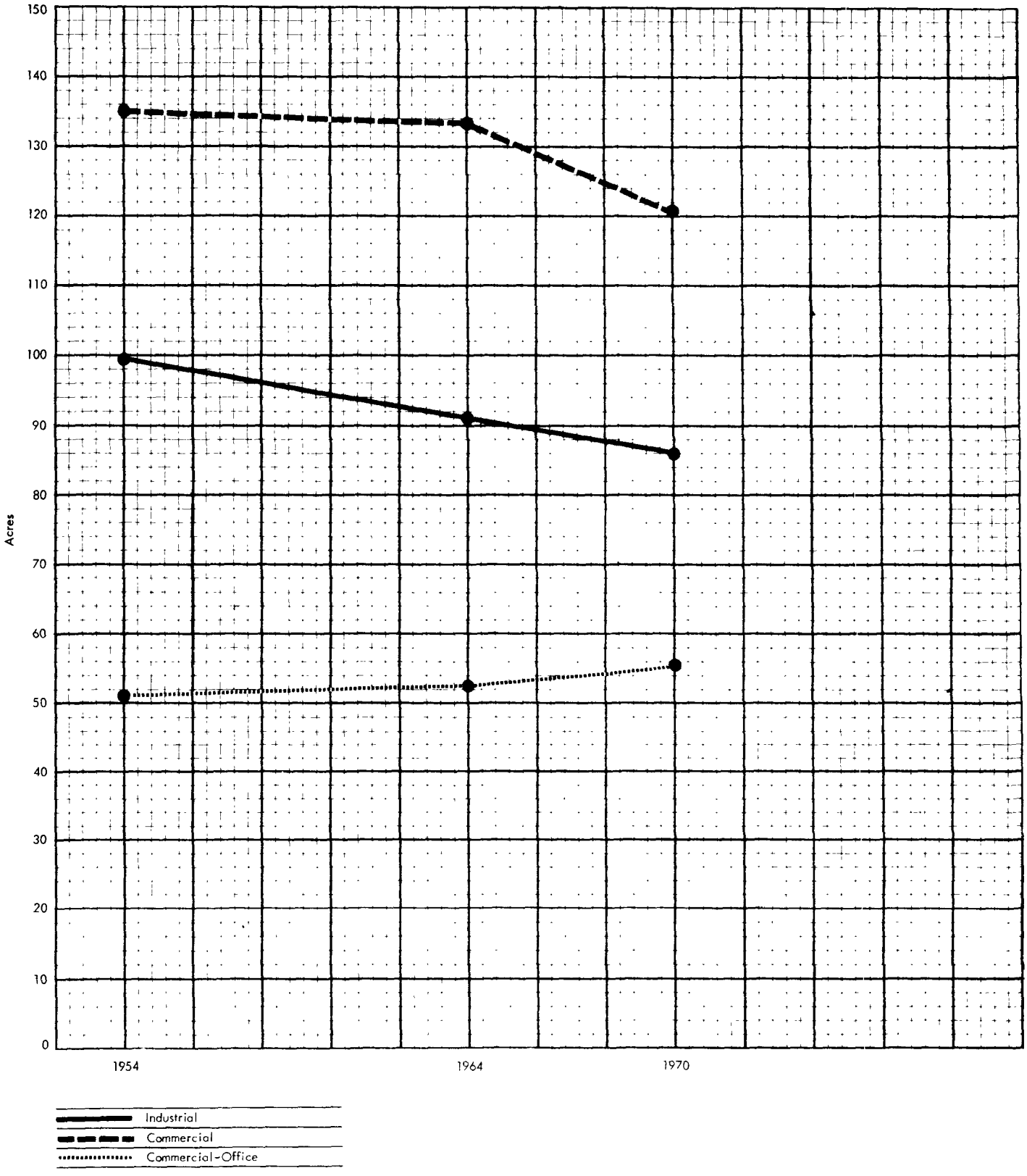
- Commercial and Industrial Patterns—Figures II-3 and II-4 show the changes in industrial, commercial, and commercial-office acreage between 1954 and 1970 for both the downtown and fringe areas. According to the figures, commercial and industrial development is occurring more rapidly in the fringe area than in downtown. However, this trend does not reflect the recent expansion of downtown office space which is discussed in section 2.2.6, projected land uses.

- Agricultural Land—The Council on Environmental Quality (CEQ) has encouraged that evaluations of proposed projects include consideration of the need to preserve prime and unique agricultural lands. In order to provide a basis for evaluating the extent to which development induced by the proposed interceptor alternatives will affect productive farmlands, this section summarizes past and recent trends in agricultural land use.

  In 1970, according to the Environmental Assessment, Franklin County had approximately 165,000 acres or 47% of its land devoted to agriculture.[1] The Department of Development, City of Columbus, arrived at a somewhat lower estimate of total

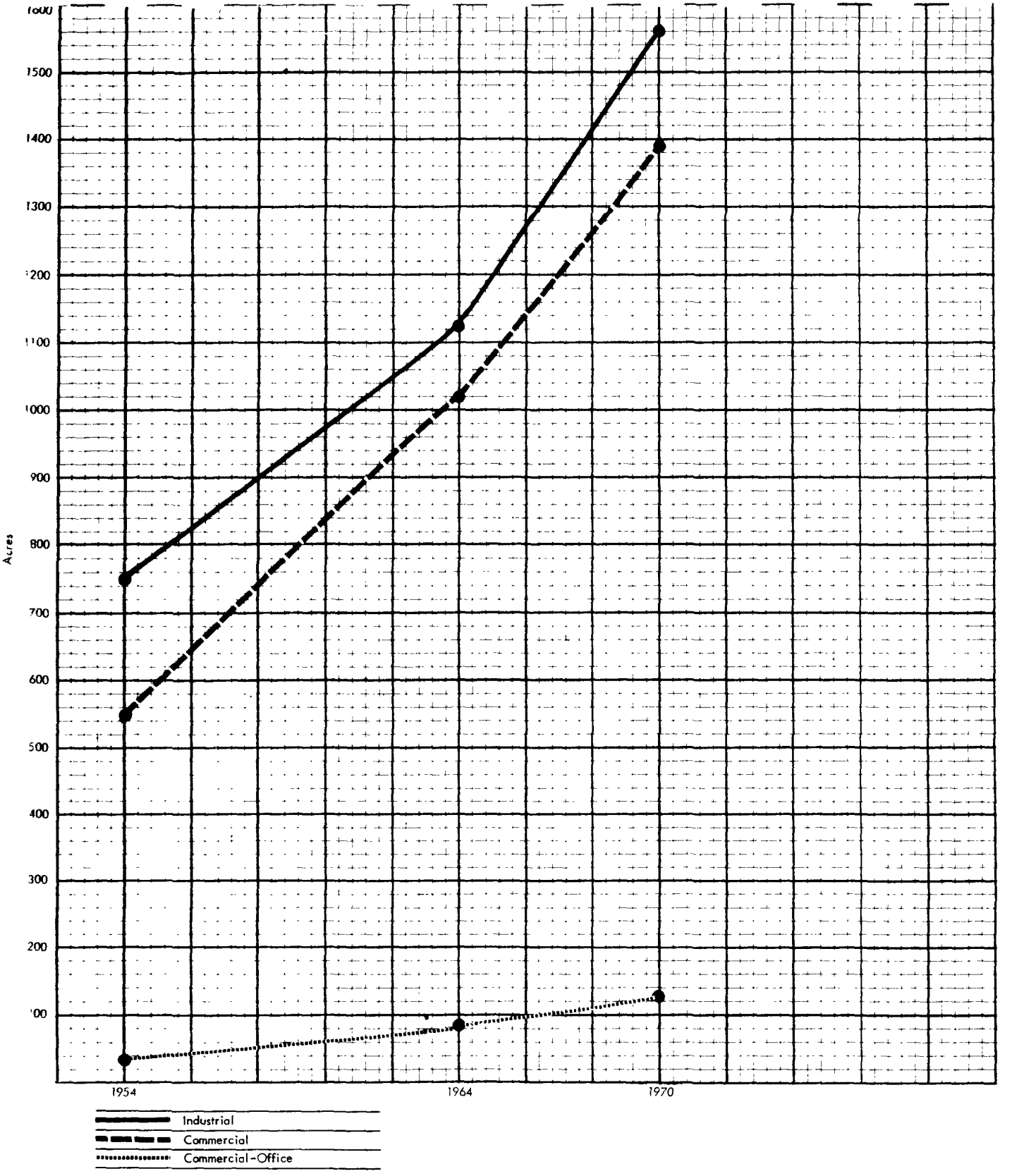
1 Environmental Assessment, Columbus Metropolitan Area Facilities Plan, Malcolm Pirnie Inc., July 1976, p. 128.

FIGURE II-3
Downtown Acreage Changes for
Industrial, Commercial and Commercial Office
1954, 1964, 1970



Source: Columbus, Ohio, Department of Development, Division of Planning

FIGURE II-4
Fringe Acreage Changes for
Industrial, Commercial and Commercial Office
1954, 1964, 1970



Source: Columbus, Ohio, Department of Development, Division of Planning

agricultural land in the county. Its 1973 land use study concluded that between 1954 and 1970 agricultural holdings decreased from over 50% of all land in Franklin County to about 35% of all land. In addition, the City of Columbus reported that between 1964-1969 there was an 11% decline in the number of farm operators, a 4.6% decrease in farmland, a 3.9% increase in average farm size and a 36.0% increase in the average value of a farm. During this period, the total value of agricultural products increased 16.5%.[1] These trends parallel those statewide.

2.2.6 Projected Land Uses

This section identifies the general trend in projected land uses and the principal factors influencing the type and location of development. In identifying these opportunities and constraints, it lays the foundation for a comparison of the growth trends likely with the proposed interceptors with those likely in the absence of those facilities.

(1) Growth Trends

Future land use patterns will depend on market demand and local land use and development patterns. This section briefly describes the development pressures. The secondary impact analysis will evaluate in greater detail the growth and development scenarios likely to occur with and without the proposed facilities. In addition to the demographic and economic characteristics already identified as having an impact on market demand and development decisions, the following factors are important:

- Urban redevelopment
- The availability of commercial space
- Transportation
- The availability of sewered, developable land
- Availability of community services

2 Overall Economic Development Plan, Department of Development, City of Columbus, October 1976.

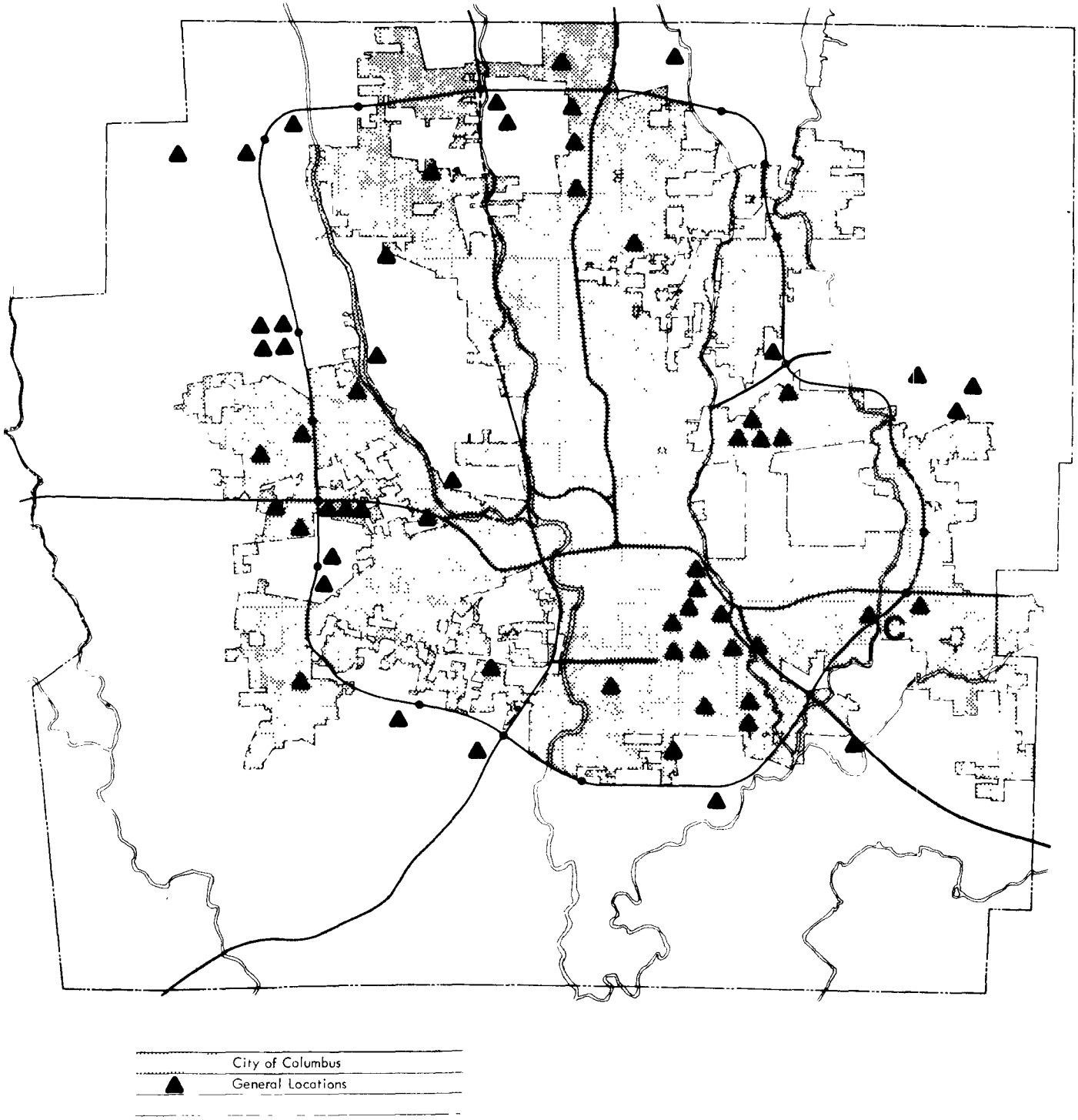
The land use and economic development policies of the City of Columbus will also continue to influence land use and growth patterns. The anticipated future patterns for each type of development are as follows:

- Industrial Trends—MORPC estimates that between 1974 and the year 2000, 4655 acres of land will be required for industrial development. Most of this development will occur in suburban areas which are easily accessible. For example, they may be near the Interstate or Outerbelt. Little development is expected to occur either in the outer fringe or the expanded area shown in Figure II-5.

- Residential—MORPC's Year 2000 study estimated an increase of 230,608 dwelling units between 1974 and 2000. These units would be both multi- and single-family types and would be located in the urban community, suburban, Franklin County, and expanded area. Of the multi-family units, high-rises are expected in the downtown area as part of the redevelopment there and along major thoroughfares. Low-rise apartments, condominiums, and townhouses are expected to develop at an average density of 16 units per net acre. Most would be located in the suburban area. This area also is expected to accommodate 80% of the anticipated single-family development. The remaining 20% would be divided between rural Franklin County and the expanded area. Density is not expected to exceed 6 dwelling units per net acre.

- Commercial Land Use—Expansion in the government, trade, and services sectors has stimulated commercial construction. By the end of 1977, approximately 1 million square feet of new commercial space, primarily devoted to offices, will become available. Two of the new buildings are the Ohio National Bank Building and the Nationwide Building. This new space will supplement space which already has become available in the past 2-3 years. As a result, although substantial office space is not currently vacant, it is likely to be in the future. This vacancy is likely to occur primarily in the "B" category space because corporations located in that older space tend to move to the new buildings. This oversupply of office space reflects the fact that corporations such as J. C. Penny, IBM, Midland Mutual and Borden have built

FIGURE II-5
Existing and Planned Industrial
Office Parks in Relation to the Freeway System



Source: Columbus, Ohio, Department of Development, Division of Planning

commercial space which exceeded their own needs. The influx of new firms will likely be insufficient to fill the available space. As of the end of 1976, there was an estimated warehouse space vacancy of approximately 2 million square feet.

(2) Interceptor Service Areas

A thorough analysis of the different characteristics of land uses in the interceptor service area with and without the proposed action will be presented in the Secondary Impacts Analysis chapter. This section describes the current estimates of which areas within the proposed service areas are expected to exhibit development pressures. It therefore contributes to an evaluation in the secondary impact analysis of the degree to which the presence or absence of the interceptors will influence development.

- Big Run—This 12,900 acre service area presently is characterized by low density, agricultural development. Recent zoning applications indicate that much of this farm land is being held for redevelopment at higher densities. This redevelopment is expected to be primarily residential, and the area's population is expected to increase from 1500 to 11,800, or over 670%, between 1975 and 2000. Such large growth would result in a change in density from 0.12 people per acre in 1975 to 0.91 people per acre in 2000.

- Scioto West—This area located in northwest Franklin County is slated for rapid residential growth. Its 24,300 acres includes an attractive area adjacent to Griggs Reservoir. It includes the rapidly growing Dublin area and areas adjacent to Hilliard and Upper Arlington. The anticipated population increase from 13,500 to 33,800 between 1975 and 2000 would shift the area's density from 0.56 people per acre to 2.0 people per acre.

- Blacklick Creek—The service area of the proposed interceptor covers approximately 32,700 acres and includes the city of Reynoldsburg and a large portion of sparsely populated, agricultural and open land between Reynoldsburg and New Albany. The area is expected to experience modest growth of a mostly residential character. It is likely to shift in density from 0.85 people per acre in 1975 to 1.45 people per acre in 2000.

- Rocky Fork—This 11,400 acre area is expected to experience a population growth of over 370% in 25 years and a density change from 0.38 people per acre in 1975 to 1.77 people per acre in 2000. The area includes both New Albany and part of Gahanna. With the completion of I-270, the accessibility and attractiveness of these areas has increased.

- Big Walnut—The 24,300 acres of this interceptor service area borders both sides of Hoover Reservoir and includes portions of Delaware and Licking Counties as well as Franklin County. It is expected to increase its population from 6000 in 1975 to 24,200 in 2000. This 300% increase will result in a change in density from 0.25 people per acre in 1975 to 1.0 person per acre in 2000. Although in no case does the anticipated change in density result in more than 2.0 people per acre, even this modest increase in density is likely to change the character of these areas. In general, these areas will evolve from sparsely populated, agricultural ones to low density, subdivisions. These changes are discussed in greater detail in the secondary impact analysis. *

(3) Opportunities and Constraints

Factors which may influence the type and location of development are identified and summarized in this section. They are discussed in greater detail in the secondary impacts chapter.

- Urban Redevelopment Plans—There is an increasing tendency for companies to relocate to the suburban area. Table II-21 shows that this trend reflects, in part the lower rental rates of new office space in the beltway vicinity. In addition, building costs are higher downtown than in suburban areas, primarily because of stringent building codes and permit requirements. The decentralization trend is evident from the decreasing number of downtown retail stores and the growth of regional shopping malls such as Northland, Eastland, and Westland, and Sawmill. However, downtown redevelopment activities may reverse or slow this trend. Plans for revitalization of the downtown include the establishment of new retail areas and construction of convention, hotel and other facilities. The secondary impact analysis will assess the degree

to which development activities planned for the suburban areas will compete with resources required to implement urban redevelopment plans.

TABLE II-21
Rental Rates of Office Space

Type of Space	Rates/sq. ft.
First Class or Class "A" Urban	$ 9-10
Second Class or Class "B" Urban	$ 7-8
Third Class Urban/ First Class Suburban	$ 5-7

Source: Interview with Columbus Area Developer

- Availability of Commercial Space—The high vacancy rate in warehouse space and potential oversupply of office space by the end of 1977 may result in a temporary respite in construction of this type. However, the vacancy in Class "B" or Class "C" urban office space may provide a continuing stimulus to plans to redevelop the central business district. Some of this space may be either replaced, or renovated and integrated into the new convention, hotel, and retail developments.

- Transportation—The excellent transportation facilities in the Columbus area attract development. Interstate highways 70, 71, 270 and 670 facilitate the movement of people and goods throughout the area. These highways together with the upgrading of Morse Road and Dublin-Granville Road has encouraged both sprawling commercial and residential development.

The Columbus area also has an extensive mass transit system which consists of the Central Ohio Transit Authority (COTA) and fourteen taxi cab companies. In addition, social service agencies provide transportation for approximately 200,000 elderly and handicapped people. Since COTA assumed ownership of the local bus system in January 1974, ridership has increased between 1974 and 1976 from 12,975,045 to 13,893,949 passengers. It is publicly subsidized from an 0.8 mill property tax level and Federal and State funds.

- Sewer Capacity/Developable Land—A 1975 MORPC[1] study showed that sufficient land within the City of Columbus is available for growth beyond 1990. Additional land is available in 20 municipalities adjacent to Columbus (Table II-22). The total of 48,281 acres available for residential development will support a growth of 977,204. In other words, the City of Columbus has sufficient developable land to support a growth in population in the city which exceeds MORPC's estimate of the growth for the entire county. The availability of developable land within Columbus is due in part to the city's annexation efforts during the 1960's and 1970's.

TABLE II-22
Land Available for Development in
Columbus and Adjacent Municipalities

	Pop.	Residential Acres	Persons/ Acre	Avail. Acres	Holding Capacity
Columbus	539,377	22,855	23.6	31.977	754,660
Adjacent Municipalities	173,720	12,727	13.65	16,304	222,544
Total	713,097	35,582	--	48,281	977,204

Source: Potential Residential Development: Columbus and 20 Adjacent Municipalities, Mid-Ohio Regional Planning Commission, July 1975

1 Potential Residential Development: Columbus and 20 Adjacent Municipalities, July 1975.

A second MORPC study shows that excess sewer capacity still exists within the city. In fact, the study indicated that in most areas, design capacity has not been approached. Exceptions noted include the central business district (CBD), to the north of the CBD along the I-71 corridor, across the I-70 corridor and in the north and northeastern areas in the vacinity of I-270. *

2.2.7 Community Facilities and Services

The availability, adequacy, and accessibility of community services will influence the community's development patterns. In the planning area, community services are provided by incorporated areas, townships, and the county. Some jurisdictions have contracts or mutual aid agreements with each other for the provision of various services. During 1977, MORPC has been conducting a survey of educational services and policies and has prepared a report on fire services. *

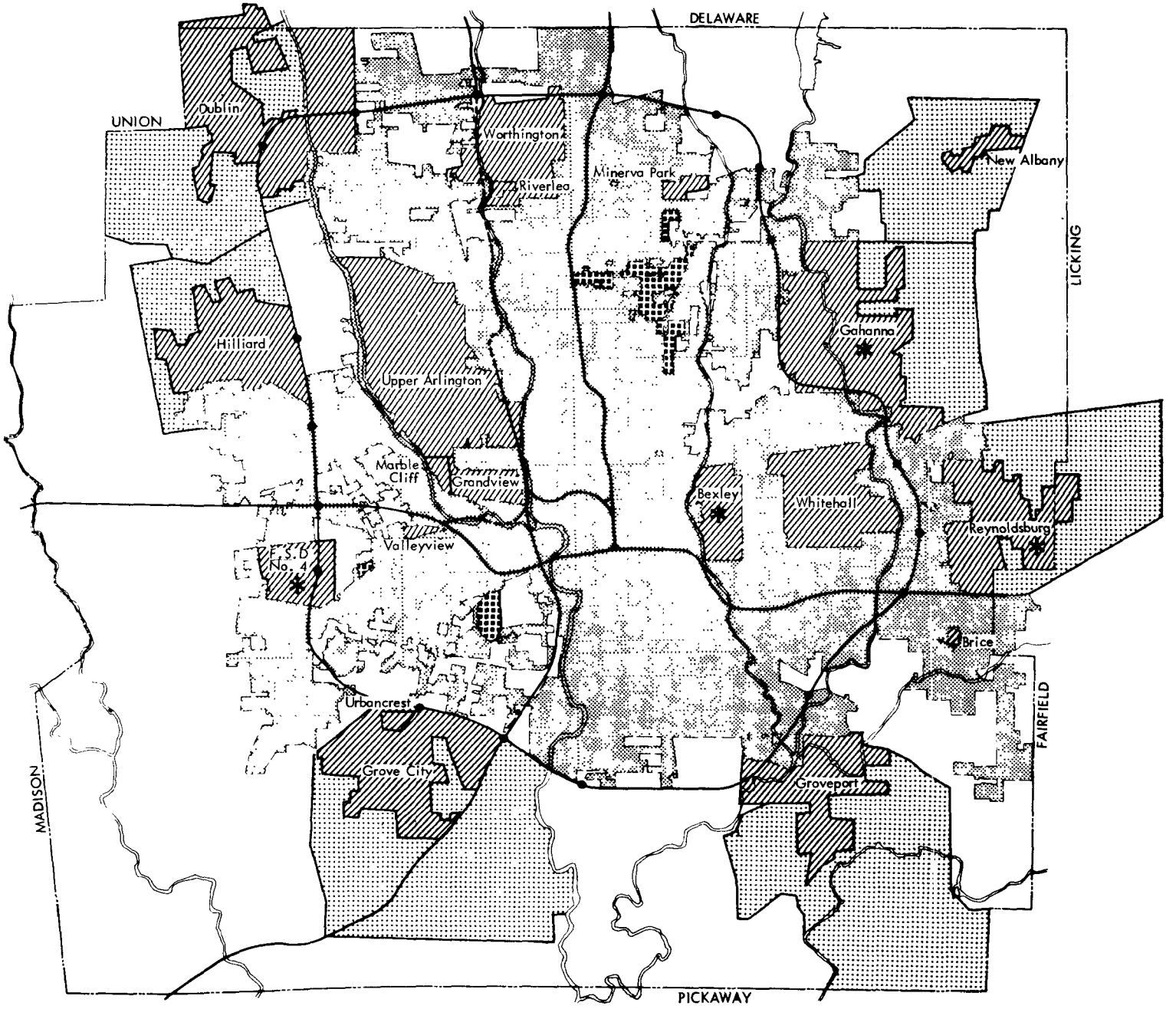
(1) Water and Sewer Services

The City of Columbus provides sewer and water services to city residents and by contract to most suburban municipalities. Figure II-6 identifies suburban communities with water service contracts. A key development tool of the city has been to set water and sewer charges for suburban communities at 130% to 150% of City of Columbus rates.[1] Upon annexation to the city, these areas have had the rates reduced. A new user charge system approved by U.S. EPA was instituted on January 2, 1978, which will eliminate the surcharge on the Federal portion of the project. *

- Water Services—Figure II-7 shows the location of City water treatment plants and reservoirs. Reservoirs include O'Shaughnessy and Alum Creek locate in Delaware County, Hoover located partly in Delaware County, and Griggs located in northwestern Franklin County. Water from these sources is treated at the Dublin Road and Morse Road plants.

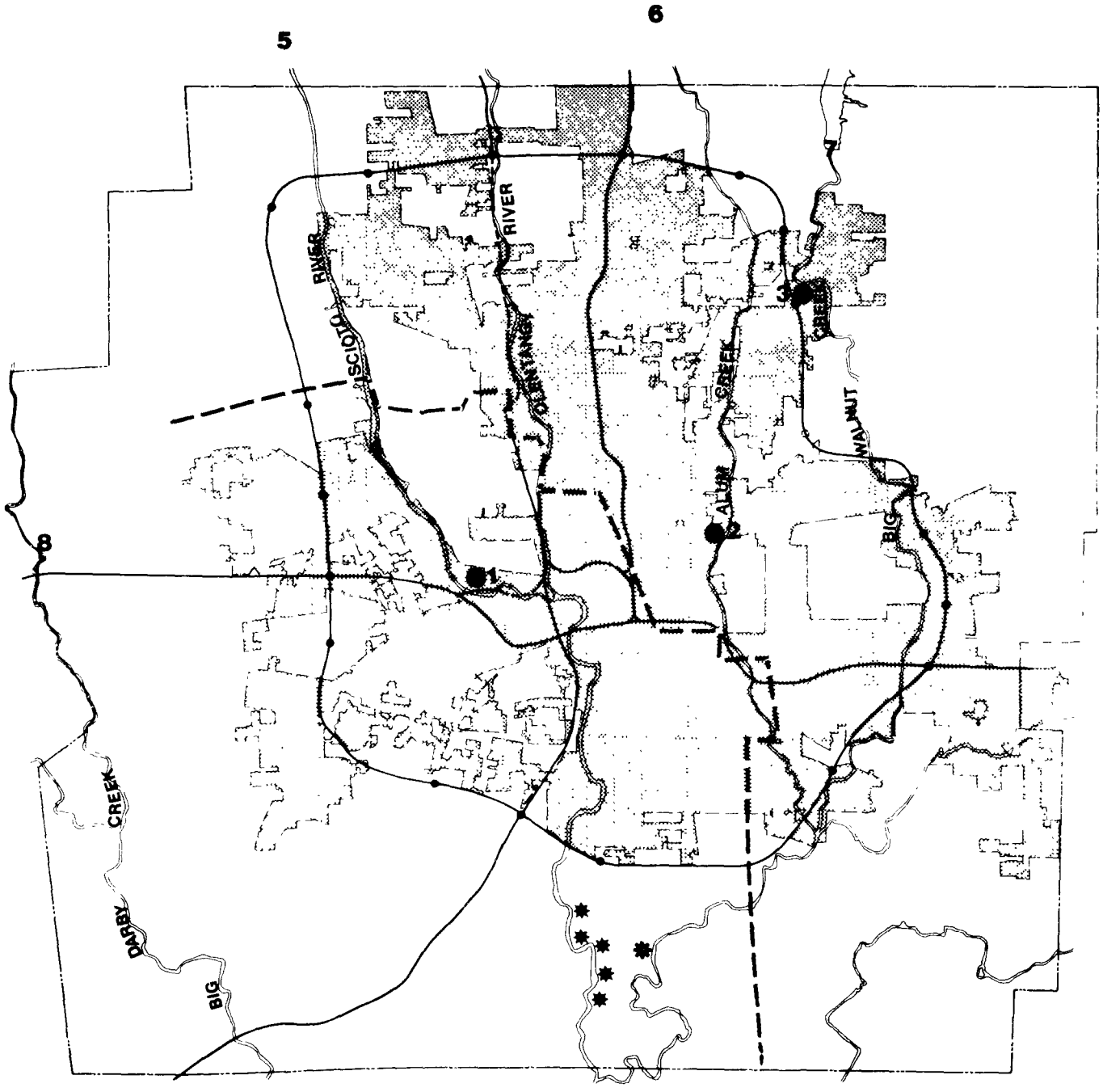
1 Table II-23 which did appear following this page, has been deleted.

FIGURE II-6
Water Service Area Map



Source: Columbus, Ohio, Department of Development Division of Planning
Note: This map has been updated since the publication of this statement.

FIGURE II-7
Columbus Water System



	City of Columbus
●	Existing Water Plant Sites
1.	Dublin Road
2.	Nelson Road
3.	Morse Road
✸	Proposed Water Plant
	Parsons Avenue

4.	Griggs Dam
5.	O'Shaughnessy Dam
6.	Alum Creek Dam
7.	Hoover Dam
8	Proposed Upper Darby Dam
— — —	Service Demarcation area betwe
	the Morse and Dublin Road Pla
✸✸✸✸	Proposed South Well Field

Source: City of Columbus, Department of Development, Division of Planning

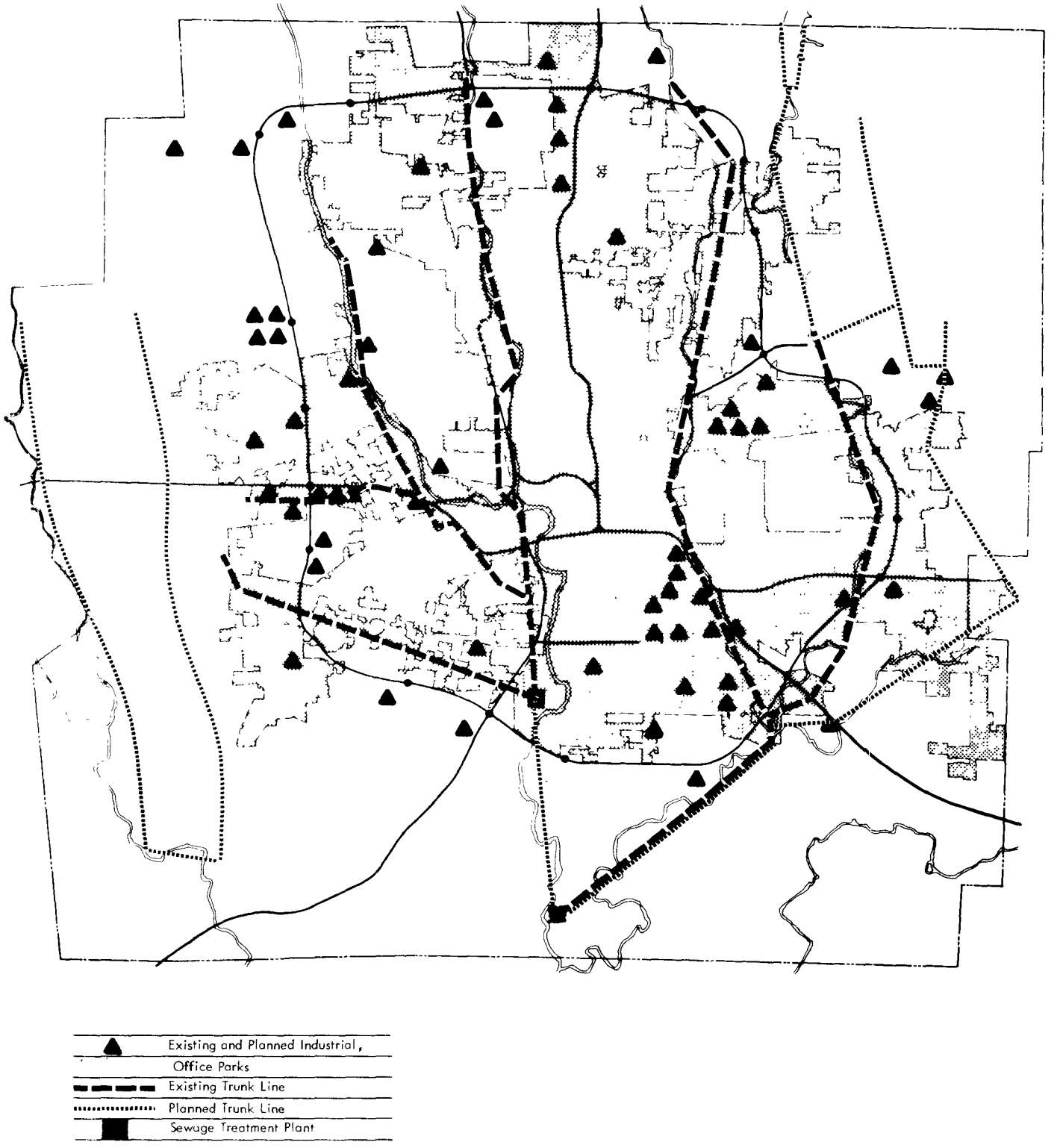
Note: This map has been updated since the publication of this statement.

The safe yield of water from these sources is presently 21 mgd on the basis of the 50 year drought. Construction underway will increase the supply to 116 mgd, which should be sufficient to sustain the present rate of growth until the mid 1980's. To meet long-term demands, however, new sources under consideration include water-well fields in southern Franklin County and the Upper Darby Creek which can supply an additional 80 mgd. Development of these sources will require at least one new water treatment plant and pumping station as well as sludge disposal facilities. Analysis performed by the City of Columbus Division of Water in cooperation with the Ohio Department of Natural Resources on the Central Ohio Water Plan (COWP) has identified a water supply deficiency occurring approximately by the year 2020. Several sources are being investigated for possible development to meet future needs.

Sewer Facilities—The City of Columbus sewer system consists of over 2000 miles of storm, sanitary and combined sewers, delivering between 136 and 155 million gallons of sewerage daily to the Southerly and Jackson Pike Treatment Plants. Figure II-8 shows the location of sewer facilities and the existing service areas. The system is primarily a gravity system with minimal pumping and conforms to the downstream flow which runs north - south through Franklin County. The Olentangy Interceptor Service Area was developed prior to the Mid-1920's and collects combined storm and sanitary flows. The combined average flow is 114 million gallons per day (mgd). The nominal capacity is 120-125.

Traditionally, the City of Columbus policy has been to plan for and to accommodate growth by providing sewer facilities anywhere politically and physically feasible in Franklin County. These policies have contributed to the gradual extension of sewer lines throughout the county. The Ohio Environmental Protection Agency (OEPA) has been discouraging the use of package plants in and around urban areas. Franklin County also is discouraging package plants since the costs to the county of operation and maintenance are too high.

FIGURE II-8
Sewer Trunk Design vs.
Industrial Park Sites



Source: Columbus, Ohio, Department of Development Division of Planning

(2) Police Services

Police services are provided by the city of Columbus, other incorporated areas, townships, and the county. Within the City of Columbus, there are 15 precincts. Some precincts share substations, resulting in a proposal in the Capital Improvement Needs Inventory for three new substations. Principal factors considered in determining boundary lines are demographic characteristics, crime rates, demands for services, and geopolitical barriers. MORPC presently is conducting a survey of police services throughout the county.

(3) Fire Protection

In February 1977, MORPC completed a report on fire protection services in Franklin County.[1] It describes and analyzes services available in all townships and incorporated areas. According to the report, Franklin County is served by a total of 25 fire departments:

- 14 township departments
- 5 city departments
- 3 village departments
- 2 Federal facilities
- 1 unincorporated private department.

The county has only one joint township department. Seven jurisdictions contract arrangements for fire services. Coordination of fire services is not the responsibility of any single organization. Several groups perform various training, prevention, and coordination functions.

(4) Hospital Services

Twelve major hospitals serve Columbus and surrounding communities. All are accessible by car and public transportation. They provide a variety of services and presently have excess bed capacity because of the declining birth rate, increasing outpatient services, and shorter hospital stays.

1 MORPC, Public Services and Facilities Profile: Fire Protection Services in Franklin County, February 1977.

(5) Education

Franklin County/Columbus has both public and private school facilities. The 287 public schools have an enrollment of 178,145 while 55 parochial/private schools have an enrollment of 15,368. The area has several business and technical schools as well as colleges and universities, of which Ohio State is the largest. Public school systems in Franklin County are in financial difficulty since voters have failed to approve higher tax levies to meet escalated costs from inflation. During 1976/1977 the Columbus system has had to curtail or postpone programs, and Groveport schools were forced to shut down temporarily. The financial problems which the school systems face threaten to decrease the quality of education and, as a result, the attractiveness of the area for development.

(6) Social Services

A network of private and public agencies, supported by Federal, State, and local grants as well as private contributions, provide a consumer affairs program, manpower counseling and development, child care, and programs for the elderly. Private and volunteer services range from information, emergency and long term shelter assistance, to physical and mental health therapy, rehabilitation programs, and educational and social activities.

(7) Other Services

The Columbus/Franklin County area offers several cultural amenities. Among these are the Columbus Library System which has branches throughout the city and in Dublin, Hilliaid, Gahanna, Reynoldsburg and Whitehall. Franklin County and adjacent counties provide entertainment and recreational facilities such as nature trails, a zoo, race track, golf courses, historical sites, hunting and fishing sites.

2.2.8. Fiscal Capabilities

The objective of this section is to provide an indication of whether the City of Columbus and other jurisdictions affected by the proposed facilities have sufficient fiscal capabilities to:

- Construct the facilities
- Operate and maintain the facilities
- Provide community services for induced population growth.

It is difficult to make a complete assessment since a single service area may cross several governmental jurisdictions each of which has different fiscal capabilities and different responsibilities for provision of community services. The construction of the facilities is to be financed by a combination of Federal and local funds. The USEPA will provide 75% of the funding. A $98,800,000 bond issue voted in November 1975 will provide the financing for the City's portion. In addition, the Industrial Cost Recovery Program will require large industrial users such as Anheuser-Busch to contribute to the cost of the facilities. Operation and maintenance costs will be covered by user's charges for both industrial and residential customers. The user's fee schedule has not yet been established.

The City of Columbus receives revenues for the provision of capital improvements and public services from the following:

- Federal Revenue Sharing
- Community Development Block Grants
- Grants
- Bond Issues
- Income Tax
- Intangible Tax
- Library Levy.

In order to improve its fiscal capabilities, the city recently has taken the following actions. In 1971, an increase in the personal income tax rate from 1.0% to 1.5% was approved. In 1976, passage of a new bond issue and, a reassessment of all property in Franklin County alleviated the borrowing constraints the City had faced in 1975. Approval of a Library levy in June 1976 provided $2,100,000 over the next five years for maintenance and limited expansion of the Columbus Public Library System. Additional

library funds come from a tax levied on stocks and bonds by the state and distributed by the county. Other jurisdictions in the planning area raise revenues through bond issues and a variety of taxes including property taxes.

2.2.9 Resource Use

This section provides a profile of energy resources in the Mid-Ohio Region and Franklin County. The profile identifies present and projected electricity consumption and natural gas usage by residences and industry.

(1) Natural Gas

Natural gas consumption in Ohio rose at an average annual rate of 4.2 percent between 1960 and 1972. In 1973, however, the consumption fell below the 1972 rate. The residential and industrial sectors together account for 80% of Ohio's natural gas consumption. Table II-23 compares the share of natural gas consumption by user type statewide in 1960 and 1973.

TABLE II-23
Share of Total Natural Gas Consumption in Ohio in 1960 and 1973 by Type of User

User	Total Consumption in 1973 (Millions of Cubic Feet)	Total Consumption in 1960 (Millions of Cubic Feet)	1973 Share	1960 Share
Residential	439,212	361,839	.398	.518
Commercial	185,033	107,915	.168	.154
Industrial	447,474	224,685	.405	.322
Electric Utilities	16,091	2,992	.015	.004
Pipeline Fuel	12,798	9,098	.012	.013
Lease & Plant Fuel	3,548	1,138	.003	.002
Total	1,104,156	698,569		

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

Columbus SMSA gas consumption patterns corresponded to statewide trends. Between 1962 and 1971 manufacturing increased its gas consumption by over 100 percent. In addition, over 85% of the households in Mid-Ohio counties utilize natural gas for home heating; in Franklin County the rate is higher. After 1972, however, the rate of consumption growth declined.

Natural gas supplies in Central Ohio are limited. Columbia Gas of Ohio serves the Mid-Ohio region and purchases most of its gas from the Columbia Gas Transmission Corporation (CGTC). The supplies originate in the South and Southwestern parts of the country. In 1972, CGTC anticipated natural gas shortage and instituted a freeze on new loads. Thus, total gas supplies to Central Ohio peaked in 1972 and declined steadily since then. Table II-24 shows natural gas sales between 1970 and 1975.

TABLE II-24
Natural Gas Sales by Customer Classification,
1970-1975, Columbus Gas of Ohio, Columbus Division

Year	Residential		Commercial		Industrial		Total	
	Mcf Sales[a]	Percent of Total	Mcf Sales	Percent of Total	Mcf Sales	Percent of Total	Mcf Sales	Percent Change
1970	40,630,548.0	44.8	17,649,996.4	19.5	32,347,954.5	35.7	90,628,498.9	--
1971	41,810,506.8	39.5	18,618,324.7	17.6	45,400,413.8	42.9	105,829,245.3	16.8
1972	42,631,358.1	38.2	19,757,179.5	17.7	49,113,336.8	44.1	111,501,874.4	5.4
1973	39,254,624.9	37.2	18,646,136.5	17.6	47,652,351.9	45.1	105,553,113.3	-5.3
1974	38,594,956.1	38.1	17,991,262.3	17.7	44,779,121.6	44.2	101,365,340.0	-4.0
1975	37,511,756.0	43.8	16,931,640.7	19.8	31,283,085.7	36.4	85,726,482.4	-15.4

a Mcf = Million cubic feet

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

In 1976 the Public Utilities Commission initiated a Self-Help Program to assist consumers whose service had been curtailed and new commercial and industrial consumers who developed their own gas sources. The gas supplies in Mid-Ohio are confined to very limited supplies in Licking and Fairfield counties. In the eastern half of the state reserves are more widespread but are useful primarily to consumers who independently develop those sources rather than to distribution companies.

(2) Electricity

This section compares electricity consumption trends in the Columbus and Southern Ohio Electric Company service area with statewide trends. Between 1960 to 1973, electricity consumption in Ohio rose 86 percent, from 57,368 MMKWH to 106,483. Table II-25 show that during this period, the relative share of the residential sector has increased while that of the commercial and industrial sectors has decreased.

TABLE II-25
Electric Energy Sales Statewide and
by Columbus and Southern Ohio Electric
(Million MWH)

Year	State Total	Columbus and So. Ohio Total
1963	64,093	3,241
1964	66,064	3,487
1965	66,920	3,789
1966	68,209	4,216
1967	71,557	4,356
1968	76,799	4,865
1969	81,639	5,394
1970	84,476	5,929
1971	88,276	6,311
1972	96,881	6,857
1973	106,483	7,536

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976

In the area served by the Columbus and Southern Ohio Electric Company consumption rose 140 percent from 3,241 MMKWH in 1963 to 7,767 MMKWH in 1974. Household consumption increased 159%; commercial sector consumption increased 224%; and industrial sector consumption increased 89 percent. Between 1963 and 1974 the combined commercial and industrial consumption rose 143 percent.

The oil embargo in 1973, appears to have increased awareness of the need for conservation. Electricity sales declined 3 percent in 1974 and between September 1974 and September 1975 ran 6.4 percent below the comparable period in 1974. Industrial sales currently are running 9 percent below 1973 levels.

The data suggests that there is surplus electricity available in Central Ohio. It is estimated that by 1978 the generating capacity will exceed demand by 37%. Table II-26 shows the projected 1985 generating capacity of the Columbus and Southern Ohio Electric Company.

2.2.10 Historical/Archeological Sites

The Environmental Assessment notes that the study area contains several historic landmarks. The National Register of Historic Place lists 20 sites, fifteen of which are in the City. Appendix D lists and describes these places. In addition, at least seventy-eight sites which may contain prehistoric relics of archeological significance have also been identified. The Ohio Historical Society is currently identifying additional sites.

2.2.11 Other Major Projects

Several other projects are underway or in the planning stages. The City of Columbus is preparing a major redevelopment project of the Central Business District. The Mid-Ohio Regional Planning Commission is coordinating the continuation of a 701 Comprehensive Planning Program and is participating in the study of alternatives for the I-670 proposed Interstate freeway link between downtown Columbus and the Outerbelt near Gahanna. In addition, the city has a responsibility for storm water management. A 208 Central Scioto Water Quality Management Plan is also under preparation by the State of Ohio.

TABLE II-26
Capacity in Relation to System Peak Demand for
Columbus and Southern Ohio Electric Co.
(in megawatts)

Year	Capacity	Peak	Ratio of Capacity to Peak
1963	942	647	1.46
1964	942	739	1.27
1965	942	807	1.17
1966	942	863	1.09
1967	990	920	1.08
1968	1,017	1,068	0.95
1969	1,110	1,144	0.97
1970	1,079	1,290	0.84
1971	1,477	1,419	1.04
1972	1,629	1,560	1.04
1973	1,957	1,719	1.14
1974	2,109	1,685	1.25
1975	2,109	1,749	1.21
1976	2,480	1,860	1.34
1977	2,480	1,981	1.25
1978	2,855	2,120	1.35
1979	3,081	2,268	1.36
1980	3,081	2,427	1.27
1981	3,456	2,597	1.33
1982	3,456	2,779	1.24
1983	3,773	2,974	1.27
1984	4,101	3,182	1.29

Sources: Ten Year Forecast Report to the Ohio Siting Commission, 1975.
Statistical Report for Financial Analysts, 1964-1974, prepared by Columbus and Southern Ohio Electric Company

CHAPTER III

SERVICE AREA AND SEWER SYSTEM ALTERNATIVES

(This Chapter has been substantially revised in the final EIS. See Appendix CC in Volume II.)

III. SERVICE AREA AND SEWER SYSTEM ALTERNATIVES

3.1 REGIONALIZATION

This Section discusses the possibility of regionalization of various divisions of the planning area. Each subarea is first defined and described, as are the regionalization alternatives proposed for each in the Facilities Plan and by subsequent review of the Plan. A final section examines the cost sensitivity of the chosen plan to various design philosophies.

3.1.1 Description of Planning Area

Figure III-1 shows the planning area and subareas. All of Franklin County except the extreme southeast and southwest corners is included, along with areas to the northwest as far as Sunbury in Delaware County. Also included is a small area of Delaware County west of the O'Shaughnessy Reservoir and small portions of Licking, Fairfield, and Pickaway Counties.

3.1.2 Existing Service Area

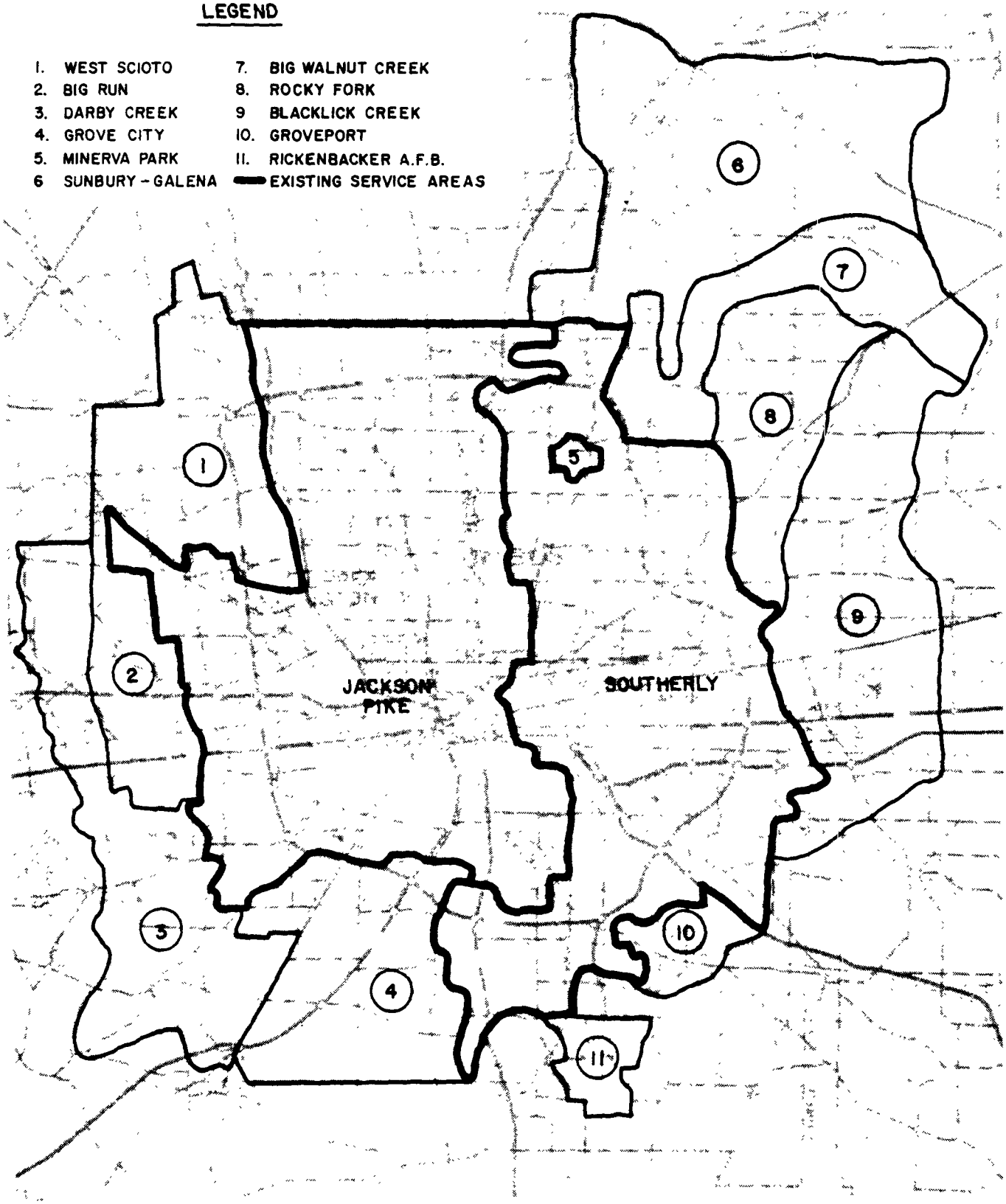
The existing service areas for the two wastewater treatment facilities serving the City of Columbus are also shown on Figure III-1. These two plants, Jackson Pike and Southerly, presently serve the City of Columbus as well as the communities of Bexley, Worthington, Westerville, White Hall, Upper Arlington, Marble Cliff, Grandview Heights, portions of Gahanna, Hilliard, and small unincorporated areas surrounding the City of Columbus.

A 42-inch gravity sewer designed to service the areas along the eastern edge of Griggs Reservoir and the upper Scioto River as well as the Dublin area west of the Reservoir is presently nearing completion. The latter area will contribute its flow via a force main across the Reservoir south of State Route 161. This main will continue to be used until an interceptor along the western edge of Griggs Reservoir is constructed. All intercepted flow will be transported to the Jackson Pike Plant for treatment.

Also nearing completion is the interconnecting sewer between the Jackson Pike and Southerly service areas. This line, which varies from 150 to 156 inches in diameter throughout the gravity portions of its length, currently

Figure III-1

Planning Area For Metropolitan Columbus



transports flow from Grove City to the Southerly Plant. Presently, the City of Columbus has a construction contract (City Auditors Engineer Contract Reference Number 2032) which would tie the interconnecting sewer to the Big Run and Frank Road Interceptors and divert these flows to the Southerly WWTP. Appendix I to this report proposes that the interconnecting sewer be used to transport excessive Jackson Pike flows (greater than 200 mgd) to Southerly to avoid a 25 to 50 mgd expansion at Jackson Pike and to utilize the full hydraulic capacity of both treatment plants. In order to fully tie the two plants together, it is proposed that the interceptor be extended from the Big Run and Frank Road connections some two to three thousand feet to connect to the Jackson Pike influent sewers. The estimated cost for this extension is $1.2 million.

Approximately 12,000 acres, or 12 percent of the areas tributary to the wastewater treatment facilities, are served by combined sewers. Twenty-five hundred acres of this total contribute flow to Southerly while the remainder are influent to Jackson Pike. At the present time, there are at least three major combined overflow points in the Southerly system, and 30 major overflows to the Scioto River in the Jackson Pike system. OEPA reports that there are some 80 - 90 additional overflow points in both systems. Present plans for the combined system are somewhat undefined, with an ongoing sewer system evaluation survey being conducted and plans being laid for the separation of some key areas. Therefore, a detailed analysis and recommendations of and for the combined areas are inappropriate for this Impact Statement at this time.

However, in the interest of completeness, a preliminary analysis and mathematical modeling of the combined sewer overflows was done to determine if any tentative conclusions could be drawn. Appendix H presents the inputs and results of this work. The major conclusions of the Appendix are:

- Degradation of Alum Creek is primarily dependent upon the quality of the combined sewer overflow, indicating treatment may be a viable alternative.

- Degradation of the Scioto River below the combined overflows is severe even at relatively good quality loadings (BOD_5 < 10 mg/l) in conjunction with all quantities of overflow modeled, indicating the need for improvements within the sewer system before attempting to treat at overflow points.

3.1.3 Subarea Description

This Section describes and discusses each of the 11 subareas shown in Figure III-1, and considers the feasibility of the inclusion of each in a regionalized system.

(1) West Scioto

This 24,300 acre unit is located in the northwestern part of Franklin County, and is bordered on the east by the Scioto River and on the south by the Cities of Hilliard and Upper Arlington. Also included are the Muirwoods Village and Shawnee Hills areas of southern Delaware County.

The present population of the West Scioto area is estimated to be 13,500 people, and is projected to increase to 31,800 by 1985, and to 42,600 by the year 2000.

(2) Big Run

The Big Run service area is also located in western Franklin County just south of the West Scioto subarea, and is comprised of the drainage to Hellbranch Run upstream of U.S. Route 40. This 12,900 acre subarea is estimated to presently contain 1,500 people, and is expected to increase to 4,600 by 1985 and 10,400 by the year 2000. The area is presently unsewered.

(3) Darby Creek

The Darby Creek area encompasses the remaining 28,500 acres in the western portion of the planning area. The present population is estimated at 4,500. The largest population center, 750 people, is the Village of Darbydale. The population projections for this area envision 11,100 people by 1985 and 17,000 by the year 2000.

There are presently no sewers in the Darby Creek subarea. The projected population density is only slightly more than one-half person per acre. The combination of such a low density and the need for either pumping of sewage into the Columbus service area or construction of deeply laid sewers precludes further consideration of this subarea as a portion of a regional plan.

(4) Grove City

The Grove City subarea is bounded on the south by the Franklin-Pickaway County line, on the east by the Scioto River, on the north by areas presently served by the City of Columbus sewer system, and on the west by the Darby Creek subarea. Relatively heavy development has taken place in and around both Grove City itself and the Village of Urbancrest. These two municipalities have a present total estimated population of 19,000, a value which is expected to increase to 20,900 by 1985 and to 26,200 by the year 2000. Recently, wastewater flows from Grove City and Urbancrest have been diverted to the Southerly-Jackson Pike interconnecting sewer, making further regionalization considerations academic.

Rural areas predominate south of Grove City, and consist of approximately 16,100 acres with expected 1985 and 2000 populations of 6,100 and 12,300 respectively. Due to this sparse population, the rural areas of this subunit will not be considered further for regionalization.

(5) Minerva Park

The Minerva Park subarea consists of 750 acres located in the north-central portion of Franklin County. Sewer service is presently provided by the Southerly WWTP for the areas to the north, south, and west of Minerva Park, with the 72-inch Alum Creek Interceptor bounding the eastern side. Wastewater from the area is presently collected and conveyed to the Minerva Park WWTP, which discharges to Minerva Lake Creek. The existing plant is a 0.17 mgd extended aeration facility which serves a contributory population of approximately 1,500 people. Projected populations for the total subarea are 3,400 by 1985 and 3,500 by the year 2000.

(6) Sunbury-Galena

The 45,000 acre Sunbury-Galena subarea is located in Delaware and Licking Counties. It is bounded on the north by an imaginary line just north of Sunbury, on the east by the Hoover Reservoir watershed divide, on the south by a line just above the Duncan Run drainage area, and on the west by a line one to two miles west of Hoover Reservoir.

Homes in the area primarily use septic tanks and leachfields for sewage disposal. The exception to this is the Village of Sunbury, which is sewered and uses a treatment facility which discharges to a tributary of Big Walnut Creek. Proposals to study sewerage alternatives in a facilities plan for the area have been submitted. The lead entity in this endeavor is the Village of Sunbury, with the Village of Galena and Delaware County also participating.

The facilities plan will consider the possibility of regionalization into the Columbus system as one alternative for Sunbury-Galena. If regionalization is deemed best, flow from the area would be treated at the Columbus Southerly facility.

(7) Big Walnut Creek

The 24,300 acre Big Walnut Creek subarea is located in northeastern Franklin County and southeast Delaware County. It includes all the drainage to Big Walnut Creek from Duncan Run south to the existing 84-inch interceptor at State Route 161.

Projected populations for this area are 14,100 by 1985 and 21,300 by the year 2000. The portion of the subarea located in Delaware County is to be included in the facilities planning activities discussed for Sunbury-Galena. This area was also included in the Columbus Facilities Plan and was, therefore, retained for review in this Environmental Impact Statement. Due to the physical layout of this and the following two subareas (Rocky Fork and Blacklick Creek), a regionalization decision made for one must be implemented in all three.

(8) Rocky Fork

The Rocky Fork subarea consists of some 11,400 acres, all of which is tributary to Rocky Fork. The Big Walnut Creek and Blacklick Creek units form the boundaries to the northeast and west, respectively. The Rocky Fork subarea presently has 4,300 people, and is expected to grow to 9,100 by 1985 and 17,800 by the year 2000. The largest centers of population are the Villages of Gahanna and New Albany (which is presently unsewered).

(9) Blacklick Creek

This subarea consists of 32,700 acres of the Blacklick Creek drainage basin, and extends from the Creek's headwaters to the existing 96-inch interceptor at Brice Road. Portions of both Franklin and Licking Counties are included.

The estimated present population of the area is 27,700. The population is projected to be 30,300 by 1985, and 41,900 by the year 2000. The heaviest population concentration is found in Reynoldsburg, which had a 1970 total of about 13,900 people. The City of Reynoldsburg operates a contact stabilization wastewater treatment plant with a 2.25 mgd design capacity. Present operation of this facility reportedly requires occasional bypassing of untreated sewage directly to Blacklick Creek.

(10) Groveport

The 5,000 acre Groveport subarea consists of the Village of Groveport and surrounding unincorporated areas. In 1970, Groveport had approximately 2,500 people. Most of the present population contributes wastewater to a 0.30 mgd trickling filter facility. The Franklin County Commissioners currently own and operate the treatment plant for the Village of Groveport. The plant and sewer system will be turned over to the Village when the bonds are retired in the near future. The discharge from this plant is to Little Walnut Creek. An expanded sewer system could collect flows from the entire area and transport them by gravity into the existing 96-inch Blacklick Creek and 108-inch Big Walnut Creek Interceptors; a total service option which is not possible with the location of the present treatment plant.

(11) Rickenbacker Air Force Base

The Rickenbacker Air Force Base consists of some 4,200 acres. The Base is currently being served by a 1.25 mgd trickling filter which discharges to Walnut Creek. In 1970, there were approximately 5,600 persons at the Base. This population is expected to decrease to 4,100 by 1985, and remain at that level for the remainder of the planning period. The possibility exists that the treatment facility may be abandoned in the future and the flow diverted to the Columbus system.

3.1.4 Summary

The following subareas were chosen from those discussed above as suitable for possible inclusion in a regionalized system:

- West Scioto
- Big Run
- Minerva Park
- Big Walnut
- Rocky Fork
- Blacklick Creek
- Groveport
- Rickenbacker Air Force Base

Selection of a final total regional area from among these subareas is dependent upon the cost-effectiveness of the inclusion of each, as analyzed and discussed in the following section.

3.2 ALTERNATIVE COMPARISON

This section will contain a description of alternatives within each planning subarea and a discussion of the primary impacts and costs associated with each. Ultimately, a final recommended plan is selected and described. (Secondary impacts are discussed for each subarea in Chapter VII.)

3.2.1 General

The Brookside Estates area, which was considered in the Columbus Facilities Plan, will not be evaluated in this Impact Statement, since its construction has been approved and completed. Construction consisted of the installation of a 30-inch sewer that connects to the Olentangy Interceptor Sewer a few hundred feet north of State Route 161. This plan was that recommended by the Brookside Estates Mini-Facilities Plan.

The East Scioto area presently has under construction a 42-inch extension of the existing 42-inch East Scioto Interceptor from Case to Martin Roads parallel to Riverside Drive. At the present time, this interceptor is approximately 95 percent complete. This system will serve the east side of the Scioto River as well as the portion of the City of Dublin which is located on the western side of the River. Service to the western side is provided by a completed pump station and force main crossing the River on the south side of Route 161. Servicing of the western side is to continue until another means of disposal is provided or the eastern side grows in population and requires the extra capacity of the East Scioto Sewer extension for its sanitary flow. Since the sewer construction is almost complete, the East Scioto area will not be considered further in this Environmental Impact Statement.

Sewers for the areas to be regionalized were designed in the Facilities Plan based on ultimate population. Guidelines proposed since the preparation of the Facilities Plan have recommended the use of year 2000 populations for sewer design. Accordingly, the sewer sizes developed in the following sections have used the slopes and peaking factors listed in the Facilities Plan (with a 0.013 Manning's n) in conjunction with year 2000 population projections. Sewers specified are assumed to flow at or near half capacity at the end of the planning period. Size and cost sensitivities to designs predicated on ultimate populations, half capacity at year 2000, and full capacity at year 2000 are provided in a later section of this chapter.

The quantity of dry weather sewage flow was calculated to be approximately 90 gpcd. This flow was developed after analyzing the Infiltration/Inflow data available for the City of Columbus[1].

The overall gaged infiltration from 19 existing service areas discussed in the I/I report can be expressed in two ways: 3,580 gallons per inch-diameter mile per day, or 173 gallons per capita per day. For ease of design computation, an allowance for infiltration expressed in gallons per capita is desirable. Using 200 gallons per inch-diameter mile as an allowable infiltration number which can be achieved in new sewers, and assuming the ratio of 3,580 gallons per inch-diameter mile to 173 gallons per capita to hold true (20:1), a value of 10 gallons per capita per day results for infiltration into newly constructed sewers.

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(1) "Infiltration/Inflow Analysis, Columbus Metropolitan Area Facilities Plan" by Malcolm Pirnie, Inc., 1975.

Having established a total estimate of 100 gallons per capita per day (gpcd) for infiltration and sanitary flow, the total design flow was calculated using the following equation:

$$\text{Design Flow} = P_{2000} \times 100 \text{ gpcd} \times \text{P.F.}$$

P_{2000} = Population in the year 2000

P.F. = Columbus Peaking Factor

The flow calculated by this equation was then divided by 0.51, a factor which will provide the capacity for a sewer which will flow half full in the year 2000[1]. The relationship of average daily flow to the peaking factors selected for use in the equation is shown in Figure III-2[2]

Interceptor costs used in the following sections were based on recent bids for sewer construction in the Columbus area. Capital costs for lateral sewers and house connections are not included in Alternative comparisons, since Federal funding for their construction will not be available except in scattered cases meeting the requirements of Appendix G[3]. Other capital costs for items such as pump stations and treatment plants were estimated based on past experience with the structures under consideration. Operation and maintenance (O&M) expenses were computed using actual current plant costs and estimates of costs that will be incurred through the year 2000. Annual O&M costs for interceptors were assumed to be equal to 0.25 percent of the initial construction cost. Any computations involving interest used an annual rate of 6-3/8% over the period starting in 1980 and ending in the year 2000. Service lives of interceptors and wastewater treatment plants were assumed to be 50 and 35 years, respectively.

A study of the New Albany area, which presently experiences water quality problems due to overutilization of septic tanks, provided a basis for establishing a threshold for maximum population densities allowable before interceptor construction should be considered. New Albany currently has an estimated population of 600 contained in an area of 400 acres. Thus, it was assumed that when other areas with soil

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(1) Appendix F provides design tables for each alternative investigated.

(2) Taken from "Cost-Effective Analysis, Vol. One", Malcolm Pirnie, Inc., 1975.

(3) PRM 77-8, "Funding of Sewage Collection System Projects", U.S. EPA, June, 1977.

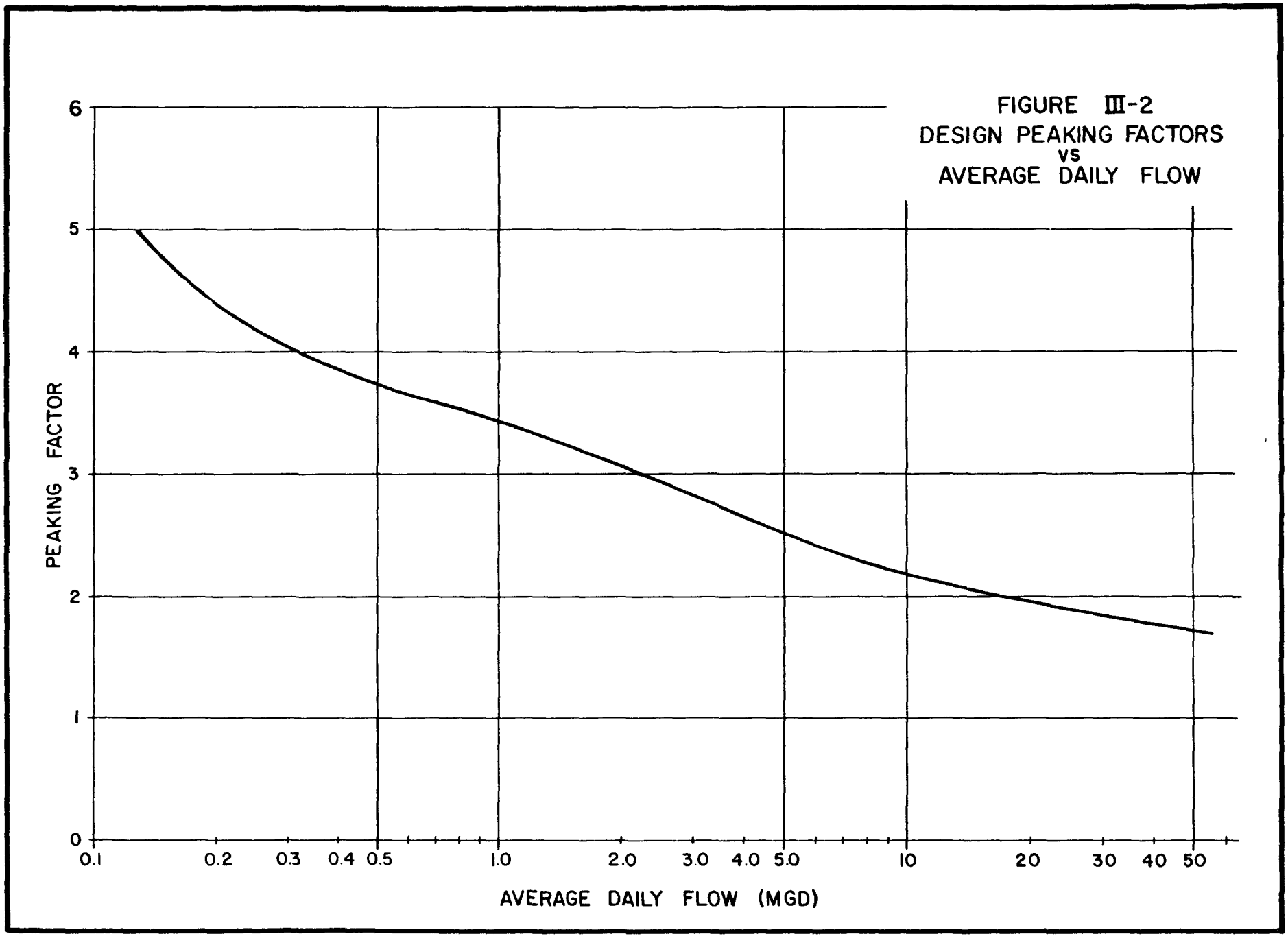
FIGURE III-2
DESIGN PEAKING FACTORS
vs
AVERAGE DAILY FLOW
PEAKING FACTOR
6
5
4
3
2
1
0
0.1
0.2
0.3
0.4
0.5
1.0
2.0
3.0
4.0
5.0
10
20
30
40
50
AVERAGE DAILY FLOW (MGD)

suitabilities for septic tank usage similar to those in New Albany reach a density of 1.5-2.0 people per acre, the provision of centralized sewage treatment or interception systems should be examined in light of the pollution problems encountered. This density criterion was used throughout the planning area, as the great majority of soil associations present are considered to be marginally suitable, at best, for heavy septic tank and leachfield usage.

3.2.2 West Scioto

The West Scioto subarea will contribute flow to the Jackson Pike Wastewater Treatment Plant if tied into the Columbus sewerage system. For the most part, this area is presently unsewered. The exceptions are the Dublin and Muirfield Village areas to the north which presently have sewers and plan to tie-in temporarily to the interceptor being constructed along the east side of the Scioto. The present population of the total area is estimated to be 13,500 people, and is expected to increase to 31,800 people by 1985 and to 42,600 by the year 2000.

(1) Alternative Description

There are two gravity sewer alternatives under consideration for servicing this area, as shown in Figures III-3 and III-4[1]. The first, known as the Low Level Alternative, consists of an interceptor that travels along the edge of Griggs Reservoir from the existing 72-inch stub of the Scioto Interceptor to Indian Run Creek near the Village of Dublin. The interceptor is 33,300 feet long, and ranges from 36 to 48 inches in diameter.

The second, or High Level Alternative, connects the same two points as the Low Level option. It differs from the Low Level Alternative north of Tudor Ditch. At this point, the interceptor crosses over open and residential areas to the intersection of Dublin and Schirtzinger Roads. From this intersection northward, the interceptor follows Dublin Road to Rings Road. After traveling west on Rings Road for about one-quarter of a mile, the route turns north through more open land until finally reaching Indian Run Creek. The length of the interceptor in the High Level Alternative is 33,800 feet, with a diameter that varies from 36 to 48 inches.

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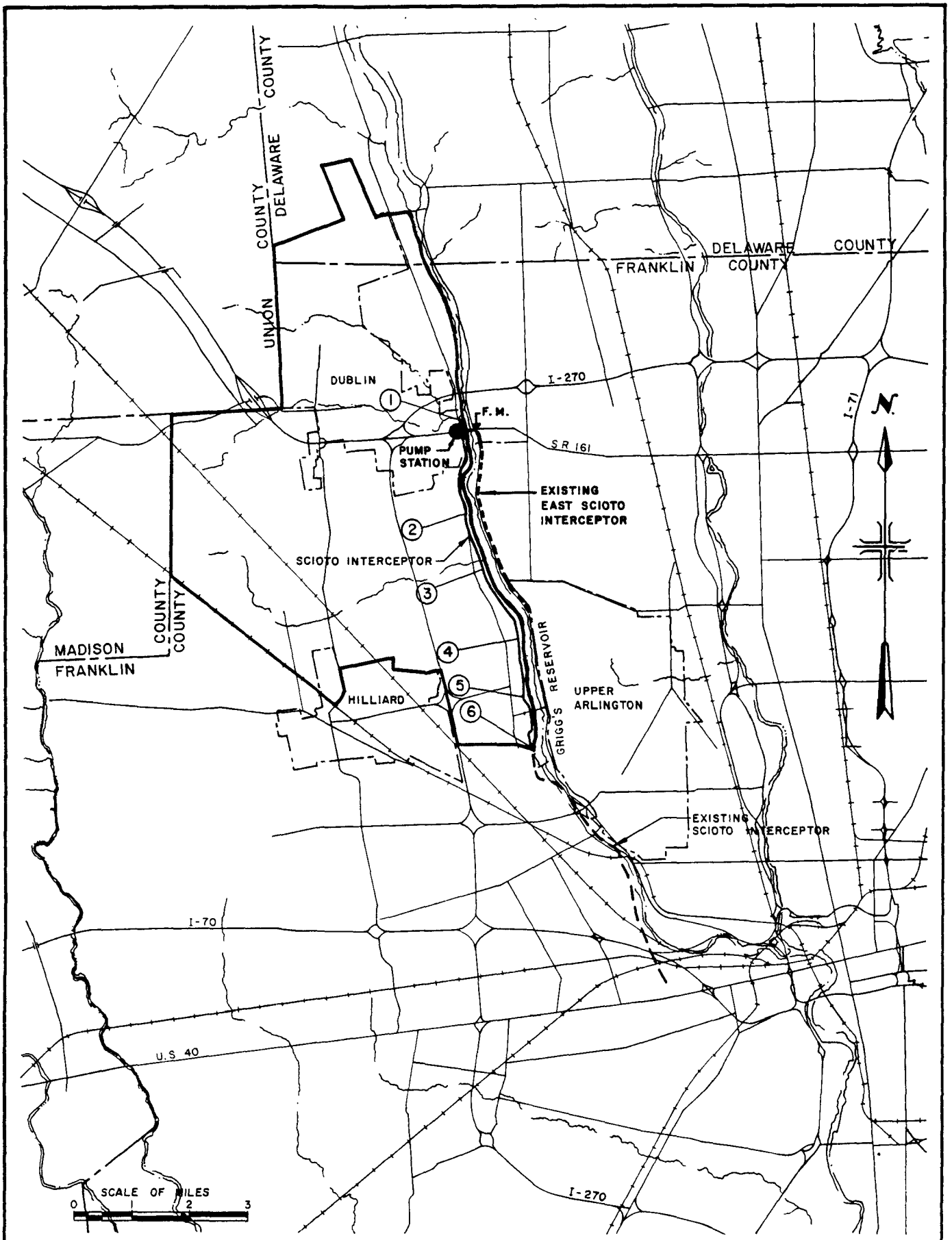
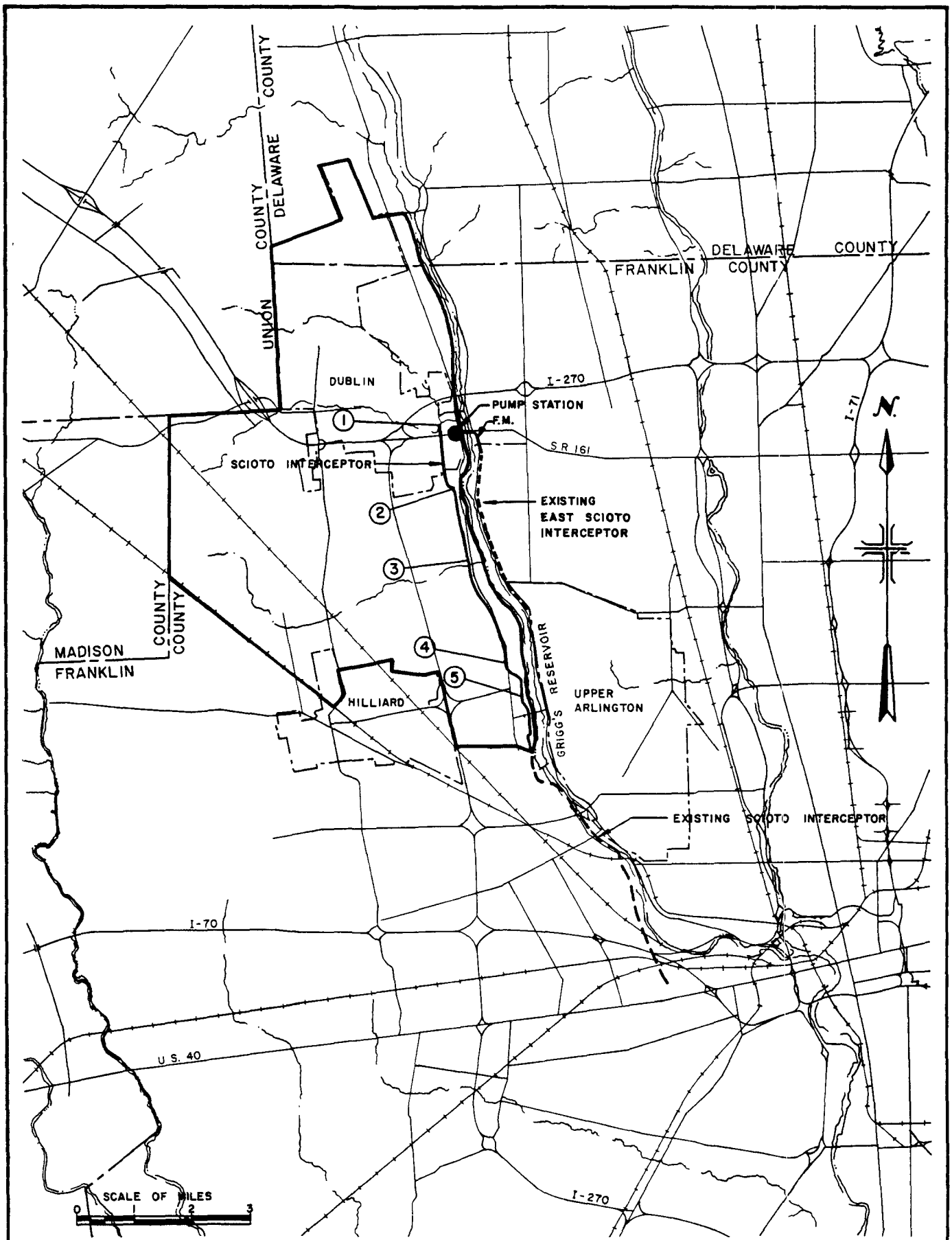
[1] Figures depicting the routes for all subareas which were considered in the Columbus Facilities Plan prepared by Malcolm Pirnie, Inc. have been reproduced for this Environmental Impact Statement with only minor changes.



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	SCIOTO RIVER SERVICE AREA LOW LEVEL ALTERNATE	FIGURE III-3

DEFIANCE



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	SCIOTO RIVER SERVICE AREA HIGH LEVEL ALTERNATE	FIGURE III-4

A No Action Alternative was not considered viable, since increasing pollutant loads upon the area's Crosby-Brookston and Milton-Ritchey-Miamian soil associations through continued use of septic tank and leach field systems could result in contamination of Griggs Reservoir, which is presently used as a potable water supply.

(2) Primary Impacts

Short-term primary impacts of the Low Level Alternative would largely be due to the erosion caused by the close proximity of interceptor construction to Griggs Reservoir and the crossing of ten streams or ditches. Levels of suspended solids and turbidity can be expected to temporarily increase in these watercourses. The Low Level Alternative also traverses 22,700 feet of steep slopes and 1,600 feet of the James Thomas Park. Because of the type of land use close to the Reservoir, this Alternative also traverses 21,900 feet of wooded area.

The long-term effects of the Low Level Alternative are associated with the purchase of easements through private yards and the removal of large trees. Most of the interceptor route is within a flood plain, and is frequently across stream and ditch outlets. These conditions will require raised manholes along with 5,400 feet of aerial sewer, creating a permanently adverse aesthetic appearance.

The High Level Alternative, which calls for 16,500 feet of sewer along Dublin Road, would create a short-term adverse impact by disruption of traffic. Dublin Road is used by commuters going to and from the City of Columbus, and presently has two schools and several churches and residential areas located along it. Another short-term adverse impact is involved in the construction of the proposed interceptor through 6,400 feet of steep slopes with 12 stream and ditch crossings. This alternative route also crosses the same 1,600 feet of the James Thomas Park as that in the Low Level Alternative.

The main long-term impact resulting from the High Level Alternative is the 1,300 feet of interceptor which must be aerial and will create an adverse impact upon the aesthetics of the area.

Both alternatives have local short-term adverse impacts due to construction, such as noise, air quality, and temporary aesthetic degradation. Both alternatives have the beneficial impact of the elimination of most septic tank systems which could possibly contaminate ground water if continued and increased usage was permitted. The High Level Alternative would require most of the homes on the east side of Dublin Road to tie into the interceptor by pumping, with some continuing to use individual septic tank systems. The Low Level Alternative would collect all sewage flow from this area.

(3) Phasing

Figure III-5 shows population densities for the West Scioto subarea for both High and Low Level Alternatives. All interceptor sections below Manhole 3 should be built by 1980 due to both the densities indicated in the Figure and the need to protect Griggs Reservoir from possible contamination. Between Manholes 2 and 3, the density is low, indicating no immediate need for construction. The City of Dublin lies above Manhole 2, and currently pumps sewage over Griggs Reservoir into the East Scioto Interceptor.

(4) Costs

Phasing considerations point toward the cost-effectiveness on a present worth basis of constructing a permanent pump station and parallel 12-inch force main across Griggs Reservoir, since the interceptor sections above Manhole 3 will not be required until after the planning period.

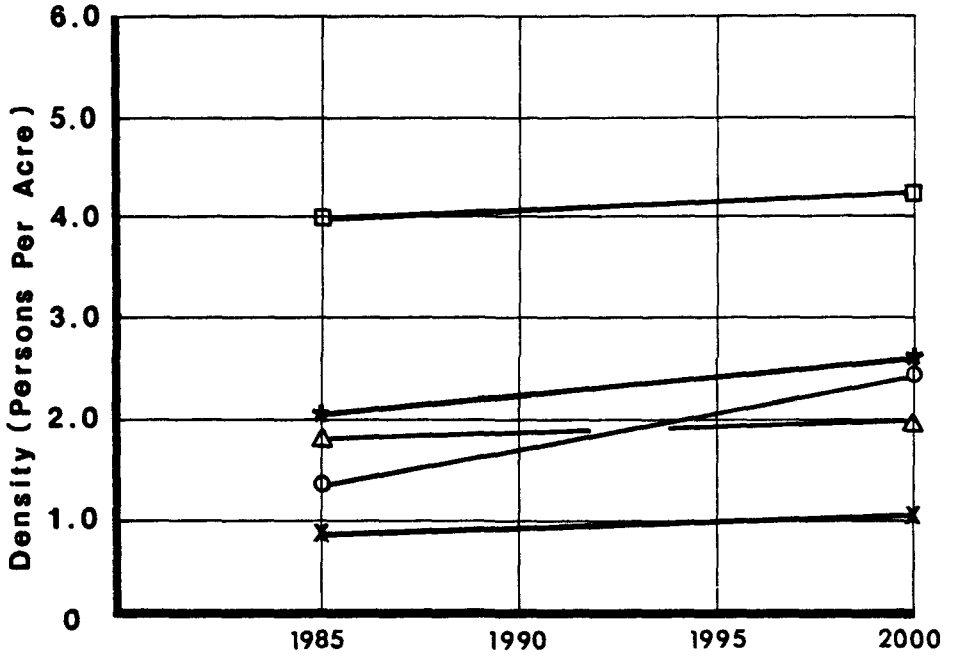
The capital cost of the pumping station and additional force main is about $413,000, with an equivalent annual O&M cost of $28,800. This cost is common to both alternatives. The remaining capital cost of the Low Level ($2,825,000) is associated with the gravity interceptor. The capital cost of the High Level Alternative serving the same area is only $2,206,000. On a present worth basis (including salvage), the Low Level Alternative amounts to $3,227,000, a value some 20% above the $2,697,000 attributable to the High Level Alternative.

(5) Summary

A summary of West Scioto data and cost results is provided in Table III-1.

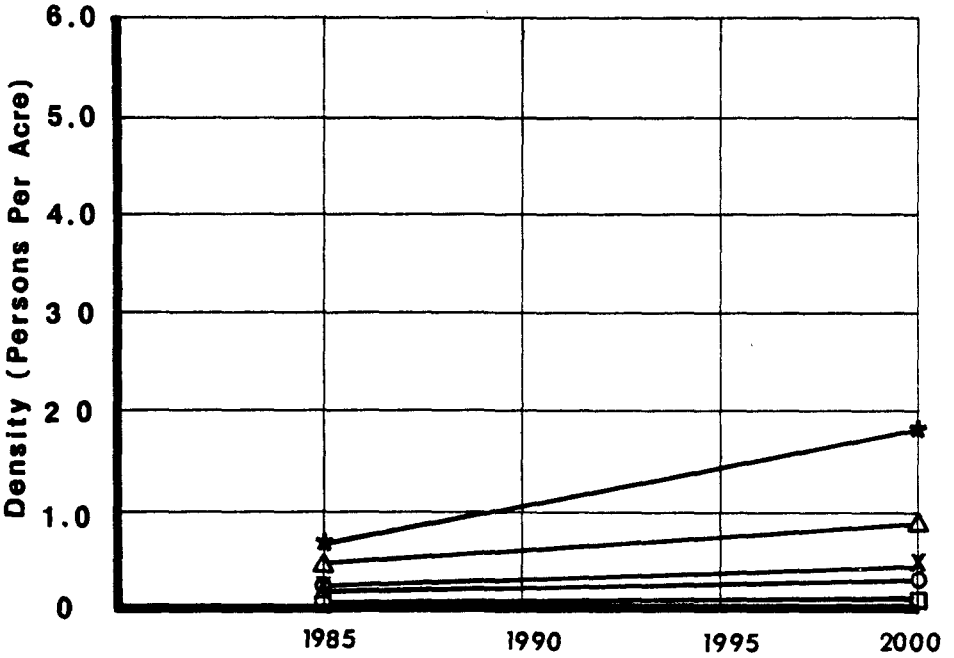
FIGURE III-5

DENSITY TRENDS FOR THE
WEST SCIOTO AND BIG RUN SUBAREAS



Manholes Beginning to #2	Code
#2 to #3	x
#3 to #4	△
#4 to #5	★
#5 to #6	□

SCIOTO RIVER INTERCEPTOR
(HIGH & LOW LEVEL ALTERNATIVE)



Manholes Beginning to #2	Code
#2 to #3	x
#3 to #4	△
#4 to #5	★
#5 to #6	□

BIG RUN INTERCEPTOR

Table III-1
Alternative Summary for the West Scioto Subarea

Item	Alternatives	
	Low Level	High Level
Length of Sewers (feet)	33,300	33,800
Type of Land Traversed (feet)		
Woodland	21,900	12,200
Open Space (rural)	100	4,600
Stream Corridor	6,400	4,100
Steep Slopes	22,600	6,400
Parks and Recreation	1,600	1,600
Reservoir Shoreline	26,900	6,400
Residential	3,700	4,300
Highway Right-of-Way	3,000	16,500
Stream Crossings	10	12
Highway Crossings	4	24
Costs (Thousands of Dollars)		
Capital (1980)	$ 3,238	$ 2,619
Capital (2000)	1,550	1,421
Annual O&M (1980-2000)	(1)	(2)
Present Worth	$ 3,227	$ 2,697

(1) O&M varies from $24,200 in 1980 to $55,100 in the year 2000.

(2) O&M varies from $22,600 in 1980 to $53,500 in the year 2000. Does not include O&M for pumpage of flows from homes unable to reach the interceptor by gravity.

The costs and primary impacts for the West Scioto area regionalization favor the High Level Alternative. Because of the large difference in costs and the less serious nature of the associated primary impacts, the High Level Alternative is the selected plan for the West Scioto area.

The Environmental Impact Statement for the Delaware County area[1] presented a plan which called for the upper reaches of the Scioto River basin within Delaware County to contribute flow to the City of Columbus' sewer system, a plan which would increase the year 2000 population projections by about 15,000 people. To allow for this option without the need to parallel interceptors and undergo dual construction impacts, a larger interceptor than that proposed for the High Level Alternative would be required. The increased sizes and costs for this modification are compared to the original alternative in Table III-2.

Table III-2
Proposed Modification to the High Level Alternative for the West Scioto Subarea

Length of Sewer (feet)	Original Size	Modified Size
7,100	36"	42"
6,600	36"	42"
9,800	36"	42"
3,900	36"	42"
6,400	48"	48"
Pumping Station (Peaked Flow)	4.5 mgd	9.0 mgd
Cost (Thousands of Dollars)		
Capital (1980)	$2,619	$2,981
O&M (2000)	1,421(1)	2,173(2)
Present Worth	2,697	3,139

(1) O&M varies from $22,600 to $53,500 in 1980 to 2000.
(2) O&M varies from $38,200 to $100,000 in 1980 to 2000.

(1) "Final Environmental Impact Statement, Olentangy Environmental Control Center and Interceptor System," for the Delaware County, Ohio Board of Commissioners, Prepared by U.S. EPA, Region V, July 1976.

Thus, for an 18 percent ($446,000) increase in present worth cost, the option of serving the Scioto River area within Delaware County can be maintained while still allowing the construction of the downstream portion of the interceptor to be completed by 1980. It would seem that this option is a reasonable one and should be implemented in any final regionalization plan. An annual equivalent cost of $21 per person per year would result for this plan using the present population, a figure which reduces to $7 per person per year for the year 2000 population.

3.2.3 Big Run

The 12,900 acre Big Run subarea is located in western Franklin County, and is comprised of the Hellbranch Run drainage basin upstream of U.S. Route 40. The flow from this area will be transported to the Jackson Pike WWTP if connection is made to the City of Columbus' sewer system. The present population is estimated at 1,500, and is expected to increase to 4,600 by 1985 and 10,400 by the year 2000.

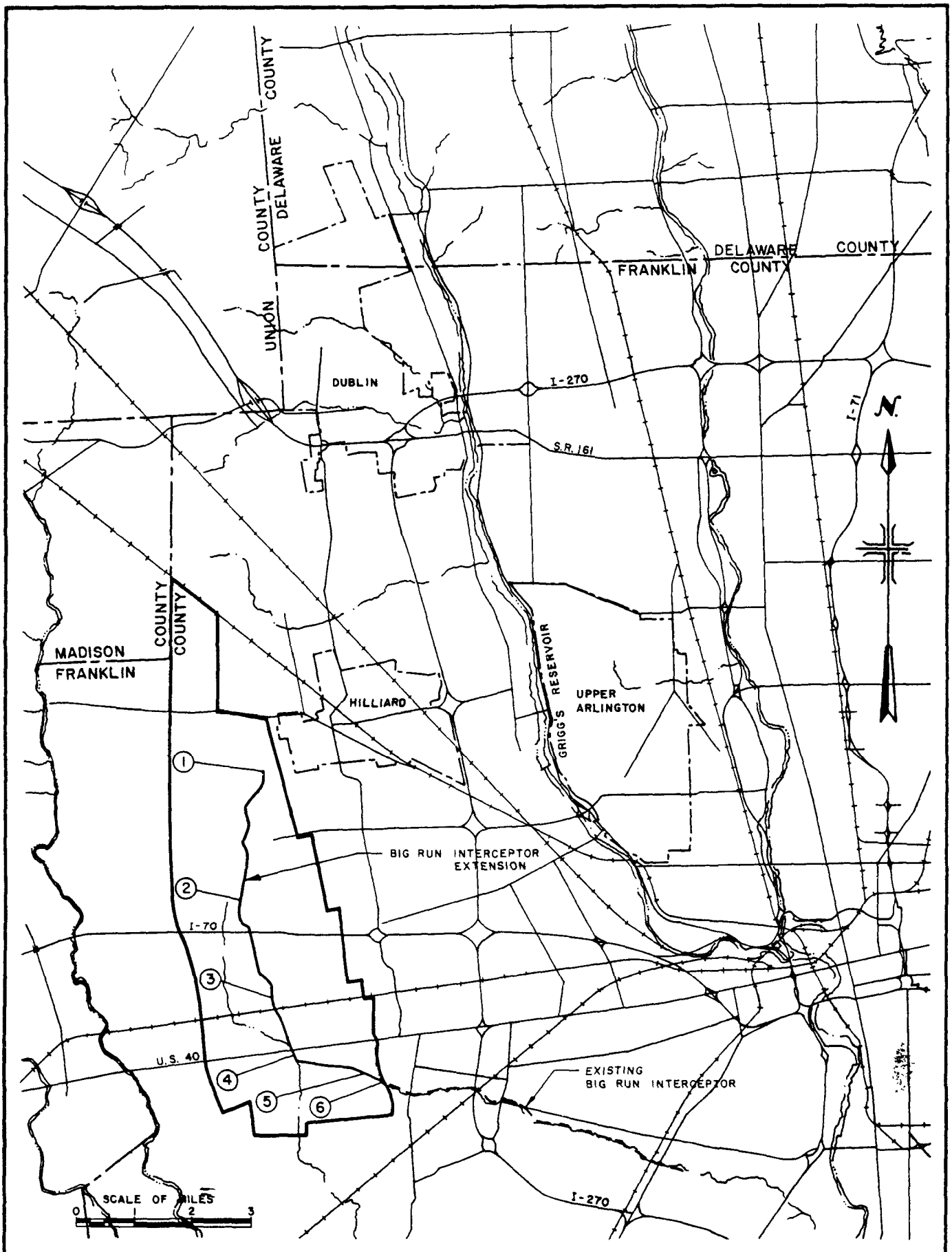
(1) Alternative Description

The general soil association within the region is the Crosby-Brookston-Lewisburg. This association is characterized by a high seasonal groundwater table and low permeability. These conditions prohibit heavy use of septic tank systems, indicating that as population increases, sewer service should be provided. The type of soil present does not permit a viable No Action Alternative.

Alternative A calls for areawide regionalization. As shown on Figure III-6, this system requires 33,000 feet of interceptor construction along Hamilton Ditch, starting approximately one mile north of the Roberts Road crossing and ending with a connection to the existing 54-inch Big Run Interceptor at Galloway Road. The proposed interceptor would vary in diameter from 18 to 27 inches. This is the only regionalization alternative deemed viable for this area.

(2) Primary Impacts

The alignment of the interceptor will result in two stream crossings and five highway crossings. The type of land which will be affected is mainly open or grassland. Adverse short-term impacts may result due to the close proximity of the interceptor route to Big



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	BIG RUN INTERCEPTOR	FIGURE III-6

DEFIANCE

Run for some 25,000 feet. Short-term impacts resulting from noise, air pollution, and aesthetics are not judged to be severe due to the open space and grasslands which will generally separate construction activities from heavily populated areas.

(3) Phasing

The population density increases shown on Figure III-5 for the Big Run area illustrate that most of the interceptor sections should not be built during the planning period. The exception to this is the section between manholes 4 and 5, which may be needed by 1995.

(4) Costs

The capital cost of Alternative A is $2,200,000, with an associated annual O&M cost of $2,500 (between 1995 and 2000). These values, along with salvage and phasing considerations, represent a present worth of only $140,000.

(5) Summary

Table III-3 provides a summary of Alternative data and costs for the Big Run subarea.

Table III-3
Alternative Summary for the Big Run Subarea[1]

Item	
Length of Sewers (feet)	33,000
Type of Land Traversed (feet)	
Open Space (rural)	33,000
Stream Corridor	25,000
Residential	0
Stream Crossings	2
Highway Crossings	5
Costs (Thousands of Dollars)[1]	
Capital (1995)	$ 1,008
(2000)	$ 1,192
Annual O&M (1995-2000)	3
Present Worth	$ 140

(1) Does not include the individual treatment unit costs necessary under a phased construction plan.

Population projections point toward a fairly heavy growth in areas surrounding Interstate 70 close to the City of Columbus. A more detailed analysis of this area suggests that sewer service may be needed by 1985. Therefore, a modification to the Big Run alternative proposed in the Facilities Plan is recommended.

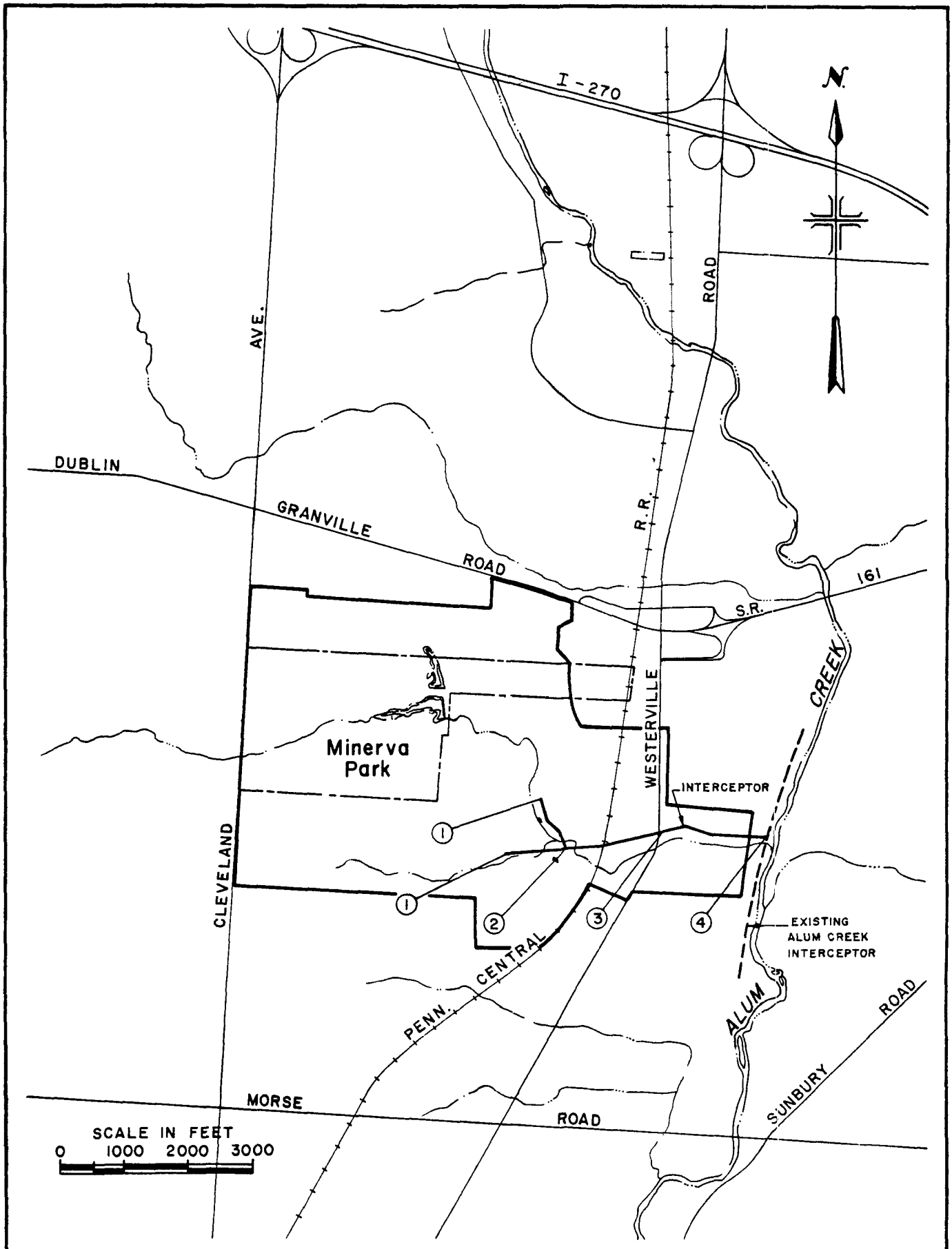
This modification entails providing sewer service to a 1,350 acre area with a population projected to be 4,100 by the year 2000. This area can be served by two trunk sewers tying into tne existing Columbus system, one along Feder Road and one along Renner Road, in order to serve areas south and north of I-70, respectively. The primary impacts of these trunk sewers are minor, since they travel along highway right-of-ways or through open farmland and lightly residential areas. The total capital cost for the construction of 7,200 feet of 18-inch diameter sewer along Renner Road and 7,900 feet of 15-inch diameter sewer along Feder Road is about $770,000. It should be noted that these sewers can only serve the two areas described, and cannot be extended, using a gravity system, any further west within the Big Run subarea. This modification results in an annual cost of $17 per person per year, for the year 2000 populations. Figure III-6 has included the routes of these proposed extensions.

3.2.4 Minerva Park

The Minerva Park subarea is located in the north-central portion of Franklin County. Wastewater treatment is presently provided by the Columbus Southerly WWTP for the areas to the north, south, and west of Minerva Park. The Alum Creek Interceptor forms the eastern boundary. Minerva Park's present wastewater treatment plant, which discharges to Minerva Lake Creek, is a 0.17 mgd extended aeration facility. The present estimated population is 1,500 people. The projected populations for this area by the years 1985 and 2000 are 3,400 and 3,500, respectively.

(1) Alternative Description

Two alternatives were considered for serving the Minerva Park subarea. The Interceptor Alternative shown in Figure III-7 is one in which an interceptor would be constructed from the Minerva Park WWTP in an easterly direction to a point on the 72-inch portion of the existing Alum Creek Interceptor. The flow would



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	MINERVA PARK INTERCEPTOR ALTERNATE	FIGURE III-7

DEFIANCE

be treated at the Southerly WWTP. The proposed interceptor will be about 3,900 feet long, and will vary from 12 to 15 inches in diameter. An extension will continue upstream of Minerva Lake Creek with approximately 900 feet of 12-inch sewer. A 20-foot permanent right-of-way has been purchased and the design of the interceptor has been completed as per the recommendations of the Facilities Plan. Plans have progressed to such an extent that a portion of the interceptor crossing Westerville Road has already been installed as part of a highway reconstruction project.

The second, or Plant Alternative, proposes expansion and improvement of the existing treatment plant. By the year 2000, a 0.6 mgd plant will be necessary. Required additions will be built adjacent to the old plant on land presently used for farming. Effluent requirements for a 0.6 mgd plant at this location will probably be quite stringent. Costs summarized at the end of this section have assumed design release levels of 8 mg/l BOD_5, 8 mg/l SS, 1.0 mg/l ammonia nitrogen (summer), and a minimum of 5.0 mg/l of dissolved oxygen at all times. Due to the large population increase projected by 1985, the plant should be built by 1980 with full capacity installed for the wastewater flow in the year 2000.

It has been reported that the effluent from the WWTP adds nutrients to and depletes oxygen from the relatively small flow in Minerva Lake Creek. It was estimated that the present flow from the WWTP is about one-third of the creek's dry weather flow. These existing conditions do not permit consideration of a No Action Alternative.

(2) Primary Impacts

The short-term impacts due to construction of the Interceptor Alternative would be the degradation of surface water quality from increases in turbidity due to construction activities along 4,200 feet of stream banks and at three stream crossings. Aquatic biology would be hampered by the increase in turbidity and by the area destruction caused by work activities in or near the stream. Woody vegetation is sparse along the proposed route, thereby minimizing the effect of any removal required. The interceptor mainly traverses

open fields and farmland, with no structures occurring along the proposed route. This situation will reduce adverse noise, aesthetic, and air quality impacts. Traffic disruption and public inconvenience is expected to be minimal, since no houses occur along the route and only one road, which already has a portion of the interceptor constructed beneath it, would be crossed. A short section of proposed interceptor will pass beneath railroad tracks. The 900-foot branch in the Interceptor Alternative requires some 350 feet of construction through steep slopes, a situation which will cause adverse short-term impacts.

Long-term beneficial impacts will mainly be found in the improvement of water quality in the Minerva Lake Creek due to the elimination of the Minerva Creek Plant. The elimination of the plant will have further beneficial impacts by improving local aesthetics, decreasing manpower costs, energy commitment, and land requirements.

Long-term adverse impacts resulting from retention of the treatment plant are the commitment of more manpower, energy, and land due to the needed expansion by 1980. The retention of the WWTP close to growing residential communities could increase impacts from odor, noise, and aesthetics.

No park, recreational area, historic, or archeologic sites are known to lie along or within the proposed locations of either alternative.

(3) Phasing

Phasing through the use of projected densities was not necessary for this subarea since the combination of the large population growth expected by 1985 and the probable stringent permit release levels for a WWTP in the area dictate interceptor or treatment plant construction by 1980.

(4) Costs

The capital cost for the Interceptor Alternative is $380,000, with an associated annual operation and maintenance cost of $1,000. For a true comparison, the O&M should include the cost of treating the 0.6 mgd from the Minerva Park area at the Columbus Southerly

plant. When this consideration is included, (along with salvage value) a total present worth for the Interceptor Alternative of $542,000 is derived.

The capital cost for the Plant Alternative (excluding land costs) is estimated to be $2,070,000. The costs for operation and maintenance of the proposed 0.6 mgd plant are estimated as approximately $400/mg. Total present worth of the Plant Alternative is then $2,325,000, assuming construction takes place by 1980.

(5) Summary

A tabular summary of data and costs for Minerva Park is provided in Table III-4. The selected plan for this subarea is the Interceptor Alternative. This selection was made primarily to minimize the longterm impacts associated with operating and maintaining a local treatment plant and because of the large difference in capital and O&M costs between the Plant and Interceptor Alternatives. Construction impacts of the Interceptor Alternative may be somewhat severe, but they will be short-term and will occur only once. A cost of $32 per person per year results using present population, whereas using the year 2000 population results in a cost of $14 per person per year for the Interceptor Alternative.

3.2.5 Big Walnut Creek, Rocky Fork, Blacklick Creek

The three individual subareas (Big Walnut Creek, Rocky Fork, Blacklick Creek) that are described in the following sections must be taken as a single unit in any alternative analysis. Three possible regionalization systems, designated as A, B and C, were proposed in the Columbus Facilities Plan. These will be reviewed in the following paragraphs along with another alternative (D) which proposes only partial regionalization of the three subareas during the planning period. Ultimately, the total service option proposed in Alternative A will be implemented for Alternative D. Figures III-8 through 12 shows the routes of the five alternatives investigated.

(1) Alternative Description

1. Big Walnut Creek

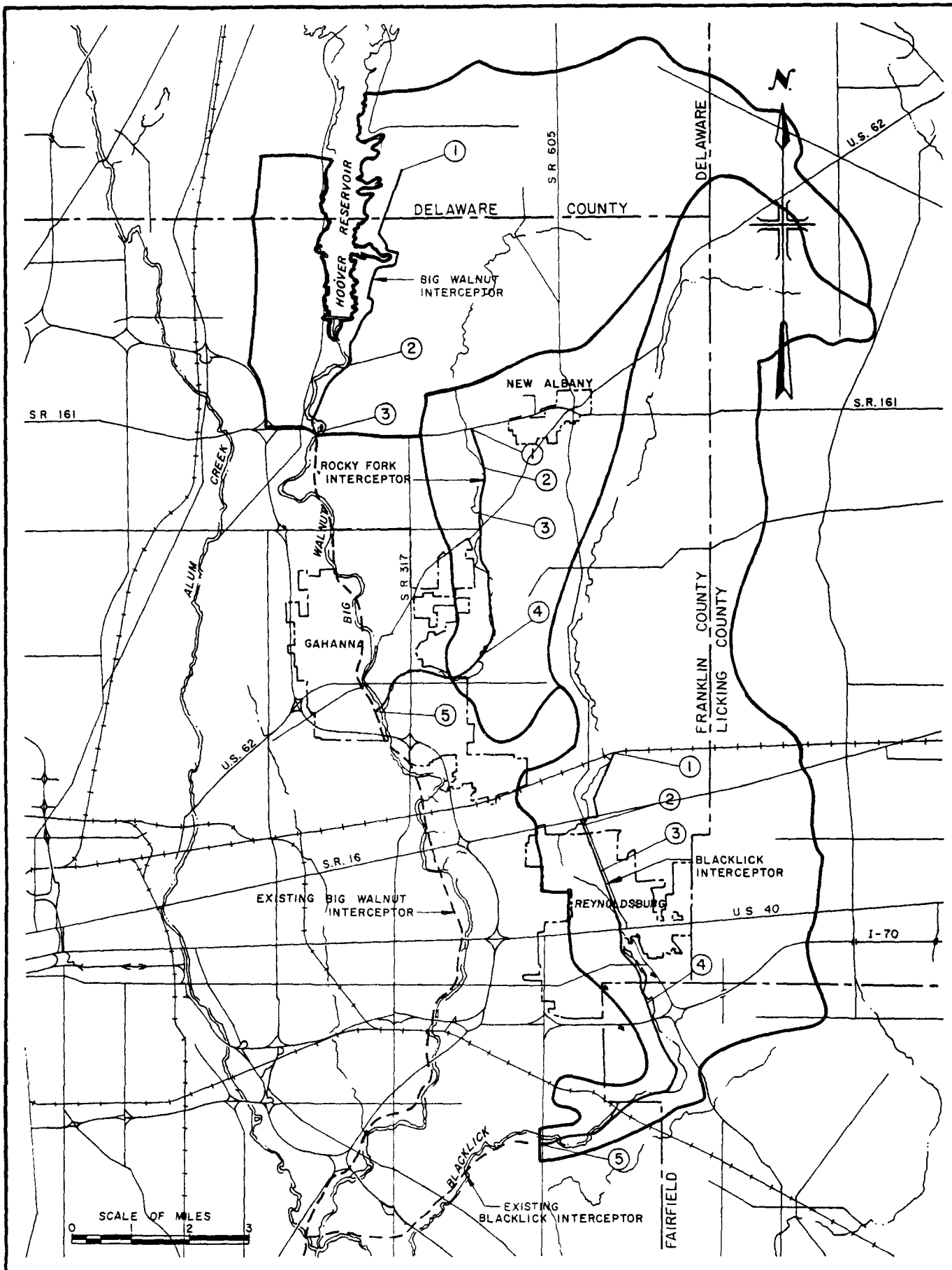
The Big Walnut Creek subarea is located in northeastern Franklin County and southeastern Delaware County. This area presently has an estimated population of 6,000. The population is expected to increase to almost 14,100 by 1985 and

Table III-4
Alternative Summary for Minerva Park Subarea

Item	Alternatives	
	Interceptor	Plant
Length of Sewers (feet)	4,800	0
Type of Land Traversed (feet)		
Woodland	1,500	0
Open Space (rural)	3,300	0
Stream Corridor	4,200	0
Steep Slopes	350	0
Agricultural	0	5 acres
Stream Crossings	3	0
Highway Crossings	Already Constructed	
Costs (Thousands of Dollars)		
Capital (1980)	$ 380	$ 2,070
Annual O&M	(1)	(2)
Present Worth	$ 542	$ 2,325

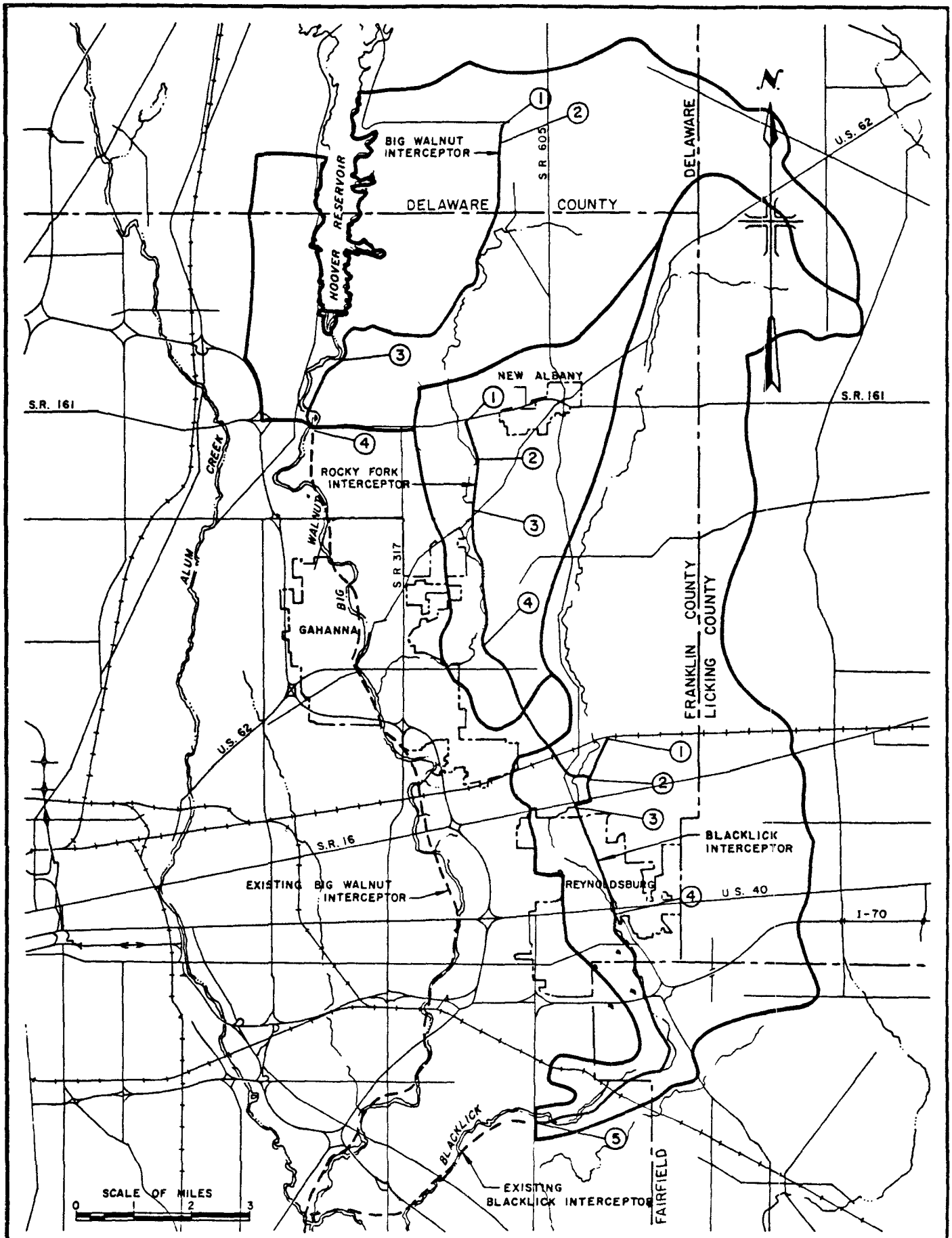
(1) O&M varies from $24,300/year in 1980 to $32,300/year in 2000.

(2) O&M varies from $32,300/year in 1980 to $51,100/year in 2000.



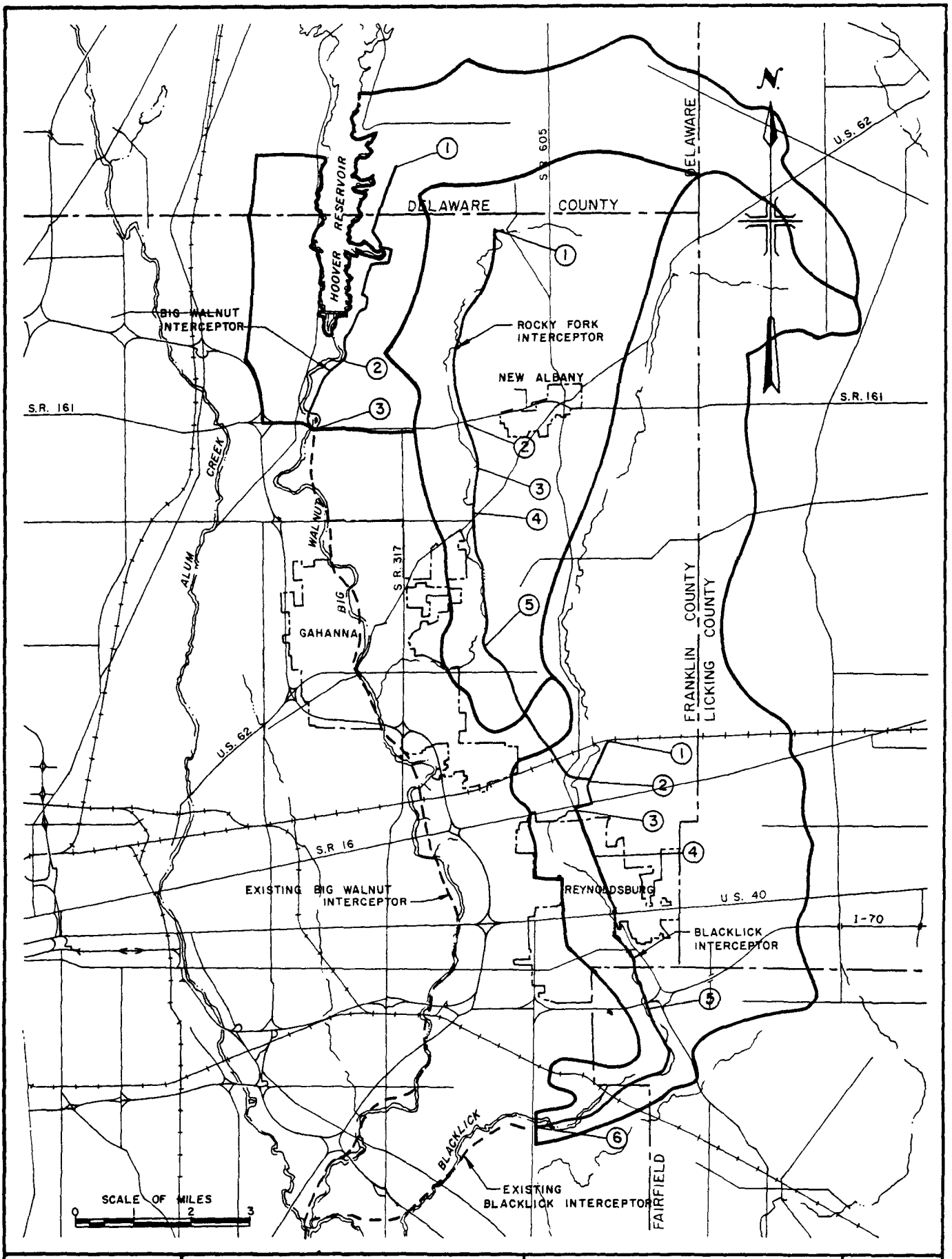
MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	BIG WALNUT CREEK SERVICE AREA ALTERNATE A	FIGURE III-8

DEFIANCE

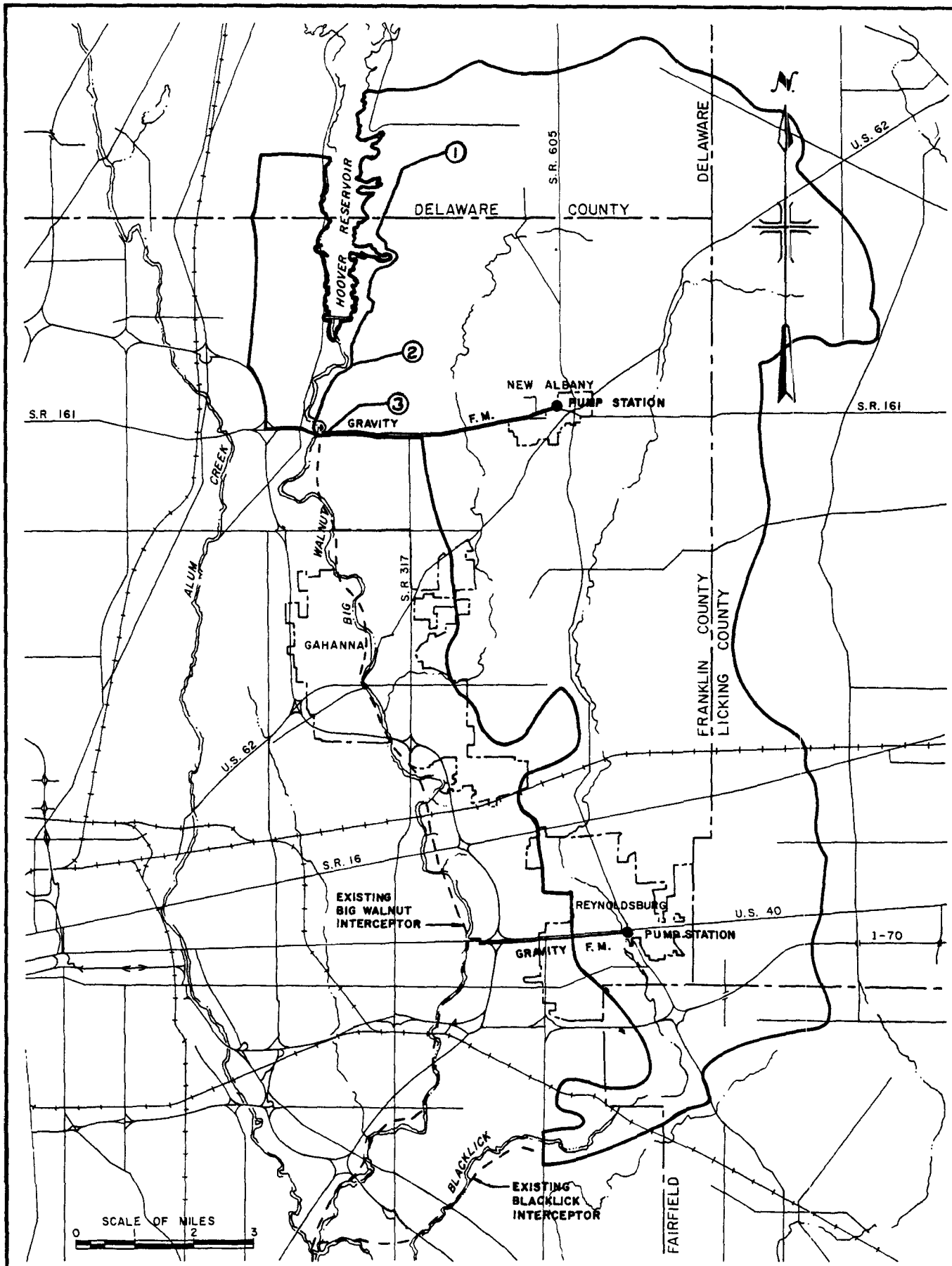


MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	BIG WALNUT CREEK SERVICE AREA ALTERNATE B	FIGURE III-9

DEFIANCE



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	BIG WALNUT CREEK SERVICE AREA ALTERNATE C	FIGURE III-10



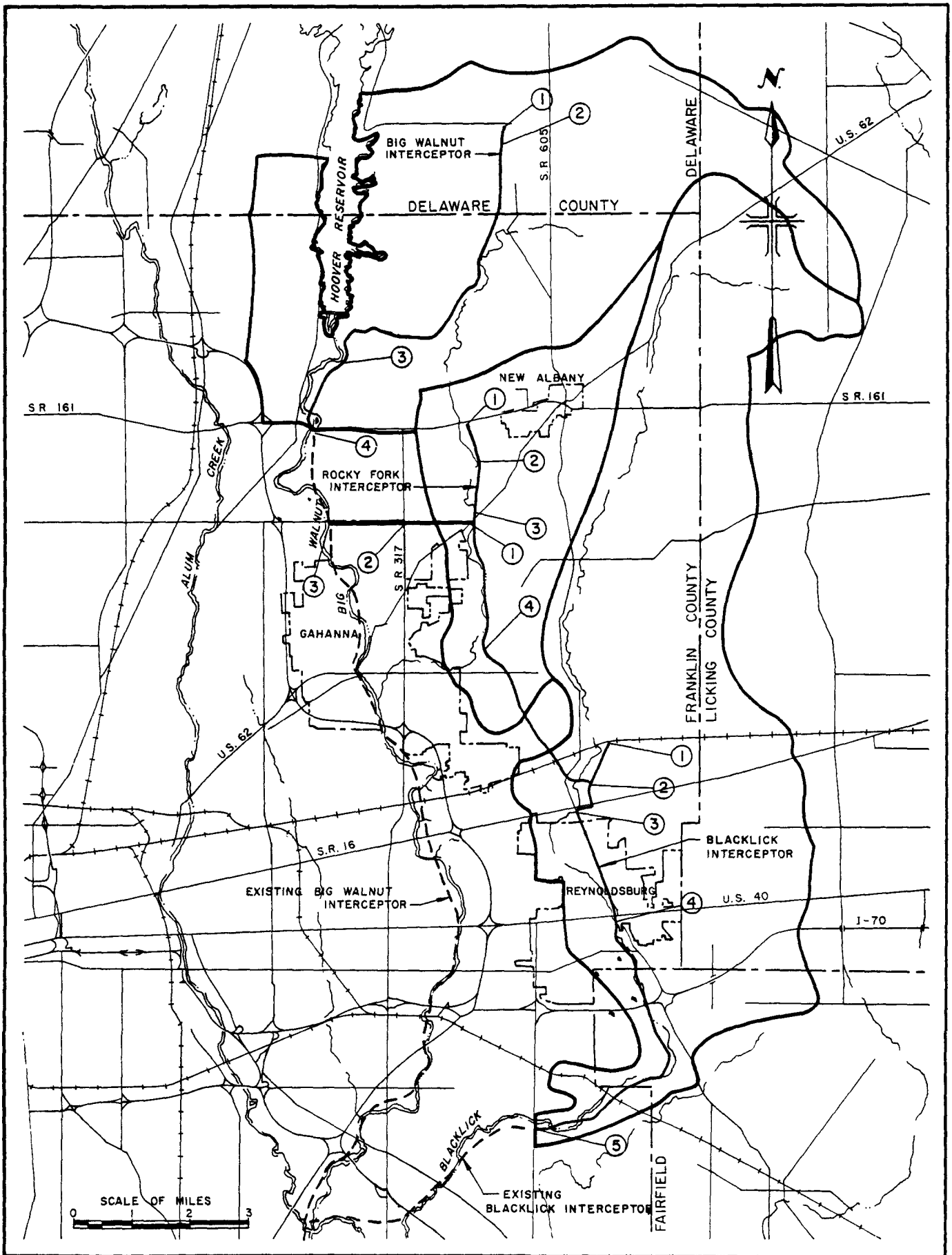
MALCOLM PIRNIE, INC.

COLUMBUS METROPOLITAN AREA FACILITIES PLAN

BIG WALNUT CREEK SERVICE AREA ALTERNATE D

FIGURE III-11

DEFIANCE



MALCOLM PIRNIE, INC.	COLUMBUS METROPOLITAN AREA FACILITIES PLAN	BIG WALNUT CREEK SERVICE AREA ALTERNATE SUB B	FIGURE III-12

DEFIANCE

21,300 by the year 2000. If regionalized into the Columbus sewerage system, flow from this subarea will be treated at the Southerly WWTP.

One of the major concerns within the Walnut Creek area is the protection of Hoover Reservoir, which is used as a potable water supply. If population growth is as predicted, heavy use of septic tanks and leachfields will occur if sewers are not provided. The local soils are mainly of the Bennington-Pewamo Association, and are unacceptable for septic tank systems.

Alternatives "A" and "D" would ultimately involve the construction of a 36 inch interceptor over 28,000 feet. The proposed interceptor route parallels the eastern edge of Hoover Reservoir and Walnut Creek. Service would be instituted from the existing 84-inch interceptor at State Route 161 northward to the Lake of the Woods area.

Alternative B envisions an interceptor which begins at Duncan Run and follows Rocky Fork to Central College Road. The interceptor route then runs westward to Walnut Creek where it turns to the south to ultimately connect to an existing 84-inch interceptor, which transports the flow to the Southerly WWTP. The proposed interceptor varies in size from 18 to 36 inches over a length of 40,000 feet.

Alternative C will involve the construction of an interceptor which is the same length and follows the same route as that in Alternative A but which would serve a smaller area. Due to this decrease in service area, the diameter of the proposed interceptor is reduced, and will vary from 30 to 36 inches. In this Alternative, some of the subarea will be served by an extended Rocky Fork Interceptor, as discussed in the next section.

2. Rocky Fork

The Rocky Fork subarea is located in the northeastern portion of Franklin County, encompassing some 11,400 acres. It is presently

unsewered. The present population for this subarea is about 4,300 people, and is expected to increase to 9,100 by 1985 and to 17,800 by the year 2000.

At the present time, the surface waters in and around the Village of New Albany are reported to become heavily polluted during low flows. Specifically, Rose Run, Sugar Run, and Rocky Fork are heavily impacted by point and nonpoint releases from individual septic tanks and leachfields. This situation again eliminates consideration of a No Action Alternative.

Alternative A consists of an interceptor running parallel to Rocky Fork for some 33,700 feet. The diameter of this proposed interceptor varies from 24 to 36 inches. Service will be provided to the Rocky Fork drainage area from just south of Granville Road to the Village of Gahanna, which presently is included in the City of Columbus' sewer system. The proposed Rocky Fork Interceptor will tie into the existing 84-inch Walnut Creek Interceptor near the confluence of Walnut Creek and Rocky Fork.

Alternative B consists of an interceptor which varies in diameter from 24 to 36 inches as it traverses some 36,800 feet along Rocky Fork to a point just north of Havens Corners Road. The route then turns southeast running across country until reaching the proposed 36-inch Blacklick Creek Interceptor. The point of connection to the Blacklick Creek Interceptor is approximately one-quarter mile south of the intersection of Taylor and Reynoldsburg-New Albany Roads.

Alternative C for the Rocky Fork subarea consists of an interceptor 46,100 feet long which varies in diameter from 18 to 36 inches. This proposed interceptor would begin near the Rocky Fork, approximately one-quarter mile south of the Franklin-Delaware County line. The route would parallel Rocky Fork on the eastern side until reaching the same location north of Havens Corners Road proposed in Alternative B. The Alternative B route is followed from this point on to the proposed 36-inch Blacklick Creek Interceptor.

Alternative D utilizes 8,000 feet of parallel 8-inch force-mains and 10,500 feet of 18-inch gravity sewer parallel to State Route 161. This sewerage system is designed to only collect flows from the New Albany area and transport them to the existing Big Walnut Creek Interceptor. The remainder of the Rocky Fork area will not be included in a regional system until at least 1990.

3. Blacklick Creek

The proposed Blacklick Creek Interceptor will extend 47,700 feet from just south of the Penn Central Railroad Bridge crossing of Blacklick Creek to Brice Road, where it will connect to an existing 96-inch interceptor. This length and route are the same for all alternatives. The only difference between alternatives is in the proposed pipe size due to the varying wastewater flows intercepted from the areas to the north of the Blacklick Creek subarea. The Blacklick Creek Interceptor route in all but Alternative D includes approximately 4,600 feet of spur line which will continue upstream along Blacklick Creek. Service will be provided by this spur line to a relatively small area on the east side of the Creek.

Alternative D calls for 11,100 feet of 24-inch gravity sewer and 5,700 feet of parallel 16-inch force mains. This system is designed to collect the sanitary flow from the Reynoldsburg area and transport it to the existing Big Walnut Creek Interceptor by way of Lancaster Street and U. S. Route 40. The remainder of the Blacklick Creek area is to be served by individual treatment units. Interceptor construction will ultimately be necessary at a time beyond the planning period.

The present population within the subarea is estimated at 27,700. This is projected to increase to 30,300 by 1985 and 41,900 by the year 2000. The major center of population is the city of Reynoldsburg, which is presently served by an overloaded contact stabilization treatment facility. Since expansion of this plant is site-limited and its continued operation unattractive economically[1], all alternatives considered have included Reynoldsburg's flow in the Blacklick Creek Interceptor.

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[1] Blacklick Creek Area Mini-Facilities Plan, Columbus Metropolitan Area Facilities Plan by Malcolm Pirnie, Inc. Page 46.

Table III-5 lists the different interceptor lengths and sizes for each alternative for the Big Walnut, Rocky Fork and Blacklick Creek subareas. Also provided in this Table is the proposed construction date for each system.

The lower section of the Big Walnut Creek interceptor will be required by 1980, since most of the future growth is projected to occur in this area. The remaining section or sections for all the Big Walnut Creek alternatives will be constructed up to twenty years later.

Due to the need for providing sewer service to the New Albany area, all Alternatives call for the construction of the major sections of the Rocky Fork Interceptor by 1980. The 18-inch line proposed in the Facilities Plan for Alternative C was found to not be required during the planning period. Populations in the lower portion of the subarea are not projected to increase rapidly, and early construction of an interceptor may cause secondary growth impacts. Therefore, a cost comparison is presented in Table III-6 (as Subalternative B) to determine whether an interceptor should be built through this area by 1980 or if service to the upper portion of the subarea should be provided by means of a 12-inch force main. The force main would be constructed from the proposed interceptor westward along Morse Road to an existing 15-inch sewer. The pump station and force main would be constructed immediately, and would remain in service until the capacity of the existing 15-inch sewer is reached. At such a time (assumed to be 1985 in this analysis), the remaining 28,300 feet of 36-inch interceptor will be constructed.

(2) Primary Impacts

1. Big Walnut Creek

The Big Walnut Creek subarea will suffer the same environmental impacts with Alternative A, C, or D. The short-term primary impacts are traffic disruption and the effects of construction in residential areas. The proposed route will traverse several thousand feet of steep slopes and wooded areas which may cause both short- and long-term adverse impacts. Due to construction near

Table III-5
Interceptor Lengths and Sizes for the Big Walnut Creek, Rocky Fork, and Blacklick Creek Subareas

Subarea	Length (feet)	Size (inches)	Construction Date (Year)
Alternative A			
Big Walnut Creek			
	19,000	36	2000
	9,000	36	1985
	28,000		
Rocky Fork			
	3,500	24	1980
	5,000	27	1980
	25,200	36	1980
	33,700		
Blacklick Creek			
	7,700	21	2000
	5,000	27	2000
	35,000	36	1980
	47,700		
Alternative B			
Big Walnut Creek			
	3,000	18	2000
	30,000	27	2000
	7,000	36	1985
	40,000		
Rocky Fork			
	3,500	24	1980
	5,000	27	1980
	28,300	36	1980
	36,800		
Blacklick Creek			
	4,600	18	2000
	3,100	30	1980
	11,000	36	1980
	29,000	42	1980
	47,700		
Subalternative B[1]			
Rocky Fork			
	3,500	24	1980
	5,000	27	1980
	6,200	12 F.M.	1980
	28,300	36	1985
	43,000		

Table III-5 - Continued
Interceptor Lengths and Sizes for the Big Walnut Creek, Rocky Fork and Blacklick Creek Subareas

Subarea	Length (feet)	Size (inches)	Construction Date (Year)
Alternative C			
Big Walnut Creek			
	19,000	30	2000
	9,000	36	1985
	28,000		
Rocky Fork			
	19,300	18	2000
	8,500	27	1980
	28,300	36	1980
	56,100		
Blacklick Creek			
	4,600	18	2000
	3,100	30	1980
	5,000	36	1980
	16,000	42	1980
	19,000	42	1980
	47,700		
Alternative D			
Big Walnut Creek			
	19,000	36	2000
	9,000	36	1985
	28,000		
Rocky Fork			
	8,000	8 FM[2]	1980
	10,500	18	1980
	3,500	24	1995
	5,000	27	1995
	25,200	36	1995
	52,200		
Blacklick Creek			
	5,700	16 FM[2]	1980
	11,100	24	1980
	7,700	21	2000
	5,000	27	2000
	35,000	36	2000
	64,500		

(1) These values replace those in Alternative B for Rocky Fork
F.M. = Force Main

(2) Two Parallel Lines.

streams and Hoover Reservoir, including three major stream crossings, temporarily severe erosion and siltation of these waters may result. Another long-term adverse aesthetic impact of these alternatives will be caused by the need for approximately 500 feet of aerial sewer in order to cross a ravine south of the Lake of the Woods area.

Alternative B for Big Walnut retains the lower portion of the interceptor proposed in Alternatives A and C. This 7,000 foot length includes the steep slopes and wooded area mentioned above. Above this portion, the interceptor route is along Central College Road, parallel to the western side of Rocky Fork. This area is mainly open grassy or cultivated land, with most wooded areas occurring within 20 to 50 feet of the stream.

The long-term benefit derived in all alternatives will be the protection of surface and ground water quality from degradation caused by continued use of inadequate individual and centralized wastewater treatment systems.

2. Rocky Fork

Short-term impacts to the Rocky Fork subarea in Alternative A are primarily due to erosion and turbidity caused by the close proximity of construction to the stream and the several creek crossings required, including one across Walnut Creek. Destruction of trees and vegetation will occur at stream crossings, through a wooded area south of Morse Road, and in an area above Sugar Run. Most of the remaining land traversed is agricultural, with residential areas disturbed only within the City of Gahanna. Traffic disruption is expected to occur since the interceptor route crosses several roadways. A public park, which consists mostly of cleared grassland, is along the route of the Rocky Fork interceptor in Alternative A. The interceptor would also cross through a few areas near Rocky Fork which have steep slopes.

The long-term beneficial impact of all alternatives for the Rocky Fork subarea is the central collection of sewage, thereby avoiding use of individual disposal systems which release to the generally nonreceptive area soils. (The septic tank and leachfield systems presently in use around New Albany are reported to already contribute to surface water pollution.)

In Alternative B, the Rocky Fork subarea is to be served by extending the interceptor to the proposed 36-inch Blacklick Interceptor. This new section eliminates Alternative A route problems such as the crossing of Walnut Creek, most of the affected residential area, and the park. The bulk of the different construction route for Alternative B is through agrarian areas.

The primary impacts associated with the construction of the pump station and force main required for Subalternative B focus on the commitment of energy, materials, and manpower required for construction that will be phased out fairly early in the planning period. The force main will be constructed along S.R. 161, and will cause some minor traffic disruption. The construction of this 6,200 feet of 12-inch main will add two more road crossings and three more stream crossings. The main reason for acceptance of this section of the alternative is the delayed construction of some 28,300 feet of 36-inch interceptor in the southern portion of the Rocky Fork subarea.

Alternative C for the Rocky Fork area is an extension of Alternative B. The basic route is the same, but instead of ending below State Route 161, the interceptor continues northward to approximately one-quarter mile of the Franklin-Delaware County line. Primary environmental impacts will be the same as with Alternative B, with the addition of four highway crossings, two pipeline crossings, and the construction of some 19,300 feet of interceptor through open and cultivated areas.

The major primary impacts associated with Alternative D (apart from the ongoing localized impacts from construction of individual treatment

systems) are caused by construction of the 18,500 feet of sewer for the interception of the New Albany waste flow. This system is completely within highway right-of-ways near open farmland and lightly residential areas, a situation which will cause some traffic disruption. The route is through some 900 feet of wooded area and 600 feet of steep slopes, and involves three stream crossings and four highway crossings. Erosion could result from construction on the steep slopes and at the stream crossings. Final construction in 1995 will result in the same impacts as those noted for similar sections proposed in Alternative A.

3. Blacklick Creek

The primary impacts to the Blacklick Creek subarea are the same for Alternatives A, B, and C, since only the sewer size varies. A short-term impact will be brought about by interceptor construction through some parkland and wooded areas. The proposed interceptor route will cross the eastern side of Blacklick Woods Metropolitan Park, which was dedicated in April of 1973 as a State Nature Preserve. This 55 acre area is located southwest of Reynoldsburg, and should be protected from construction damage, possibly necessitating an interceptor route change. Short-term erosion and turbidity is expected to occur due to construction near streams and at seven stream crossings. Traffic disruption will occur due to the several highway crossings and construction along Reynoldsburg-New Albany Roads.

Long-term adverse impacts include those associated with the removal of some trees most of which occur within 20 to 50 feet of the streams. An aerial crossing will also be required due to a ravine in the area north of Route 16. No Historical or Archeological sites are known to exist along any of the routes chosen in any alternative.

The principal long-term beneficial impact of these three alternatives is in the improvement of water quality in Blacklick Creek which will result from the elimination of the Reynoldsburg WWTP and several other inadequate smaller treatment plants.

During the planning period, alternative D collects flow only from the Reynoldsburg area through a 16,800 foot gravity sewer and force main system. The route crosses Blacklick and Big Walnut Creeks once each along with 11 highway crossings (including U. S. Route 40 and Interstate 270). The type of land traversed is mainly residential with the exception of 1200 feet of open grassy areas which have about 200 feet of steep slopes. The route will be entirely within the highway right-of-way. Primary impacts expected are due to the short-term surface water quality degradation from construction activities beneath or near the two creeks, the possible erosion caused by construction on steep slopes, and traffic disruption, primarily on U. S. 40. Ultimately, the impacts noted for Alternative A will occur for this Alternative as well.

(3) Phasing

1. Big Walnut Creek

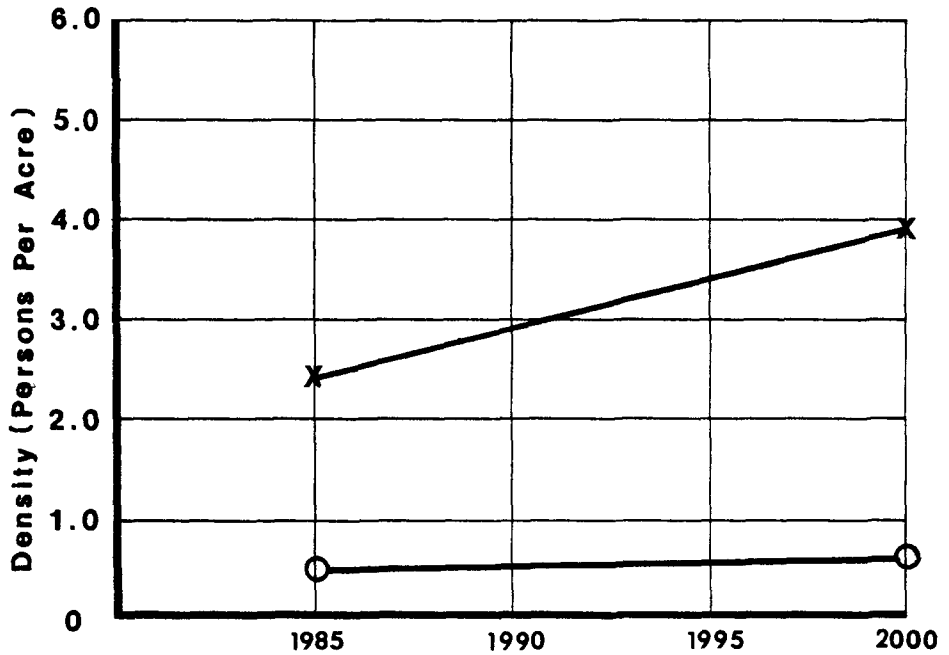
Figure III-13 illustrates the population densities for the Big Walnut Creek alternatives. In all cases, the projected population densities (apart from the section just below the Hoover Reservoir) are below 1.0 person/acre during the planning period. The section below the Reservoir may require construction by 1985 if the population growth occurs as predicted.

2. Rocky Fork

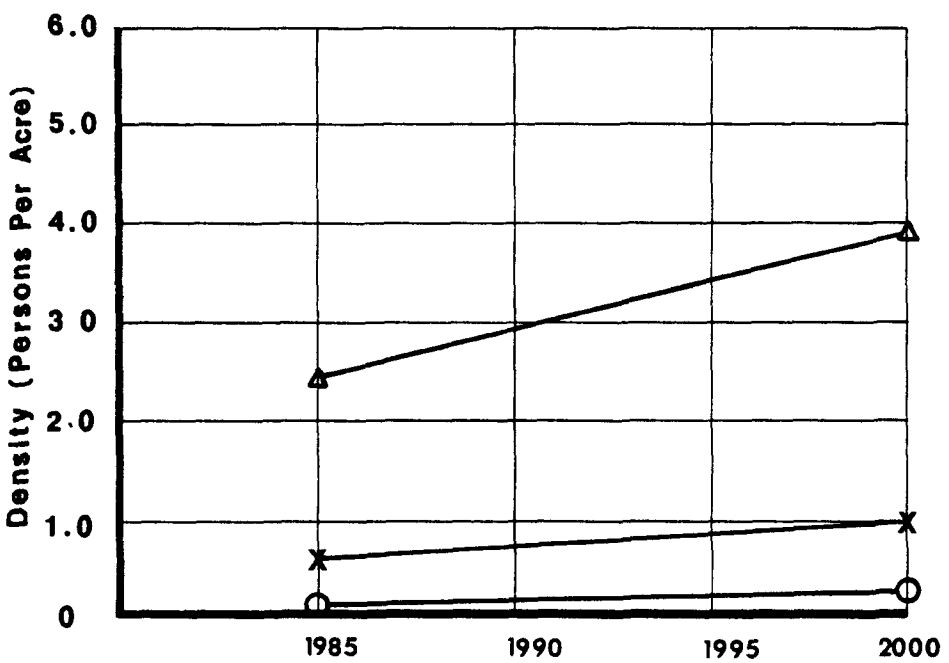
Figure III-14 indicates that no interceptors for this subarea should be constructed until 1995, with the far upstream sections of each probably not required during the planning period. However, Alternatives A, B, and C must have all sections from manhole 2 to the connection with the existing interceptor constructed by 1980 due to the immediate need of transporting sewage away from the New Albany Area. The provision of the force main in Alternative D delays the need for interceptor construction below New Albany until 1995.

FIGURE III-13

DENSITY TRENDS FOR THE
BIG WALNUT SUBAREA



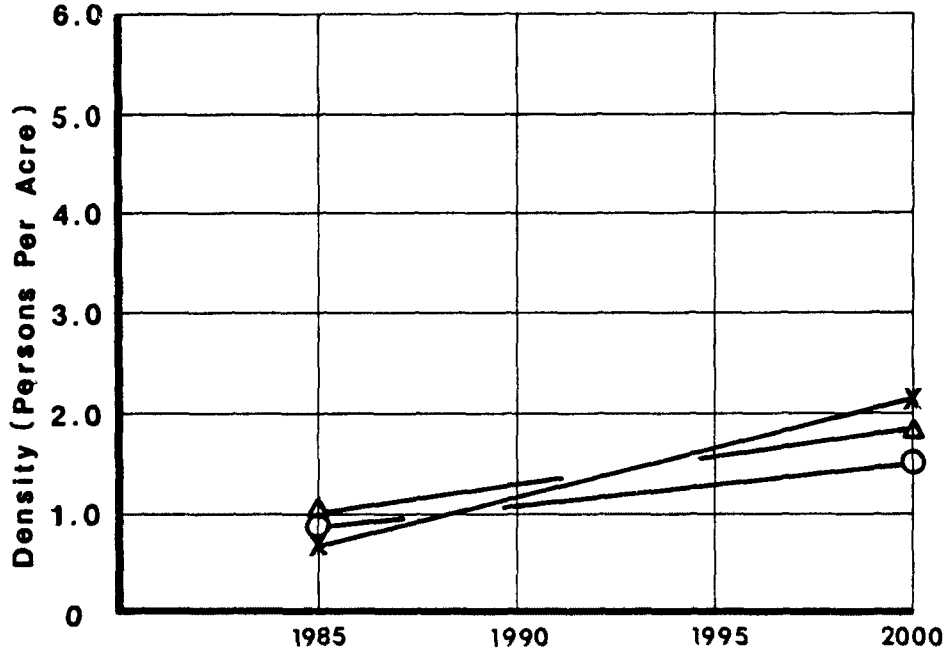
BIG WALNUT INTERCEPTOR (ALTERNATIVES A & C)



BIG WALNUT INTERCEPTOR (ALTERNATE B)

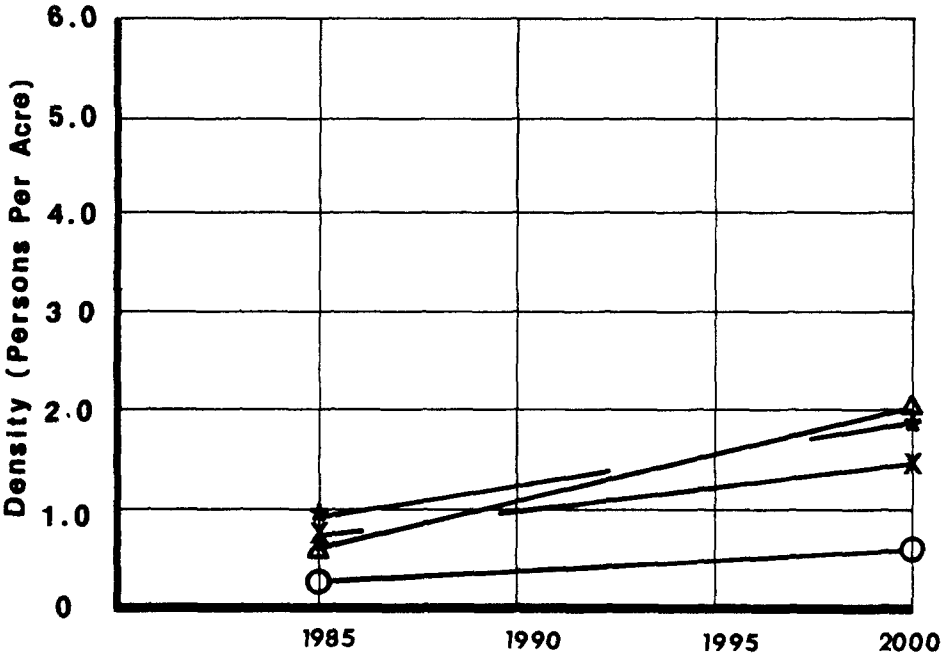
FIGURE III-14

DENSITY TRENDS FOR THE ROCKY FORK SUBAREA



Manholes	Code
Beginning to #2	O
#2 to #3	X
#3 to #4	△

ROCKY FORK INTERCEPTOR (ALTERNATIVES A & B)



Manholes	Code
Beginning to #2	O
#2 to #3	X
#3 to #4	△
#4 to #5	*

ROCKY FORK INTERCEPTOR (ALTERNATE C)

3. Blacklick Creek

Figure III-15 illustrates that the only portion of the Blacklick Creek Interceptor which must be built within the planning period is that which collects and transports the waste flow from the Reynoldsburg area to the Southerly treatment plant. Construction must take place by 1980 in all alternatives except D due to the overloaded condition of the present Reynoldsburg plant. Alternative D will provide force main service by 1980 to Reynoldsburg, with gravity construction delayed until the year 2000.

(4) Costs

The costs presented in Table III-6 show the total capital costs for each subarea alternative broken into the proper time frame.

Table III-6 shows that Alternative A, at $15,800,000, has the lowest capital cost; while Alternative Sub B has the highest, $17,830,000. The cost of the force main variation of Alternative B is higher than the nonforce main Alternative by $320,000. This is due to an increase of $170,000 for the force main construction and $150,000 for the construction of a prefabricated pumping station with an assumed life of 20 years. However, it should be noted that this cost difference is reversed on a present worth basis due to the delaying of portions of the interceptor construction.

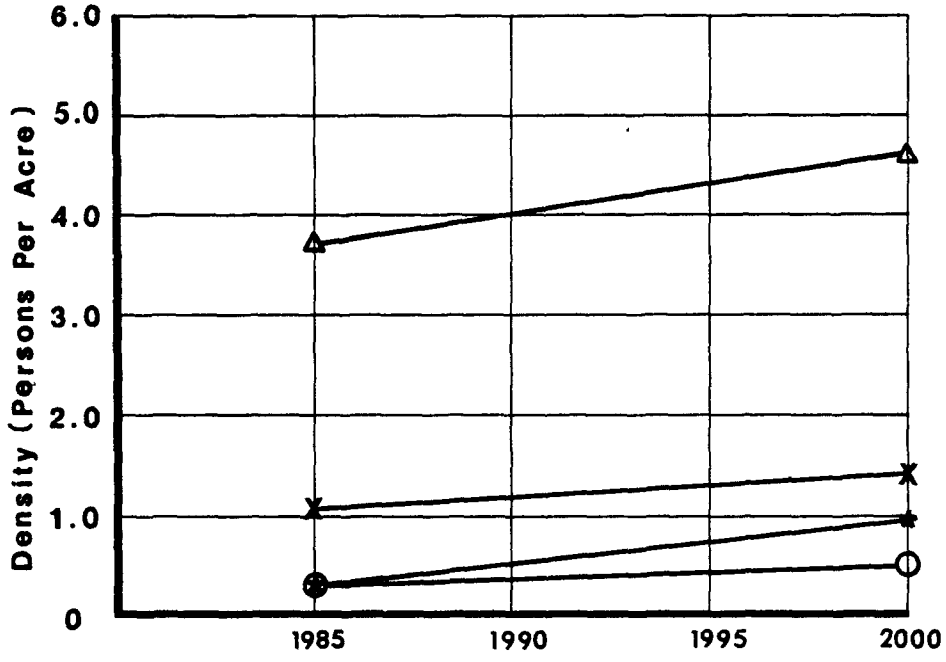
(5) Summary

Table III-7 provides a summary of each alternative in regards to primary impacts and cost.

Alternative D is the recommended plan, primarily due to its allowance for flexibility in future decision making and the low present worth costs associated with it. It should be noted that this alternative involves the most primary impacts when completely implemented. However, these drawbacks are outweighed by the ability to make flexible future decisions and by the minimizing of possible secondary impacts due to early provision of interceptors.

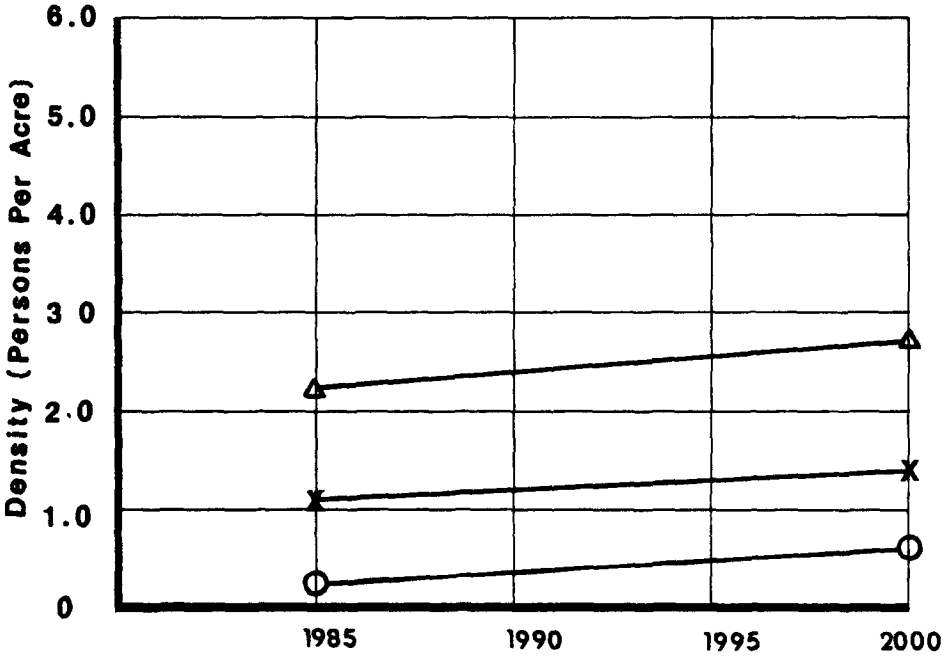
FIGURE III-15

DENSITY TRENDS FOR THE BLACKLICK SUBAREA



Manholes Beginning to	Code
#2	O
#2 to #3	X
#3 to #4	Δ
#4 to #5	*

BLACKLICK INTERCEPTOR (ALTERNATIVES A & C)



Manholes Beginning to	Code
#3	O
#3 to #4	X
#4 to #5	Δ

BLACKLICK INTERCEPTOR (ALTERNATE B)

Table III-6
Interceptor Costs for the Big Walnut Creek, Rocky Fork, and Blacklick Creek Subareas

Subarea	Construction Costs, $1,000 1980	1985	2000	Total
Alternative A				
Big Walnut Creek	$ 0	$1,720	$3,670	$5,390
Rocky Fork	3,360	0	0	3,360
Blacklick Creek	4,920	0	2,130	7,050
TOTAL	$8,280	$1,720	$5,800	$15,800
Alternative B				
Big Walnut Creek	$ 0	$1,330	$5,510	$ 6,840
Rocky Fork	4,280	0	0	4,280
Blacklick Creek	6,160	0	230	6,390
TOTAL	$10,440	$1,330	$5,740	$17,510
Subalternative B[1]				
Big Walnut Creek	$ 0	$1,330	$5,510	$ 6,840
Rocky Fork	970[1]	3,630	0	4,600
Blacklick Creek	4,720	1,440	230	6,390
TOTAL	$5,690	$6,400	$5,740	$17,830
Alternative C				
Big Walnut Creek	$ 0	$1,720	$3,960	$ 5,680
Rocky Fork	4,350	0	1,790	6,140
Blacklick Creek	5,140	0	230	5,370
TOTAL	$ 9,490	$1,720	$5,980	$17,190
Alternative D				
Big Walnut Creek	$ 0	$1,720[2]	$3,670	$ 5,390
Rocky Fork	570[1]	3,360	0	3,930
Blacklick Creek	1,020	0	7,050	8,070
TOTAL	$ 1,590	$5,080[3]	$10,720	$17,390

[1] Includes capital cost of pump station(s).

[2] Construction in 1995.

[3] Construction in 1985 and 1995.

Table III-7
Alternative Summary for the Big Walnut Creek, Rocky Fork, and Blacklick Creek Subareas

Item	Alternatives				
	A	B	Sub B	C	D
Length of Sewers (feet)	109,400	124,500	157,500	131,800	144,700
Pump Stations	0	0	1	0	2
Type of Land Traversed (feet)					
Woodland	28,000	18,900	18,900	26,000	28,900
Open Space (Rural)	54,200	70,200	76,400	83,700	72,000
Stream Corridor	34,900	30,500	30,500	35,300	34,900
Steep Slopes	9,200	5,100	5,100	8,800	10,000
Parks and Recreation	7,600	6,200	6,200	6,200	7,600
Reservoir Shoreline	10,900	0	0	10,900	10,900
Residential	8,600	7,300	7,300	8,600	25,200
Highway Row	12,500	25,100	31,000	12,500	47,800
Stream Crossings	25	26	29	27	30
Highway Crossings	35	31	33	41	50
Costs (Thousands of Dollars)					
Capital (1980)	$8,280	$10,440	$5,690	$9,490	$1,590
(1985-1995)	1,720(3)	1,330(3)	6,400(3)	1,720	5,080(4)
(2000)	5,800	5,740	5,740	5,980	10,720
Annual O & M (1980-2000)	20.7 to 25.0	26.1 to 29.4	(1)	23.7 to 28.0	(2)
Present Worth	$18,010	$9,640	$8,644	$9,043	$3,560

(1) O & M varies from $32,600/year in 1980 to $48,600/year in 2000.
(2) O & M varies from $72,500/year in 1980 to $98,600/year in 2000.
(3) Construction in 1985.
(4) Construction in 1985 and 1995.

The cost of building a treatment plant in the New Albany area was investigated using a base population of approximately 20,000 people, and is summarized in Table III-8 along with the pump station and force main costs involved in Alternative D. The pump station-force main system is shown to be half as expensive as the treatment plant option.

Table III-8
Treatment Plant Costs vs. Pump Station Costs in the New Albany Area

	Treatment Plant	Pump Station
Capital Cost		
Treatment Plant	$2,070,000	-
Pump Station	-	$ 170,000
Interceptor	-	710,000
Total	$2,070,000	$ 880,000
Present Worth		
Treatment Plant		
(capital)	$1,810,000	-
(O&M)	$ 990,000	-
Pump Station (capital)	-	$ 170,000
(O&M)	-	110,000
Interceptor (capital)	-	590,000
(O&M)	-	20,000
Southerly Treatment Plant (O&M)	-	420,000
Total	$2,800,000	$1,310,000

A modification to the lower section of the interceptor proposed for the Walnut Creek subarea may be necessary. The portion of this unit which is in Delaware County will be included in a Facilities Plan to be undertaken shortly by entities within Delaware County. It is suggested that the final design size for this interceptor be determined by the Facilities Plan.

Per person costs for Alternative D decrease from $12 per year using the present population to $6 per year using that projected for the year 2000. The pump station and force mains for New Albany and Reynoldsburg will serve a specific population of 22,000 in the year 2000, resulting in an annual equivalent cost of $10 per person per year.

3.2.6 Groveport

The Groveport subarea consists of approximately 5000 acres. Route 33 near Blacklick Creek makes up most of the unit's northern boundary, while the eastern edge lies just east of George Creek. Walnut Creek and Swisher and Saltzgaber Roads form the southern and western boundaries, respectively. The only existing sanitary sewer system serves the City of Groveport. Sewage is treated at a 0.30 mgd trickling filter installation which currently discharges to Little Walnut Creek.

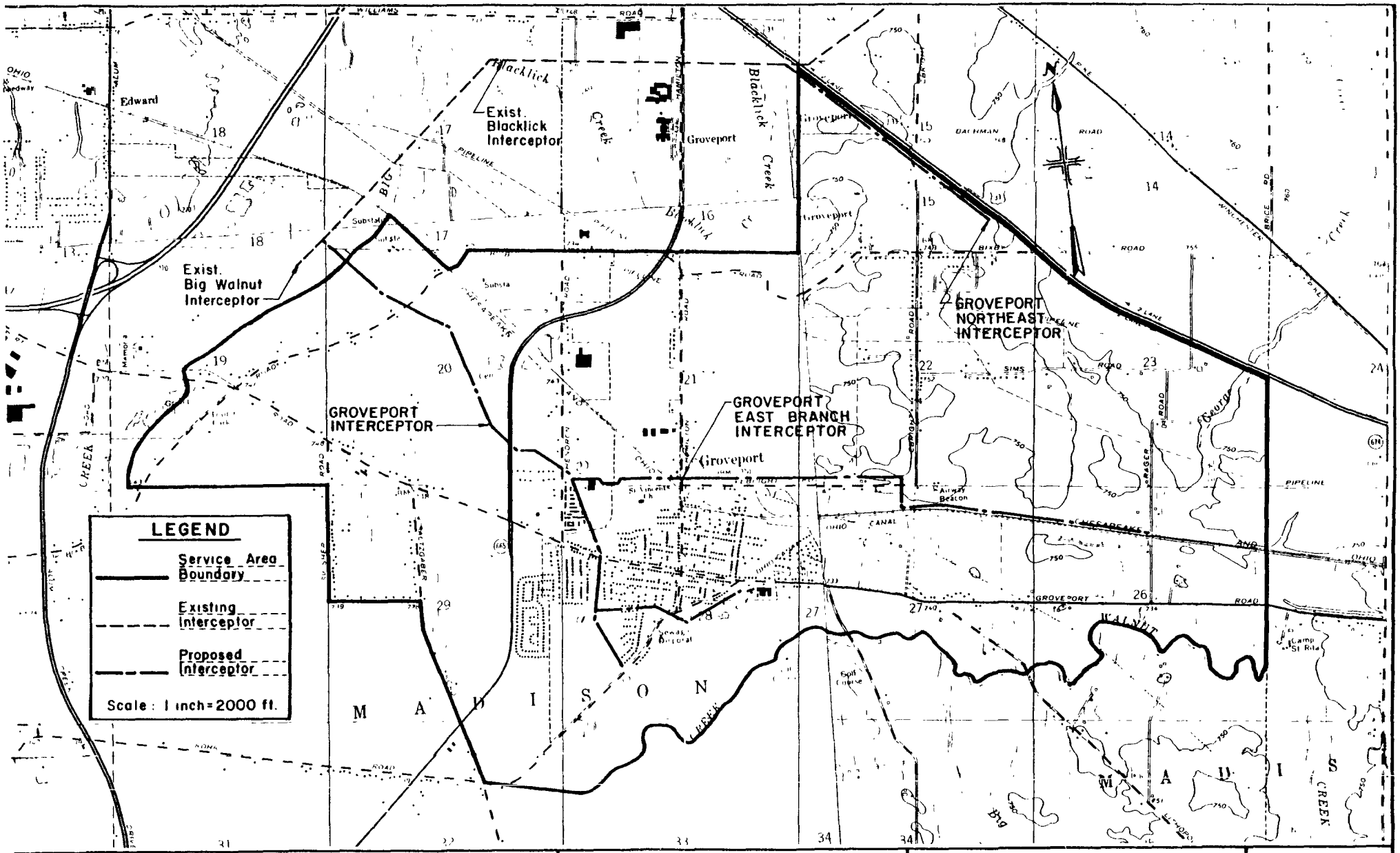
(1) Alternative Description

The Groveport area population is presently estimated at about 4,000, and is expected to increase to 6,500 by 1985 and to 11,600 by the year 2000. This projected increase in population, coupled with the varying suitability of the local soils to septic tank and leachfield treatment systems, precludes further analysis of a No Action Alternative for this subarea.

Service to the developing portions of the Groveport area cannot be entirely provided by a gravity system while totally utilizing the existing wastewater treatment plant. This plant presently has no NPDES permit. Since it discharges to Little Walnut Creek near the Rickenbacker Air Force Base, it was assumed that eventually both releases will have the same effluent limitations. The proposed 30 day average release levels for the Air Force Base are 8 mg/l BOD_5, 8 mg/l suspended solids, 1 mg/l ammonia nitrogen (summer), and 1 mg/l of total phosphorus.

Three regionalization alternatives will be considered for this subarea: a plant alternative and two interceptor alternatives (shown in Figures III-16 and 17). The treatment plant alternative would upgrade and expand the existing facility to 1.7 mgd. This alternative will also require the construction of a gravity sewer to handle the 1.2 mgd average flow coming from the area northeast of the plant near Route 33.

The two interceptor alternatives also utilize a "northeast interceptor" which will parallel Route 33 for some 5,000 feet to provide service to the northern portion of Groveport. This 15-inch interceptor will connect to a 96-inch section of the existing Blacklick Creek Interceptor on the eastern bank of Blacklick Creek near Route 33.

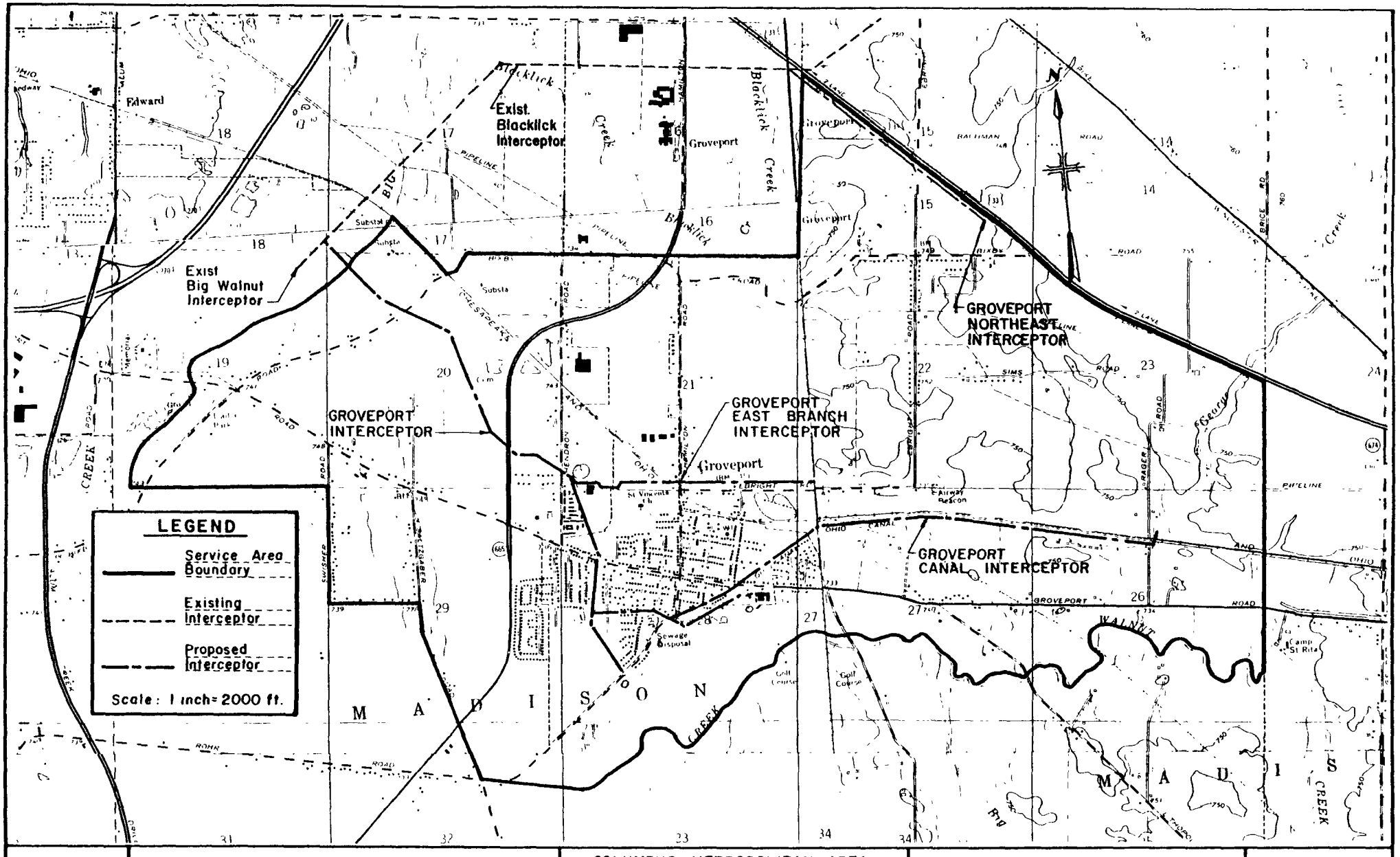


MALCOLM PIRNIE, INC.

COLUMBUS METROPOLITAN AREA
FACILITIES PLAN
FACILITIES REPORT

GROVEPORT SERVICE AREA
ALTERNATE A

FIGURE III-16



MALCOLM PIRNIE, INC.		COLUMBUS METROPOLITAN AREA FACILITIES PLAN FACILITIES REPORT	GROVEPORT SERVICE AREA ALTERNATE B	FIGURE III-17

Interceptor Alternative A differs from Alternative B in the manner of interception of flows from the southern portion of the area. Alternative A includes an interceptor branch which starts at Rager Road and travels westward along the Chesapeake and Ohio Railroad to a point just south of the 90 degree turn in Ebright Road. Here the interceptor crosses to the north, and follows Ebright Road into the main interceptor at Hendron Road. This 14,100 foot branch will be 24 inches in diameter.

The main interceptor in Alternative A collects flow from the area near the wastewater treatment plant. From this point, the route crosses a few streets within the City, turns in a northwestern direction, and follows an intermittent stream to Big Walnut Creek. After crossing Big Walnut Creek, the interceptor will tie into a 108-inch section of the existing Big Walnut Creek Interceptor. The proposed line is some 17,500 feet in length, and ranges in diameter from 18 to 27 inches.

The main interceptor in Alternative B traverses the same route as that in Alternative A, but ranges in size from 18 to 30 inches. Alternative B differs by the inclusion of two branch interceptors. The East Branch connects to the main at Hendron Road as in Alternative A, but is only 15 inches in diameter and 5,600 feet long, running parallel to Ebright Road. The other (Canal) branch starts near Rager Road and initially runs westward along the Chesapeake and Ohio Railroad. It then turns south, following the old Ohio Canal route until connecting to the main interceptor close to the intersection of Hamilton and Rohr Roads. The Canal Branch Interceptor will be 24 inches in diameter for its entire length of 11,800 feet.

(2) Primary Impacts

The Plant Alternative will involve long-term adverse impacts due to the ongoing commitment of manpower, materials, land, and energy required for the upgrading and expansion of the Groveport WWTP. The retention of the WWTP close to growing residential areas could result in adverse impacts due to odor, noise, and aesthetic degradation.

The northeast interceptor parallel to U. S. Route 33 is common to all three alternatives. It will be constructed through either cleared land or farmland, with little adverse primary impacts expected. The route of the main branch of the Groveport Interceptor is also common to Alternatives A and B. Most of the 11,000 feet of the main interceptor travels through open farmland, occasionally crossing some residential backyards. Four road crossings, including a proposed tunnel under Route 665, will occur along this section of the interceptor. Crossing of Big Walnut Creek will result in short-term surface water degradation due to erosion and turbidity. The remainder of the interceptor length will involve about 1,000 feet of roadway construction along Lambert Avenue and the crossing of Rohr Road in order to intercept flow from the present wastewater treatment plant.

All road crossings (except the proposed tunneling under Route 665) are expected to cause unpleasant short-term impacts in regard to noise, air quality, and aesthetics.

The interceptor proposed in Alternative A for the southern portion of the subarea will collect flow from an elementary and a junior high school. Most of the interceptor route traverses open farmlands, with the exception of the school property and the single crossing of Ebright Road, which may cause some temporary traffic disruption.

Alternative B includes the East Branch and Canal Branch Interceptors. The East Branch traverses the same route as the southern interceptor of Alternative A, but is only 5,600 feet long, terminating prior to a crossing of Ebright Road. Again, little impact is expected from construction through the school property and the cleared farmland. The Canal Branch starts at the existing treatment plant and proceeds along Rohr and Wirt Roads, eventually crossing Groveport Road to meet the main interceptor. This is the only construction in or along a roadway, with the exception of the crossing of Rager Road at the uppermost end of the interceptor. Traffic disruption and inconvenience is expected to occur in these areas for short periods of time.

Construction along Wirt Road passes the Groveport Log House, which is listed on the National Register of Historic Places. No other historic place is known to be in the area.

After crossing Groveport Road, the interceptor route follows the old Ohio Canal right-of-way until reaching the Chesapeake and Ohio Railroad. A number of homes and large trees exist along the Canal. Many of these trees will have to be moved, and construction in this area will negatively impact local residents in terms of noise, air pollution, and aesthetic degradation.

At the intersection of the Chesapeake and Ohio Railroad, the interceptor route follows the southern side of the railroad tracks, traversing open farmland and cleared land until crossing the tracks at Rager Road by means of a tunnel. Little adverse primary impacts are expected to occur as a result of this last section of interceptor construction.

(3) Phasing

Figure III-18 shows the population densities served by the two interceptor alternatives for the Groveport subarea. These Figures indicate that the northeast interceptor need not be constructed until about 1995, but that the main branch of the interceptor should be constructed by 1980. Besides the heavy densities served, another reason for construction of the main interceptor by 1980 is to intercept and transport flows from the present Groveport treatment plant site.

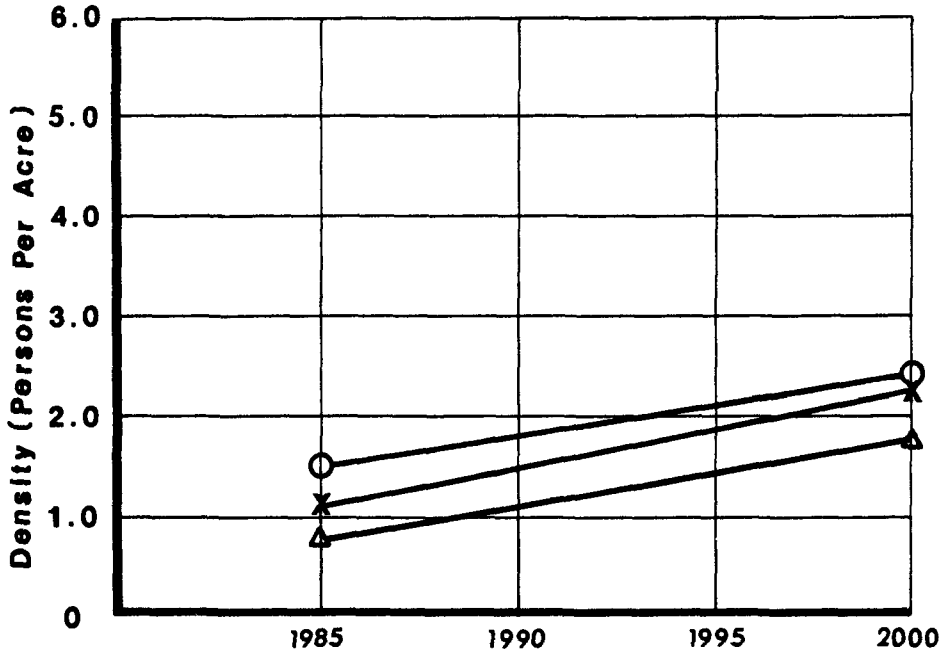
The East Branch in Alternatives A and B may be be required by 1990, and the Canal Interceptor in Alternative B may be needed by 1985.

(4) Costs

The capital cost for an upgraded and expanded plant for the City of Groveport which is able to meet average summer month release standards of 8 mg/l BOD, 8 mg/l SS and 1 mg/l ammonia nitrogen, is estimated to be approximately $3,680,000. The capital cost for the northeast interceptor is $180,000, bringing the total capital cost of the Plant Alternative to $3,860,000. The operation and maintenance cost for the plant is estimated at $350/mg, while the annual O & M for the northeast interceptor is $440.

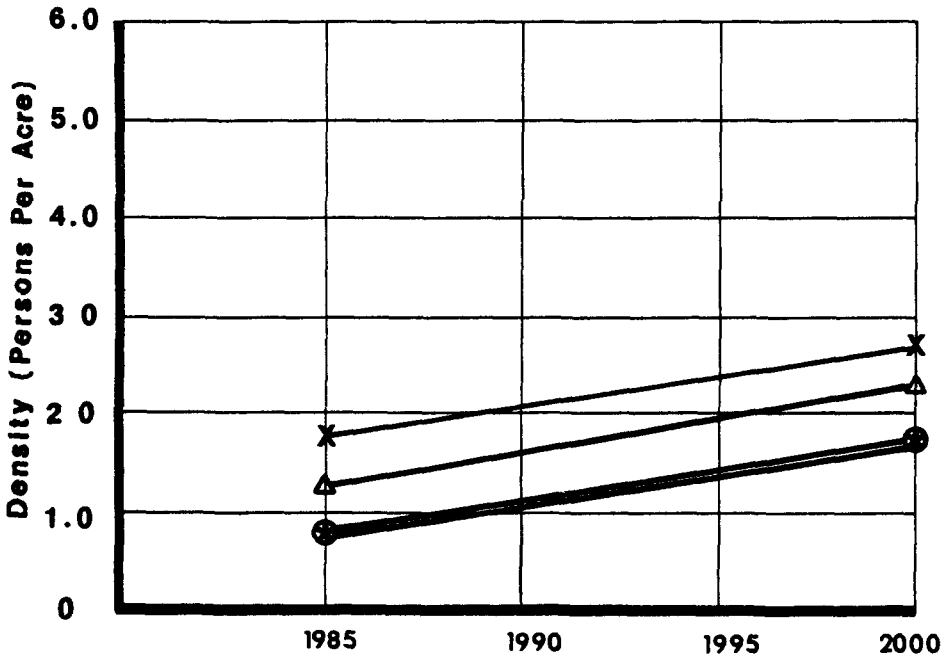
FIGURE III-18

DENSITY TRENDS FOR THE GROVEPORT SUBAREA



Manholes	Code
East Branch	O
Main Branch	X
Northeast Branch	Δ

GROVEPORT INTERCEPTOR (ALTERNATE A)



Manholes	Code
East Branch	O
Canal Branch	X
Main Branch	Δ
Northeast Branch	*

GROVEPORT INTERCEPTOR (ALTERNATE B)

Capital costs for Interceptor Alternatives A and B are estimated as $2,260,000 and $2,050,000, respectively. The O & M costs are $5,600 per year for Alternative A, and $5,100 per year for Alternative B. Treatment costs at the Southerly plant have been included in Alternatives A and B for comparison purposes.

(5) Summary

A summary of interceptor lengths, primary impacts, costs, and present worths for the three alternatives are provided in Table III-9.

The selected plan for the Groveport subarea is Alternative A. This option costs more than Alternative B on a capital basis, but, due to phasing of sections of interceptors, the present worth of A is far less. Alternative A calls for less interceptor length and involves fewer environmental impacts than Alternative B. The Plant Alternative is higher than either interceptor plan in terms of capital costs, O&M costs, and present worth, and commits more long-term resources. Alternative A involves a dollar per person per year cost of $41 using the present population, or $14 per person per year using the projected year 2000 population.

3.2.7 Rickenbacker Air Force Base

The Rickenbacker Air Force Base encompasses some 4,200 acres, and is served by an existing 1.25 mgd trickling filter installation. Currently, this facility receives only sanitary wastewater, and discharges effluent to Little Walnut Creek via an outfall sewer. There are two other small treatment plants on the Base which serve a golf course and a trailer park. Plans call for the abandoning of both small facilities in the near future.

(1) Alternative Description

The Waste Allocation Report for the Scioto River Basin suggests that the summertime average monthly effluent limitations imposed on the Rickenbacker treatment plant should be 8 mg/l BOD, 8 mg/l SS, 1 mg/l ammonia nitrogen, and 1 mg/l total phosphorus. Since these proposed limitations are not presently being achieved, the No Action Alternative was not considered to be viable.

Table III-9
Alternative Summary for the Groveport Subarea

Item	Alternatives		
	Plant	Interceptor	
		A	B
Length of Sewers (feet)	5,000	36,600	39,900
Type of Land Traversed (feet)			
Woodland	100	300	1,300
Open Space (Rural)	5,000	32,300	28,800
Stream Corridor	0	12,700	15,500
Residential	0	5,800	7,800
Highway R.O.W.	0	1,800	3,600
Stream Crossings	0	2	3
Highway Crossings	1	14	16
Costs (Thousands of Dollars)			
Capital (1980)	$3,680	$ 1,210	$ 1,180
(1985)	0	0	520
(1990)	0	870	170
(1995)	180	180	180
Annual O & M (1980-2000)	(1)	(2)	(3)
Present Worth	$4,030	$ 1,660	$ 1,750

(1) Varies from $27,800 in 1980 to $149,100 in the year 2000.
(2) Varies from $16,000 in 1980 to $ 77,800 in the year 2000.
(3) Varies from $16,700 in 1980 to $ 77,400 in the year 2000.

Three alternatives were analyzed for this subarea, including the retention and upgrading of the treatment plant and two gravity interceptor alternatives. The interceptor alternatives are shown in Figures III-19 and III-20.

The route of Interceptor Alternative A does not actually enter the Air Force Base, initiating at a point just above the Base where Route 665 turns to the northeast. At this tie-in point, the interceptor will be some 12 feet deep, enabling easy connection from almost any part of the Air Force Base. The interceptor initially travels westward along Route 665 to Alum Creek Drive. The proposed route then follows Alum Creek Drive northward to Bixby Road, at which point it continues along Bixby to Reese Road near Walnut Creek. The interceptor will then tie into the Big Walnut Creek Interceptor at Manhole 30. The proposed sewer is to be 24 inches in diameter throughout its entire length of 18,200 feet.

The interceptor route of Alternative B begins at the same point as Alternative A. However, the interceptor proposed in this Alternative continues along Route 665 until it reaches Lockbourne Road. At this point it travels northward along Lockbourne for some 2,000 feet, and then runs eastward until tying into manhole 16 of the existing 108-inch Big Walnut Creek Interceptor. The proposed interceptor is again 24 inches in diameter for its entire length of 19,200 feet.

The above sizing took into consideration the fact that the Air Force Base will be the only area served by this interceptor. Therefore, its design assumed full flow in the year 2000, using the Air Force estimated average flow of 0.8 mgd over the entire planning period.

(2) Primary Impacts

The primary impacts associated with the Plant Alternative are the future commitments of manpower, material, and energy required for the upgrading and operation of the facility.

The most significant primary impact of Alternative A is the disruption of the small residential area included in the interceptor route along Route 665. Along Alum Creek Drive, the route is mainly through

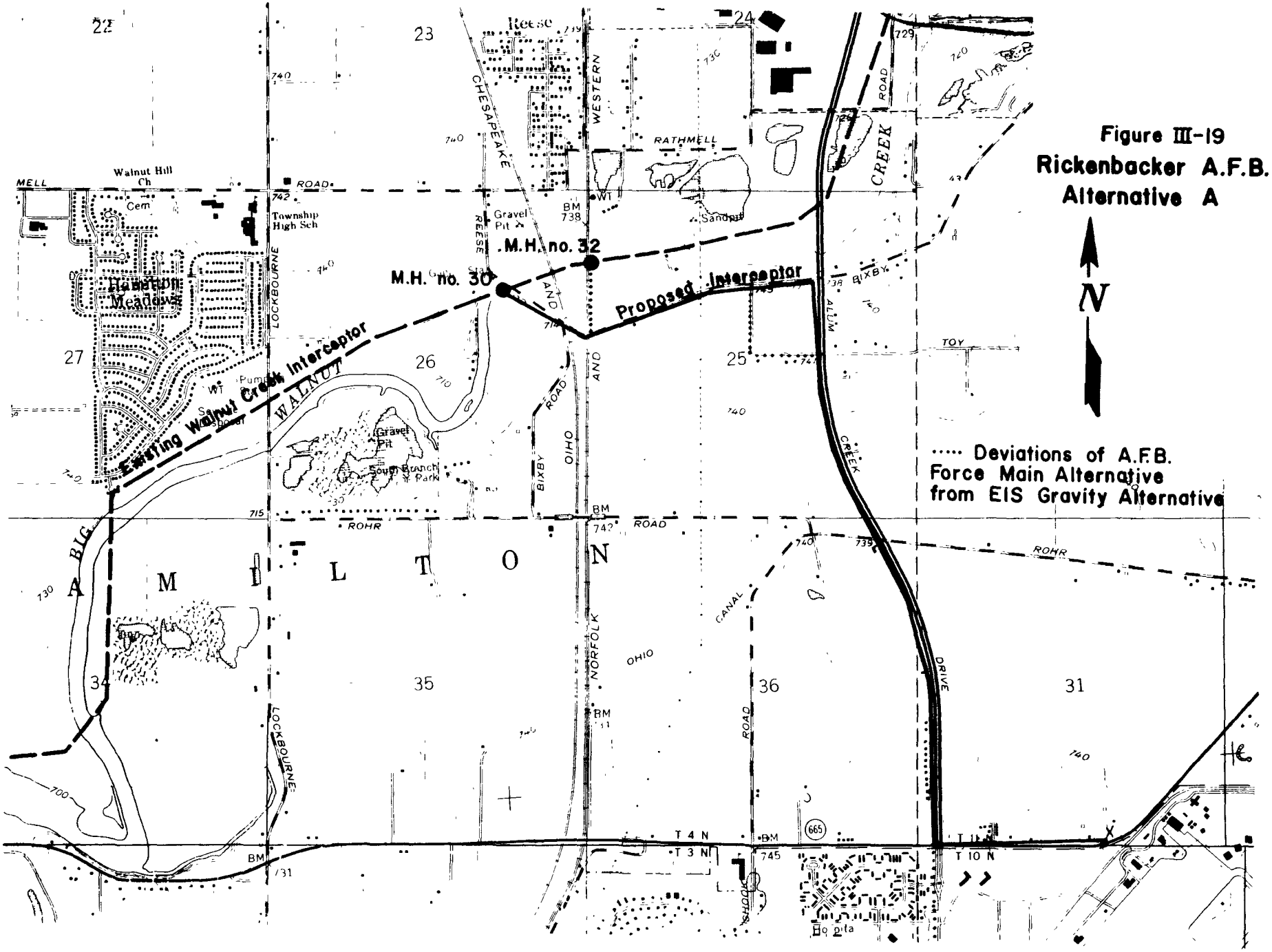


Figure III-19
Rickenbacker A.F.B.
Alternative A
N
..... Deviations of A.F.B. Force Main Alternative from EIS Gravity Alternative
Existing Walnut Creek Interceptor
Proposed Interceptor
M.H. no. 30
M.H. no. 32
WALNUT
CREEK
OHIO
AND
BIXBY
ROAD
ROHR
CANAL
DRIVE
NORFOLK
WESTERN
CHESAPEAKE
LOCKBOURNE
ALUM
TOY
RATHMELL
Reese
Walnut Hill Ch
Cem
Township High Sch
Gravel Pit
Sandpit
Hamilton Meadows
South Branch Park
Pump
WT
BM
AMLTON
T 4 N
T 3 N
T 1 N
22
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24
25
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27
31
34
35
36
665

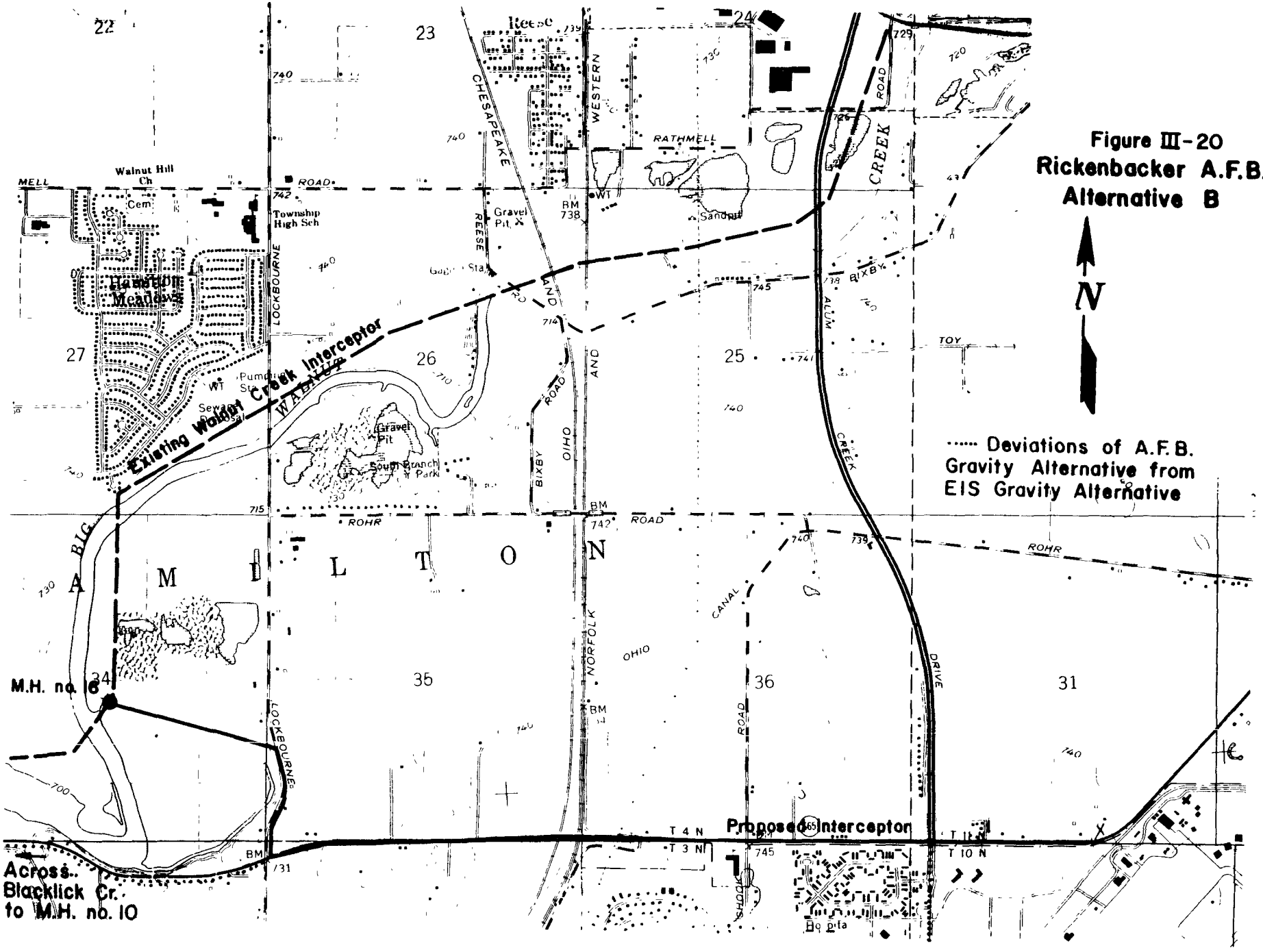
Figure III-20
Rickenbacker A.F.B.
Alternative B
N
..... Deviations of A.F.B. Gravity Alternative from EIS Gravity Alternative
Existing Walnut Creek Interceptor
Proposed Interceptor
M.H. no. 16
Across Blacklick Cr. to M.H. no. 10
AMLTON
Walnut Hill Ch
Cem
Township High Sch
Hamilton Meadows
Gravel Pit
South Branch Park
Reese
Chesapeake & Western
Rathmell
Sandpit
Alum Creek
Bixby Road
Oiho Road
Lockbourne Road
Norfolk & Ohio Canal
Rohr Road
Toy Drive
Big Run
Bo pta
22
23
24
25
26
27
34
35
36
31
T 4 N
T 3 N
T 10 N

open farmland, and interceptor construction can be accomplished with minimal traffic disruption. The interceptor will travel along the southern side of Bixby Road in order to avoid the heavily wooded areas to the north. The agricultural land on the south side of Bixby Road continues for the remainder of the route until the existing 108-inch Big Walnut Creek Interceptor is reached. Tunneling will be required within this final portion in order to cross the Norfolk and Western and Chesapeake and Ohio Railroads.

The primary impacts of the route proposed in Alternative B are associated with the disruption of the residential area near Route 665 where the interceptor begins, and with the required construction through wooded areas along Lockbourne Road and Big Walnut Creek. Most of the remainder of the affected area is open farmland. A tunnel is also required for this alternative for crossing the same two railroads mentioned in Alternative A.

(3) Phasing

No density plot is provided for this subarea since no growth is expected to occur during the planning period. Due to the need for abandoning or improving the present treatment plant to meet stringent effluent discharge requirements, the interceptors for either regionalization alternative considered should be constructed by 1980.

(4) Costs

The costs associated with the Plant Alternative are for construction ($1,500,000), and operation and maintenance ($350/mg). The total present worth of this plan, including salvage values, is $2,435,000.

Alternatives A and B require capital expenditures of $1,318,000 and $1,140,000, respectively. Annual operation and maintenance costs are $3,300 for Alternative A, and $2,900 for Alternative B. The operation and maintenance expenses incurred at the Southerly treatment plant due to the flow from the Base must also be included for a true comparison of the plant and interceptor alternatives on a present worth basis. Construction on the Base and routing of flows to the tie-in point of each Alternative is regarded as an internal matter, and costs have not been included in this analysis.

(5) Summary

Table III-10 gives a summary of the primary impacts and costs for the three alternatives.

Alternatives A and B entail more primary impacts than does the Plant Alternative. The Plant Alternative does involve a long-term commitment of resources and will require double the O&M cost of either interceptor alternative. This cost-effective analysis performed using a 24 inch interceptor illustrates that a regionalization alternative, whether it be A or B, is the preferred method of handling flow from the Air Force Base.

The Base has prepared its own preliminary economic analysis and conveyed the information in a letter dated October 21, 1977. The salient comments are presented below.

> Currently, an engineering firm is designing the sewage connection system. The preliminary design calls for a 14-inch force main (route shown on Figure III-19) or a 21-inch gravity line (route shown on Figure III-20). The exact size of the line will be decided upon after further analysis.

- The economic analysis comparing the upgrading and operating of the on-base plant to the construction of a connection line to the City of Columbus has been revised using the new proposed user rates. Results of this analysis showed the present worth of a plant alternative to be $7.8 million dollars; while the cost of a force main alternative was $5.4 million. (These costs assumed an annual inflationary rate of 8 percent. Ignoring inflation, the costs are reduced to $5.9 million and $3.2 million, respectively.) The analysis shows that the connection to the city system is more economical.

- The environmental assessment concerning the connection to the City of Columbus, forwarded by our letter of 18 August 1977, is applicable to either a gravity line or to a force main. Either system, if selected, would be designed and constructed with a capacity to serve the base only, and would be routed along the right-of-way of an existing roadway.

Table III-10

Alternative Summary for the Rickenbacker Air Force Base Subarea

Item	Plant	Alternatives Interceptor A	Interceptor B
Length of Sewers (feet)	0	18,200	19,200
Type of Land Traversed (feet)			
Woodland	0	300	0
Open Space (Rural)	0	15,200	15,900
Residential	0	2,700	3,300
Highway R.O.W.	0	18,200	16,400
Stream Crossings	0	3	3
Highway Crossings	0	5	6
Costs (Thousands of Dollars)			
Capital (1980)	$1,500	$1,318	$1,140
Annual O & M (1980-2000)	100.8	52.3	51.8
Present Worth	$2,435	$1,670	$1,517

The City of Columbus has agreed to accept the base's wastewater as noted in their letter to US EPA on 1 March 1977.

Two additional comments should be made concerning the regionalization of the AFB. The first is that, as shown on Figures III-19 and III-20, the routes proposed by the Air Force are similar to those proposed by the EIS and therefore, similar primary impacts would be expected to result. The exception to this is the portion of the route proposed by the AFB for the gravity alternative which crosses Blacklick Creek, a crossing not found in the EIS alternative.

The second comment concerns the fact that no secondary impacts are anticipated to result from any regionalization scheme since the interceptor line would carry only flows from the Rickenbacker AFB.

3.2.8 Sensitivity Analysis

Analyses were performed to show the size and cost differences between designs based on ultimate population, on interceptors flowing half full in the year 2000, and on interceptors flowing full in the year 2000. Table III-11 shows the slopes, sizes, and costs of the chosen alternatives for each subarea as well as the sensitivity of the design concept of sizing each interceptor at half capacity in the year 2000.

The cost difference between designs using half full by 2000 and full by 2000 vary from 3% to 24%, with the average and median variation around 18%. This demonstrates that, on the average, an 18% increase in cost will permit twice as much intercepted flow at design conditions.

Table III-12 shows the comparison of ultimate density versus the projected design density for the year 2000. The table shows that most of the areas are at or less than 25% of their ultimate density by the year 2000, making designs based on an ultimate population concept uneconomical.

3.2.9 Conclusion

Based on the analysis in Chapter 3 and Chapter 7, USEPA has determined that preparing designs based on an ultimate population concept is generally not cost-effective for the Columbus area.

Table III-11
Design Sensitivity of Selected Alternatives

Subarea	Slope %	Facilities Plan Size Inches	Facilities Plan Capacity mgd	Facilities Plan Cost $1,000	Half Full by 2000 Size Inches	Half Full by 2000 Design Q mgd	Half Full by 2000 Cost $1,000	Full by 2000 Size Inches	Full by 2000 Design Q mgd	Full by 2000 Cost $1,000
West Scioto										
High Level	0.15	48	24.6		42	17.5		30	8.9	
	0.15	54	31.0		42	20.9		30	10.7	
	0.15	60	41.1		42	23.0		30	11.8	
	0.83	72	54.7		42	24.3		36	12.4	
	0.10	72	66.7		48	27.7		42	14.1	
				$5,540			$5,150 (2)			$4,190 (2)
Big Run										
Alt. A	0.05	30	6.0		18	1.5		15	0.8	
	0.30	30	14.7		18	2.1		15	1.1	
	0.12	36	15.1		21	3.3		18	1.7	
	0.12	42	22.7		27	6.9		21	3.5	
	0.12	48	32.1		27	6.9		21	3.5	
Feder Rd.	0.11	-	-		15	1.4		12	0.7	
Renner Rd.	0.30	-	-		18	2.1		15	1.1	
				$3,040			$2,970			$2,582
Minerva Park										
Int. Alt.	0.80	18	6.1		12	1.2		12	0.6	
	0.80	21	9.1		15	2.5		12	1.3	
	1.00	21	10.2		15	2.7		12	1.4	
	0.80	18	6.1		12	1.7		12	0.9	
				$ 430			$ 380			$ 370
Big Walnut Cr.										
Alt. D	0.10	60	53.2		36	8.9		24	4.6	
	0.10	72	36.0		36	12.5		27	6.4	
				$8,770			$5,390			$4,570

Table III-11 (Cont'd)
Design Sensitivity of Selected Alternatives

Subarea	Slope %	Facilities Plan Size Inches	Facilities Plan Capacity mgd	Facilities Plan Cost $1,000	Half Full by 2000 Size Inches	Half Full by 2000 Design Q mgd	Half Full by 2000 Cost $1,000	Full by 2000 Size Inches	Full by 2000 Design Q mgd	Full by 2000 Cost $1,000
Rocky Fork										
Alt. D	varies	(1)			2-8 FM	3.0		8FM	1.5	
	0.28				18	3.7		15	1.9	
	0.20	36	19.5		24	6.2		21	3.2	
	0.20	48	41.4		27	7.5		21	3.8	
	0.10	60	53.2		36	11.0		27	5.6	
	0.50	48	65.4		36	11.0		27	5.6	
							$3,930(3)			$3,050(2)
Blacklick										
Alt. D	varies	(1)			2-16 FM	12.9		16 FM	6.6	
	1.1				24	12.9		18	6.6	
	1.40	54	80.7		21	5.2		15	2.6	
	0.30	60	92.1		27	10.2		21	5.2	
	0.30	66	119.2		36	19.8		27	10.1	
	0.30	72	149.2		36	21.4		27	10.9	
							$8,070(2)			$6,100(2)
Groveport										
Alt. A	0.16(3)				18	1.8		12	0.9	
	0.16				18	1.8		12	0.9	
	0.12				24	3.8		18	1.9	
	0.15				27	6.9		21	3.5	
NE Int.	0.16				15	1.2		12	0.6	
							$2,260			$1,840
Rickenbacker										
AFB-Alt. B	0.045	(1)			(4)			24	2.8	
	0.045							24	2.8	
	0.045							24	2.8	
										$1,140

(1) Data Not Available from Facilities Plan.
(2) Includes pump station costs.
(3) EIS slope only - sizes are reported in the Facilities Plan.
(4) No sensitivity done, recommended design is for full by 2000.

Table III-12

Year 2000 vs. Ultimate Densities Per Subarea

Subarea	Population Density EIS Year 2000	Facility Plan Ultimate
West Scioto	2.0	10-20
Big Run	0.9	4-4.6
Minerva Park	5.3	7-24
Big Walnut Creek	1.0	4
Rocky Fork	1.8	8
Blacklick Creek	1.5	6-10
Groveport	2.6	7.4
Rickenbacker A.F.B.	1.3 - 1.0	(1)

(1) Subarea not in Facility Plan

CHAPTER IV

ALTERNATIVES TO THE PROPOSED PROJECT PLAN

IV. ALTERNATIVES TO THE PROPOSED PROJECT PLAN

The National Environmental Policy Act (NEPA) specifically requires an Environmental Impact Statement to study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternate uses of available resources. The purpose of this charge is to provide a vehicle by which other alternatives, even those outside the authority of the responsible agency, may be examined early in the planning process in order to not prematurely foreclose options which might enhance environmental benefits or lessen environmental degradation.

This chapter responds to the NEPA requirement of alternative action study. It begins with an analysis of the overall goals associated with wastewater collection and ultimate disposal of the liquid and solid products of wastewater treatment. This goal analysis serves to delineate the opportunities for resource savings through modification of the overall concepts either developed or accepted in the improvements proposed in the Facilities Plans for Columbus. It then examines several alternatives to the internal processing concepts incorporated in the project plan and explores the opportunities for optimization through energy conservation, surge control, and peak shaving. This examination, prepared with a view towards accomplishing similar objectives by alternate means with different environmental impacts, addresses technical and regulatory developments which may have arisen since the preparation of the original project plan, and attempts to minimize the commitment of new resources in goal accomplishment.

A detailed description and review of the process sequences and units proposed in the Columbus Facilities Plans is provided in Appendix I to this Impact Statement.

4.1 GOAL ANALYSIS: WASTEWATER COLLECTION

In this section the concepts that influence the magnitude and quality of the wastewater delivered to the Columbus Wastewater Treatment Plants are examined for their influence upon the proposed project plan.

4.1.1 Service Areas

The regionalization alternatives to the proposed project plan have been described and developed in Chapter III of this report. The conclusions which deviate from the service areas proposed in the Facilities Plan by the end of the planning period (the year 2000) are as follows:

- Southerly Service Area

  - Rickenbacker AFB added
  - Service only provided to Reynoldsburg in the Blacklick Creek subarea
  - Service only provided to New Albany in the Rocky Fork subarea
  - Only partial service to the Big Walnut Creek Subarea

- Jackson Pike Service Area

  - Some portions of Delaware County to be included with the West Scioto subarea;
  - Service will not be provided to the Big Run subarea.

Details of recommended changes in phasing, interceptor sizing, and transport routes can be found in Chapter III.

4.1.2 Infiltration/Inflow

As described earlier, a full scale analysis of the magnitude of infiltration and inflow at Columbus has not yet been conducted. Estimated quantities used in this report for a year 2000 average day inflow have been 32 and 20 mgd at Jackson Pike and Southerly, respectively. These quantities may be reduced as the City's combined sewer overflow pollution abatement program is implemented. This program consists of the planned elimination of hydraulically troublesome combined sewers, and may include an upsystem treatment concept that removes the suspended pollutants from the contaminated point sources of storm water. The City's strategy is one that will not needlessly overload the hydraulic capacity of its treatment plants while offering the potential of adding to sewer and plant capacity as storm flows are eliminated. Pending the results of an ongoing sewer system evaluation survey, it is not recommended that any additional hydraulic capacity be provided at the two Columbus treatment facilities. The only exception to this recommendation is a proposed increase in pumping capabilities at Southerly from 180 to 230 mgd.

4.1.3 Industrial Pretreatment

Historically, municipalities and authorities that have developed effective programs to control industrial pollutants have been motivated by one or more of the following factors:

- frequent or serious treatment plant upsets;
- stringent water quality standards or noticeable degradation of the receiving stream; and
- the opportunity to derive revenues.

In recent years, the interest in controlling nonresidential contributions to public sewers has increased as an outgrowth of the requirements of Public Law 92-500 and the issuance of NPDES permits. As a result of the effluent standards listed in a permit, it is now incumbent upon a municipality or authority to control any industrial pollutant which may deleteriously impact the performance of a treatment facility.

The City of Columbus presently has a sewer use ordinance which specifically excludes significant releases of pollutants that are incompatible to either the collection system or the treatment processes employed at the treatment plant. Incompatible pollutants would include those materials which may inhibit biological processes, are flammable, release toxic gases, cause significant deposits, or corrode or scale the sewers. Examples of compatible pollutants include biodegradable releases of carbon and nitrogen, flows with pH values of 6 to 9, infectious organisms, and reasonable concentrations of suspended solids. Other than the compatibility requirement, the City of Columbus has no industrial pretreatment standards. In response to the requirements of Public Law 92-500, the City is now in the process of developing a sewer rate ordinance which will include industrial cost recovery considerations. It is anticipated that this ordinance will be implemented in 1978.

The present industrial base of Columbus consists of some 1,000 dischargers of wastewater which collectively send approximately 15 mgd of wastewater to the two treatment plants. This total industrial release is slightly less than 10 percent of the average daily wastewater flow received at Jackson Pike and Southerly. Of these many and varied industrial releases, only one, that due to Anheuser-Busch, presents the opportunity to derive significant changes in the proposed project plan through implementation of an industrial pretreatment requirement. Thus, this section of the report examines the impact of varying degrees of pretreatment at Anheuser-Busch upon the proposed project plan at the Southerly Wastewater Treatment Plant.

(1) Brewery Waste Pretreatment Alternatives

The brewery waste impacts the Southerly Wastewater Treatment Plant through the promotion of a bulking

activated sludge, the exertion of a high carbonaceous oxygen demand, and the production of excessive quantities of secondary sludge. The cost impact of handling the brewery waste at Southerly can be developed by examining the year 2000 treatment scenarios described below:

1. Brewery wastes without pretreatment (the present contemplated condition);

2. Pretreatment of the brewery wastes to the point that the soluble oxygen demanding load is largely removed (a roughing filter at Anheuser-Busch); or

3. Pretreatment of the brewery wastes to remove and handle the large majority of the oxygen demand and suspended solids.

4. Total brewery waste treatment to Southerly NPDES effluent restrictions at Anheuser-Busch.

Table IV-1 shows the impact of each scenario on the year 2000 influent wastewater characteristics at Southerly for the assumed representative unit processes suggested for brewery waste pretreatment. Values are shown for raw brewery loadings of 100,000 and 60,000 pounds per day of BOD_5. The conceptual basis of design for the pretreatment installation was that it should perform to an efficiency level similar to the installation proposed for Southerly in the Facilities Plan. If this were the case, roughing filters at Southerly could be eliminated, along with the intermediate sedimentation system. In scenario 2, the primary sedimentation system at Southerly can serve to provide solids capture of the sloughed secondary solids released from the Anheuser-Busch roughing filter. In scenario 3, these sloughed solids are captured and handled at the Anheuser-Busch plant site. Scenario 4 assumes a nitrifying activated sludge system following the roughing filter with subsequent effluent filtration, chlorination, dechlorination, and post-aeration.

(2) Cost-Effective Analysis

Table IV-2 summarizes the new capital and entire operating costs for each of the scenarios. Treatment costs at the brewery were developed in today's time frame and indexed backward to the 1974-1975 period to standardize these costs with those developed in the Facilities Plans. Capital cost estimates at Southerly

Table IV-1
Southerly Influent Characteristics for Different
Brewery Waste Treatment Scenarios (Year 2000)

Parameter	Treatment Scenario 1		2		3		4	
	No Pretreatment		Soluble Oxygen Demand Control		Scenario 2 and SS Control		Complete Treatment and Discharge	
Representative Unit Processes at Anheuser-Busch	None		Screening and degritting, equalization-neutralization with nutrient addition, pump station, and synthetic media roughing filter with recirculation. Roughing filter contains lightweight cover and air circulation devices		Same as Scenario 2 with sedimentation, waste sludge holding tank, centrifugal sludge thickening, and filter press sludge dewatering with transport to landfill		Same as Scenario 3 with the roughing filter immediately followed by a nitrifying activated sludge system and subsequent effluent filtration, disinfection, dechlorination and post aeration	
Southerly Influent Characteristics, 1,000 lbs/day	(2)	(3)	(2)	(3)	(2)	(3)	(2) &	(3)
Sus. Solids								
VSS	145	135	170	150	125	125	123	
SS	175	165	205	185	155	155	150	
BOD_5 Sus.	120	110	125	115	100	100	100	
Sol.	125	95	80	60	80	60	45	
Σ	245	205	205	175	180	160	145	
COD Sus.	230	220	265	240	205	205	200	
Sol.	235	185	160	130	160	130	95	
Σ	465	405	425	470	365	335	295	
TKN Sus.	6.2	6.0	10.4	8.7	6.1	6.1	5.8	
Sol.	15.2	15.0	15.0	14.7	15.0	14.7	14.6	
Σ	21.4	21.0	25.4	23.4	21.1	20.8	20.4	
PO_4-P Sus.	1.7	1.5	2.2	1.8	1.4	1.4	1.3	
Sol.	4.9	4.7	4.4	4.4	4.4	4.4	4.3	
Σ	6.6	6.2	6.6	6.2	5.8	5.8	5.6	

(1) Sus= suspended; Sol. = soluble
(2) Brewery at 100,000 lbs/day
(3) Brewery at 60,000 lbs/day

TABLE IV-2

COST COMPARISON OF ALTERNATE BREWERY WASTE TREATMENT SCENARIOS
(Millions of Dollars, 1974/1975 Basis)

	Scenarios							
	100,000 lb/day raw Brewery Load				60,000 lb/day raw Brewery Load			
	1	2	3	4	1	2	3	4
I. Capital Cost Estimate - $								
Brewery	0	4.2	11.4	30.8	0	2.9	7.3	20.3
Southerly	66.4 (2)	48.1 (3)	41.9 (1)	41.9 (1)	66.4 (2)	41.9 (1)	41.9 (1)	41.9 (1)
Total	66.4	52.3	53.3	72.7	66.4	44.8	49.2	62.2
II. Operating Cost Estimate - $/Year								
Brewery	0	0.3	0.9	1.3	0	0.2	0.5	0.8
Southerly	5.5	5.4	5.3	5.3	5.4	5.4	5.3	5.3
Total	5.5	5.7	6.2	6.6	5.4	5.6	5.8	6.1
III. Present Worth Equivalent Estimate - $								
Brewery	0	7	20	42	0	5	12	27
Southerly	120	103	96	96	119	97	96	96
Total	120	110	116	138	119	102	108	123

(1) Unit processes eliminated from Facilities Plan: First stage biological treatment @ $14.1, HVAC, etc. equivalent @ $1.4, new dissolved air flotation units @ $2.3, one additional thermal conditioning system @ $1.8, one dewatering centrifuge @ $0.7, one half of recycle treatment system @ $2.7, and solids handling equivalent contingency @ $1.5. (Total = $24.5 million)

(2) Original Facilities Plan

(3) Unit processes eliminated from Facilities Plan: First stage biological treatment @ $14.1, HVAC, etc. equivalent @ $1.4, new dissolved air flotation uni @ $2.3, and solids handling equivalent contingency @ $0.5. (Total = $18.3 million)

(4) Present worth equivalent at 6-3/8 percent interest and 20 years
= 0.9 (Capital Costs) + (Annual Costs)

were determined by deleting a unit process of some fraction of its parallel processing capability as a function of the brewery waste treatment strategy. The table contains cost estimates for a 60,000 lbs./day BOD_5 and 100,000 lbs./day BOD_5 brewery load to illustrate cost sensitivity at the brewery and at Southerly.

Scenario 4, which excludes a joint municipal brewery treatment scheme, is seen to be the least attractive. Scenario 1, the present project plan, and scenario 3 are also seen to represent nonoptimum alternatives. The best overall brewery waste treatment strategy is found with scenario 2, which satisfies the majority of the industrial waste's soluble oxygen demand before release to the city sewer.

4.1.4 Conclusions

The goal analysis associated with wastewater collection reveals that regionalization and infiltration/inflow considerations have no significant impact upon the proposed project plan. In contrast, the industrial pretreatment studies show that if the Anheuser-Busch brewery waste was pretreated to control its soluble oxygen demand, a substantial economic savings could be developed. Based on the present BOD_5 discharges from the Anheuser-Busch brewery, the effect of the user charge system on the strength of the waste stream discharge by the brewery, and discussions with Anheuser-Busch, USEPA has determined the cost-effective BOD_5 loading prior to pretreatment from the Anheuser-Busch facilities in Columbus, Ohio to be a maximum 30-day average BOD_5 of 60,000 lbs./day, with a maximum single day peak of 75,000 lbs./day. A revised project plan that incorporates pretreatment of the brewery waste stream to the level of treatment identified herein is recommended. All subsequent analyses include the assumptions that the brewery will pretreat its 60,000 lb./day BOD_5 load for control of its soluble oxygen demand (scenario 2) and that the roughing trickling filter and intermediate sedimentation system at Southerly have been eliminated.

4.2 GOAL ANALYSIS: PRODUCT LIQUID

Public Law 92-500 requires examination of each discharge of wastewater from the following standpoints:

- treatment and land application;
- treatment and reuse; and
- treatment and discharge.

The main stream treatment Facilities Plan and the Environmental Assessment considered these concepts with varying degrees of detail. The following paragraphs examine each to determine their viability as a management concept.

4.2.1 Treatment and Land Application

The Facilities Plan examined this concept to the point of developing and costing several application alternatives. The results of this analysis are described in the following paragraphs.

(1) General

The basic assumption of any land based effluent disposal scheme is that secondary treatment equivalency is all the pretreatment required, since the land is intended to be an equivalent replacement for onsite advanced waste treatment technology. At Columbus, the land based system would replace the following major unit processes: metal salt addition for phosphorus removal, nitrification, and final effluent filtration. Thus, a land based liquid disposal system offers the advantage of eliminating the expenditures associated with conventional advanced waste treatment with the benefit of providing both irrigation water and nutrients for growing crops. In Ohio, with a statewide annual precipitation of 32 to 44 inches, irrigation water is of little benefit. Corn yields statewide range from 110 to 125 bushels per acre and up without irrigation. Depending on the type of land application system utilized, the impact on a receiving body of water may be less than noted with a conventional treatment and discharge system carrying an equivalent pollutant load due to the nonpoint nature of the flow from most land based systems.

The Facilities Plan investigated three basic types of land application procedures: irrigation, infiltration-percolation, and overland flow. Irrigation involves the application of wastewater by spraying or surface spreading. Treatment is accomplished by a combination of physical, chemical, and biological means. Such a system may be designed for limiting nutrient discharge, maximizing cash return from sale of crops, water conservation in normal irrigation practices, or to preserve and enlarge green belts and open space.

Infiltration-percolation is similar to irrigation except that wastewater is applied at a higher rate. System design may have the objective of groundwater recharge, treatment and collection of applied flow, or treatment and dispersed release through buried transport conduits.

Overland flow is essentially a biological process in which the applied wastewater is permitted to flow in a thin sheet over a sloped, relatively impermeable land area. Product water is collected and either discharged or recycled to an irrigation or infiltration-percolation system.

All three systems, if properly located and managed, will provide BOD and suspended solids removals of 90-99 percent. Nutrient removals are more variable, depending to a large extent on crop uptake. Infiltration-percolation generally is the poorest system in regard to nutrient removal and the growth of marketable crops, but provides the best means of groundwater recharge, cold weather operation, and product water recovery. Care must be exercised in all systems to assure proper control of aerosols and water-borne contaminants through provision of adequate buffer zones and monitoring facilities. Loading rates must be controlled so as to not tax the treatment capabilities of the soil with regard to hydraulics, nutrient uptake, cation exchange capacity, or toxicity limitations, especially as related to heavy metals.

(2) Potential Application Sites and Site Characteristics

Application sites considered in the Facilities Plan had to meet at least the following criteria:

- proximity to transportation routes;
- proximity to the two wastewater treatment plants;
- land to be primarily within Franklin County;
- large parcels of land readily available.

To satisfy these points, only land areas to the south of Columbus were considered further.

Five sites which fulfilled the above criteria were deemed as suitable for receiving the treated Columbus wastewater. An exact delineation of these areas will

not be provided here, for, as the Facilities Plan points out, they will be large enough to treat only a small percentage of the total wastewater flow and serve only to develop representative and acceptable effluent loading rates.

The topography of the sites selected is representative of the Till Plains of the Central Lowlands province. Relief is generally less than 50 feet, with surface water courses in shallow valleys. Soils are generally moderately well drained, medium acidic, and moderately high to high in crop productivity. Groundwater may occur in lenticular deposits embedded in clay throughout the area, but uniformly high yields are principally available from the underlying limestone and outwash deposits near the Scioto River and Big Walnut Creek. The latter source would be the most susceptible to impact by the induced infiltration resulting from a land application system.

Based on records of first and last freezing temperatures, it was assumed in the Facilities Plan that any land treatment system could operate only 35 weeks per year. Historic average precipitation during this operating period has been 0.73 inches/week, with an average evapotranspiration of 0.88 inches/week. Soil permeability in the possible application areas averages 15 feet/week.

A water balance performed using the above data indicates that an application rate of 1.95 inches of effluent per week would satisfy hydraulic requirements for a spray irrigation system (the most rate limiting of the three application types) during the annual operating period. However, an analysis of the nitrogen budget, assuming corn as the crop being grown, produced an allowable irrigation rate of only 0.65 inches per week. Due to the many assumptions and uncertainties involved, a compromise rate of 1.0 inches/week was chosen as the basis for irrigation design in the Facilities Plan, with application rates of the other two types of application systems proportionately greater. The buildup of toxic materials and the attendant life of an application area was not addressed in the published portion of the Plan.

(3) System Requirements and Costs

Six types of land application systems were costed in the Facilities Plan. Four of these were variations on irrigation systems utilizing buried spray on crops or woodlands, center pivot spray, and surface irrigation by ridges and furrows. Costs were also developed for infiltration-percolation and overland flow applications. Common requirements for all systems include a storage reservoir capable of holding 17 weeks of effluent flow at 185 mgd, and pumping and transportation facilities (pipelines) to bring the treated wastewater to the point of land application.

Table IV-3 summarizes the land requirements and cost estimates for the six alternate application schemes. Secondary treatment costs at the Jackson Pike and Southerly Wastewater Treatment Plants were estimated since they were not clearly defined in the Facilities Plan. Conveyance and application costs were indexed to 1974 for direct comparison.

The four irrigation systems are the most expensive, followed by overland flow and infiltration-percolation. Unfortunately, the silty types of soil present in the possible application areas are not well suited to infiltration-percolation, and probably preclude its use. The next cheapest alternative, overland flow, has little supportive documentation of its effectiveness as a reliable wastewater treatment device, particularly in terms of phosphorus removal.

The costs for the proposed project plan are presented for reference purposes; it is seen that the least cost land based alternative, which has questionable technical applicability, is some 25 to 30 percent more expensive to implement than a treatment and discharge system (when land costs are considered) with essentially the same operating cost.

A common drawback of all land application alternatives is the enormous amounts of land required, which range from 12,000 to 70,000 acres (19-109 square miles). Most of this area is presently classified as prime farmland, and three of the six alternatives, including the two shown to be most cost-effective, would not permit marketable crop production; while the other three would likely reduce or restrict present land production capabilities.

Table IV-3
Facilities Plan Cost Estimates For Land Application Alternatives

Alternative	Land Requirement Acres	Cost Estimates, Millions of Dollars					
		Capital Costs			Annual Operating Costs		
		Treatment (1)	Conveyance and Application (2)	Total	Treatment (3)	Conveyance and Application (4)	Total
Buried solid set Spray, crop irrigation	70,000	$115.2	$292.5	$407.7	$ 7.5	$2.3	$ 9.8
Above, woodland irrigation	70,000	115.2	252.8	368.0	7.5	8.7	16.2
Center pivot spray, crop irrigation	45,000	115.2	188.0	303.2	7.5	2.3	9.8
Surface irrigation	70,000	115.2	148.4	263.6	7.5	4.9	12.4
Overland flow	25,000	115.2	109.9	225.1	7.5	5.5	13.0
Infiltration - Percolation	12,000	115.2	75.8	191.0	7.5	3.3	10.8
Treatment and Discharge	-	159.0	-	159.0	11.2	-	11.2

(1) Developed by eliminating chemical addition, first stage bio-stabilization, effluent filter, and proportional HAVC costs from Jackson Pike, and effluent filter and proportional contingency from Southerly.
(2) Excluding land purchase price at $1,000 per acre (Facilities Plan Cost).
(3) Largely developed by excluding chemical costs for phosphorus removal, energy for nitrification and final effluent filtration at both plants, and first stage biological treatment at Jackson Pike with attendant reduction in manpower.
(4) Net costs, including revenue from corn production at $244 per acre (Facilities Plan Cost).

An unanswered question for a land based application scheme concerns the rights of downstream users of the Scioto, particularly during the nonoperating time of each year when no flow is returned to the River. The Division of Water of the Ohio Department of Natural Resources has expressed particular reservations to a land based plan due to this flow depletion and the need for land which is presently classified as "prime" farmland.

4.2.2 Treatment and Reuse

Treatment and reuse of the wastewater is an attractive environmental goal. The definable reuse options for the two Columbus plants are fourfold: drinking water, plant water, aquifer recharge, and cooling water. The applicability of each to the Columbus situation is discussed in the following paragraphs.

(1) Drinking Water Reuse

The Environmental Assessment of the Facilities Plan considered the feasibility of preparing the wastewater to the point suitable for potable reuse. It was concluded that the present availability of superior raw water sources caused the drinking water reuse option to not be viable. Data presented in the Assessment estimated a future water demand on the Columbus system of about 250 mgd, with a developable upstream reservoir safe yield of about 350 mgd. The ultimate supply from Delaware County sources was estimated to be 530 mgd.

(2) Plant Reuse

Wastewater treatment plants normally practice some form of effluent reuse for scrubber water, washdown operations, sealing water, and landscape maintenance. As practiced at Jackson Pike and Southerly, these uses amount to less than five percent of the plant's flow, with the actual consumptive use limited to landscape maintenance. There is no opportunity to increase the plants' internal reuse of effluent in the future.

(3) Aquifer Recharge

Another wastewater reuse application that has been considered is the recharge of the sand and gravel aquifers adjacent to the Scioto River in the vicinity of Walnut Creek. Such a system was deemed to not be

feasible for two major reasons: the potential need to achieve a total nitrogen concentration of 10 mg/l or less in the injected effluent, and the possibility of severe surface water flow depletion under low flow conditions.

The first objection points to the need for more sophisticated treatment than required by either the NPDES limits or by water quality standard maintenance demands. Capital costs in addition to those involved in a treatment and discharge system would be brought about both by the inclusion of an onsite nitrogen removal capability (e.g., fractional flow treatment by denitrification) and by the equipment required for transport and injection of the effluent.

The problems involved in surface flow depletion are fairly serious, and encompass legal as well as environmental concerns. As mentioned in the section on land application of effluent, state regulatory agencies have already expressed their disapproval of any treatment system which will adversely affect downstream surface water uses by lowering flow quantities.

(4) Cooling Water

Present planning in the Columbus Metropolitan Area presents the possibility of reusing the effluent from the Jackson Pike plant as cooling water for a proposed coal- and refuse-fired power generating plant which would be owned and operated by the Columbus Division of Electricity. The proposed plant, as envisioned by a 1975 report from the consulting firm of A.E. Stilson and Associates, would be located just south of the Jackson Pike Treatment Plant and designed for either a 60 or 90 megawatt power generation capability. The proposed condenser cooling system incorporates a composite of once-through cooling with supplemental makeup from a cooling tower recycle. The estimated water needs are 95 or 130 mgd, depending upon whether or not a 60 or 90 megawatt installation is constructed. Jackson Pike's estimated annual average flow is between these two extremes both now and in the year 2000. Thus, the Jackson Pike effluent could potentially satisfy the majority, if not all, of the cooling water requirements of the proposed power plant.

The concept of using treated plant effluent as a cooling water source is not unique, but rarely do needs so closely match in terms of quantity and proximity. The possibility of directly using the Jackson Pike effluent in a cooling function at the proposed power plant should be investigated at a detail beyond the scope of this Environmental Impact Statement since, although diluted by the background river, some indirect reuse will undoubtedly occur with the present location of the plants. The apparent advantages are as follows:

- potential elimination or reduction of more expensive cooling tower requirements;
- potential elimination or reduction of river water withdrawals and impact upon the organisms which may be drawn into the intake;
- more consistent cooling water quality with potential return of pretreatment expenditures; and
- a beneficial use of the Jackson Pike effluent prior to discharge to the Scioto River.

However, these advantages must be weighed against the following considerations:

- a cooling water quality that can be expected to promote the growth of slimes and deposits more so than a mixture of river water and effluent, and
- regulatory control and municipal personnel responsibility for a single discharge that meets the combined NPDES restrictions for a thermal release and a wastewater effluent.

If it is assumed that the water quality considerations do not present a significant technical barrier, then the City of Columbus has a favorable institutional framework to make the concept work, since both the Jackson Pike Wastewater Treatment Plant and the proposed power plant fall under the common public aegis of the City. This option can be preserved with little additional expense simply by provision of a bulkhead in the chlorine tank at Jackson Pike and the maintenance of a clear route between the treatment plant and the power facility.

4.2.3 Treatment and Discharge

(1) Chlorine Disinfection, Dechlorination, and Post Aeration

As pointed out in Appendix I, the present NPDES permit requirements may result in instream chlorine toxicity problems at some flow regimes. If the Jackson Pike plant reaches 100 mgd and achieves its required chlorine residual of 0.5 mg/l, then an upstream Scioto River flow of about 770 cfs would be required to assure complete freedom from chlorine toxicity. Normal summer Scioto River flows are below this minimum. Further, a chlorine residual of 0.5 mg/l and a fecal coliform count of less than or equal to 200 counts per 100 ml are inconsistent from the standpoint of the normal chlorine dosage and demands that are encountered when attempting to achieve a high level of disinfection with a nitrified, filtered wastewater effluent. Thus, the present NPDES requirements force the use of dechlorination concepts whether or not instream chlorine toxicity is considered. Finally, since the most economical dechlorinating agent (sulfur dioxide) is also a deoxygenating agent, post-aeration becomes a design requirement to protect against the inevitable overdosing that may occur with attempts to dechlorinate.

The preceding discussion suggests the construction of facilities that will allow successful achievement of the NPDES restrictions and protection from instream chlorine toxicity with an operation that addresses seasonal flows and the downstream impact of the wastewater releases. It is probable that dechlorination of the plant effluent is not technically justified from the standpoint of instream chlorine toxicity for at least half of the year. This consideration alone would allow a fifty percent reduction in the annual expenditure for dechlorination.

More fundamentally, the question of year around disinfection requirements needs to be addressed. Throughout its entire 40 years of service, Jackson Pike has never practiced chlorine disinfection. Table IV-4 summarizes the recent water quality data above and below Jackson Pike as reported in Appendix C of this report. The assumed coliform levels of 100,000 and 200 counts/100 ml, respectively, reflect the absence and presence of disinfection at Jackson Pike. It is seen that Jackson Pike apparently causes a substantial increase in fecal coliform counts at all flow regimes

Table IV-4
Measured and Anticipated Fecal Coliform Counts

Scioto Flow at River Mile 26.8+ (1)	Number of Observations	Median Fecal Coliform (No/100 ml)			
		Recent Water Quality Data At River Mile		Jackson Pike Effluent Quality (2)	
(cfs)	(1975-1976)	27.5	24.2	100,000	200
100-500	≤ 50	2,700	21,000	35,000	1,900
500-1,000	≤ 20	4,500	14,500	20,000	3,800
1,000-5,000	≤ 14	3,100	8,200	7,710	3,000
5,000+	≤ 3	5,000	2,000	5,000+	5,000

(1) Average Annual Flow = 1,383 cfs
(2) Jackson Pike Discharges at River Mile 26.8, assumed plant flow = 150 cfs, assumed Scioto flow = 300, 750, 3000, and 5000 cfs.

below 1,000 cfs; thereafter, the impact of the plant becomes less significant. It is also observed that disinfection makes little impact upon instream coliform counts at flow regimes above 1,000 cfs, and that median coliform levels will consistently remain above the present 200 counts/100 ml general water quality standard. Again, from a technical standpoint, there appears to be little need to practice chlorination for more than about six months out of the year. If a chlorine cost of $0.15/pound is assumed along with a total wastewater flow of 180 mgd and a chlorine dose of 3 mg/l, then an operational expenditure of about $125,000 per year could be saved by chlorinating only six months of the year. This savings translates to about $200,000 per year if the potential dechlorination costs are included.

(2) Present and Future Required Final NPDES Treatment Levels

Appendix B, Mathematical Characterization of the Scioto River below Columbus, suggests a need for a higher performance level than presently defined in the NPDES permits for both Columbus plants during critically low stream flows.

However, under normal summer conditions, with the conceptual technology proposed, an ammonium free effluent with a BOD_5 of less than 5 mg/l can be anticipated. An ammonium free effluent could be guaranteed with a backup breakpoint chlorination system designed to remove any ammonium leakage from the system. (A chlorine dose of 10 mg/l will reliably eliminate one mg/l of ammonium nitrogen). Thus, the performance of the plants will probably approach that defined by the computer model for Jackson Pike under the seven consecutive day, ten year low flow regime with the proposed technology and easily implemented increased chlorination capabilities.

A second consideration deals with the modeling procedures used to define the required effluent limitations for oxygen demanding materials. No assumption was made for a lower rate of deoxygenation until an L_o value of 3 mg/l was achieved. It is probable that an attenuation of the rate will progressively increase as L_o values approach assumed future conditions. Thus, at the final effluent requirements, it is probable that the model's predictions for instream dissolved oxygen are unduly severe.

Collectively, the realities of technology and the limitations of the dissolved oxygen water quality model support the recommendation that the present NPDES permit limitations for oxygen demanding pollutants under critical low flow conditions remain the same as presently defined by the Ohio Environmental Protection Agency. The need for additional technology to maintain water quality standards beyond that achievable with the proposed concepts should be proven by stream surveys under conditions of improved plant operation before additional money is spent to this end.

4.2.4 Conclusions

An examination of the three alternate methods discussed for disposal of the product liquid derived from wastewater treatment reveals the following:

- The least cost land application alternative suffers from formidable implementation considerations, some technical reservations, and a first cost some $44 million more than the proposed project plan with nearly equivalent operating expenditures. This alternative is not considered viable for the Columbus plants.

- The potential reuse of the Jackson Pike effluent as a source of cooling water for a proposed 60 to 90 megawatt coal- and refuse-fired power generating station appears to suffer from no major technical or implementation reservations, with a possible benefit in terms of the environment and operating expenditures at the power plant. It is recommended that this beneficial use of the Jackson Pike effluent be thoroughly explored by the City of Columbus before the onset of detailed design for both the Jackson Pike improvements and the power plant. This reuse consideration has no bearing on the conceptual treatment technology proposed in the Facilities Plan. It should be noted that construction of this power facility is still questionable even though the bond issue has been passed.

No change in the seven consecutive day, ten year low flow effluent limitations for oxygen demanding materials or the conceptual technology to achieve these residuals is recommended at this time. Before additional money is spent for technological improvements beyond the potential of the proposed system, detailed stream surveys should be conducted under conditions of improved plant performance to determine whether or not water quality standards will truly be violated. A dechlorination and post-aeration capability is recommended at both plants to eliminate the potential for instream chlorine toxicity and to meet the NPDES requirements at low flow regimes.

4.3 GOAL ANALYSIS: PRODUCT SOLIDS

This section of the report examines the various ultimate disposal concepts that may be available for the product solids derived from the Columbus wastewater treatment plants. It begins with a characterization of the potential waste products (sludge and ash) as quantified in this Environmental Impact Statement. Codisposal opportunities, four resource recovery schemes, and a landfill disposal option are then addressed. The section closes with specific conclusions for the Columbus situation.

The quantities cited for the wastewater treatment plants assume the implementation of the brewery pretreatment strategy defined in Section 4.1.3 (soluble oxygen demand control at the brewery with elimination of the trickling filter - intermediate sedimentation complex at Southerly) and incorporation of the recycle management system recommended in Appendix J (fractional to complete anaerobic stabilization of the thermally conditioned product sludge and elimination of the isolated aerobic treatment system for stabilization of the thermally conditioned sludge concentration liquors).

4.3.1 Waste Product Characterization

Tables IV-5 and IV-6 summarize measured characteristics of the waste solids at the Jackson Pike and Southerly Wastewater Treatment Plants, respectively. The product from the thermal conditioning system was sampled three times over an elapsed period of one month. The raw sludge source for this product was largely waste secondary sludge. Raw primary

Table IV-5

Jackson Pike Solids Analyses

(Total= mg/kg TS , Soluble= mg/l on 0.45μ filtrate, unless otherwise noted)

	Before Thermal Conditioning		After Thermal Conditioning						Ash		Sludge Lagoon	
	4-21-77		4-21-77		5-11-77		4-11-77		5-11-77		5-11-77	
PARAMETER	Total	mg/l	Total	mg/l	Total	mg/l	Total	mg/l	Total	mg/l	Total	mg/l
BASIC ANALYSES												
Total Solids-kg/l	0.039	3,400	0.148	4,900	0.154	8,300	0.138	6,900	-	-	0.340	1,800
Total Vol. Solids	630,000	2,000	560,000	3,900	530,000	6,900	570,000	5,300	9,500	-	370,000	670
BTU-BTU/Lb TVS	12,000	-	13,000	-	13,000	-	13,000	-	-	-	9,000	-
BASIC STRUCTURE												
Total Carbon	-	-	220,000	-	360,000	-	360,000	-	-	-	220,000	-
Hydrogen	-	-	13,000	-	52,000	-	33,000	-	-	-	27,000	-
Nitrogen	-	290	17,000	970	17,000	1,200	16,800	880	-	-	14,000	180
Oxygen	-	-	280,000	-	77,000	-	125,500	-	-	-	27,000	-
Phosphorus	20,000	44	20,000	200	22,000	170	25,000	280	64,000	-	20,000	3
Sulfur	7,900	-	10,900	-	7,900	-	7,200	-	-	-	7,100	-
METALS												
Aluminum	13,000	<0.12	19,000	0.12	22,000	0.24	15,000	<0.10	22,480	-	20,000	-
Arsenic	9.6	0.002	8.1	0.01	9.6	0.028	6.6	0.013	6	-	17	-
Boron	-	-	-	-	390	0.1	-	-	-	-	-	-
Cadmium	38	0.012	6.1	0.008	56	0.008	24	0.008	75	-	20	-
Chromium	780	0.044	950	7.5	890	1.06	550	0.021	890	-	460	-
Copper	600	0.021	720	0.021	830	0.03	670	0.039	1,080	-	460	-
Gold	-	-	0.30	0.016	-	-	-	-	1.4	-	-	-
Iron	18,000	53	24,000	90	29,000	92	15,000	78	51,000	-	26,000	-
Lead	270	0.062	450	<0.012	680	0.07	180	<0.017	910	-	330	-
Mercury	3.9	<0.0006	3.9	<0.0006	3.8	0.00075	4.7	0.02	0.00002	-	4.9	-
Nickel	350	0.061	410	0.65	530	1.4	320	1.02	570	-	240	-
Silver	14	0.015	11	0.012	78	0.012	14	0.008	77	-	38	-
Zinc	2,500	0.06	3,500	0.23	4,700	0.086	2,900	0.30	3,640	-	2,600	-
ORGANICS												
Arochlor 1248	<19	-	<5.1	-	<4.9	-	<5.4	-	-	-	<2.2	-
Arochlor 1254	<7.8	-	<2.0	-	<2.0	-	<2.2	-	-	-	<0.9	-
Chlorobenzenes												
Ortho- and Para-	34	-	12	-	6.5	-	13	-	-	-	4.7	-
1,2,4-Tri	1.0	-	0.3	-	1.5	-	0.4	-	-	-	0.4	-
COD	810,000	2,000	830,000	10,000	1,140,000	13,000	900,000	11,000	-	-	320,000	570
Cyanide	-	-	-	-	36	-	-	-	-	-	-	-
Oil and Grease	-	-	-	-	217,000	-	-	-	-	-	-	-
Phenolics	-	-	-	-	72	-	-	-	-	-	-	-
MISCELLANEOUS												
Alkalinity	105,000	1,900	74,000	1,900	58,000	1,800	23,500	1,700	14,000	-	58,000	1,300
Calcium	32,000	-	7,600	-	6,400	-	6,400	24	78,000	-	14,000	253
Chloride	-	93	-	230	-	210	-	150	-	-	-	91
Magnesium	5,500	-	6,300	-	7,300	-	7,000	92	10,000	-	11,000	70
Potassium	4,100	-	2,100	-	3,400	-	1,600	71	4,700	-	5,300	100
Sodium	3,400	-	1,000	-	910	-	450	66	3,000	-	980	180

Table IV-6
Southerly Solids Analyses
(Total= mg/kg TS, Soluble= mg/l on 0.45μ filtrate, unless otherwise noted)

PARAMETER	Before Thermal Conditioning		After Thermal Conditioning						Ash	
	5-11-77		5-11-77		4-21-77		4-11-77		5-11-77	
	Total	mg/l	Total	mg/l	Total	mg/l	Total	mg/l	Total	mg/l
BASIC ANALYSES										
Total Solids Kg/l	0.024	1,670	0.105	8,400	0.079	7,200	0.094	8,800	-	-
Total Vol. Solids	750,000	780	700,000	6,400	710,000	6,000	660,000	7,200	16,500	-
BTU-BTU/Lb TVS	11,000	-	12,000	-	11,000	-	12,000	-	-	-
BASIC STRUCTURE										
Total Carbon	-	-	440,000	-	430,000	-	410,000	-	-	-
Hydrogen	-	-	60,000	-	60,000	-	56,000	-	-	-
Nitrogen	115,000	920	34,000	1,530	40,900	1,500	40,000	1,600	470	-
Oxygen	-	-	133,000	-	154,000	-	134,000	-	-	-
Phosphorus	39,000	260	20,000	410	23,000	380	24,000	400	72,000	-
Sulfur	9,200	-	6,700	-	7,100	-	7,300	-	-	-
METALS										
Aluminum	4,900	∠0.4	850	0.6	9,300	∠0.07	12,000	0.21	32,000	-
Arsenic	8.6	0.002	0.9	0.010	3.4	0.010	2.9	0.004	18	-
Boron	-	-	28	∠ 0.1	-	-	-	-	-	-
Cadmium	380	0.005	56	0.010	47	0.012	63	0.009	56	-
Chromium	300	0.12	310	0.53	450	0.94	320	0.45	1,390	-
Copper	280	0.05	360	0.02	330	0.021	350	0.03	1,730	-
Gold	-	-	0.41	0.03	-	-	-	-	2.2	-
Iron	7,900	16	8,000	83	9,400	38	7,740	15	32,000	-
Lead	250	∠ 0.02	460	0.18	390	∠0.01	300	∠0.02	1,900	-
Mercury	9.3	0.0015	6.0	0.0016	3.9	∠0.0006	4.9	0.013	0.0002	-
Nickel	55	0.05	62	0.25	54	0.27	49	0.21	180	-
Silver	23	0.005	33	0.011	28	0.012	29	0.008	36	-
Zinc	1,600	0.07	1,900	0.48	2,000	0.95	2,200	0.20	3,230	-
ORGANICS										
Arochlor 1248	∠32	-	∠7.2	-	∠9.5	-	∠8.0	-	-	-
Arochlor 1254	∠13	-	∠2.9	-	∠3.8	-	∠3.2	-	-	-
Chlorobenzenes										
Ortho- and Para-	25	-	8	-	10	-	15	-	-	-
1, 2, 4-Tri	4.2	-	1.0	-	0.25	-	1.2	-	-	-
COD	1,250,000	7,100	1,100,000	17,000	1,000,000	13,000	980,000	14,000	8,000	-
Cyanide	-	-	7.7	-	-	-	-	-	-	-
Oil and Grease	-	-	192,000	-	-	-	-	-	-	-
Phenolics	-	-	59	-	-	-	-	-	-	-
MISCELLANEOUS										
Alkalinity	105,000	2,420	20,000	2,000	37,000	2,600	31,500	2,500	13,400	-
Calcium	20,100	-	5,400	-	5,700	24	5,300	18	80,000	-
Chloride	-	120	-	380	-	200	-	310	140	-
Magnesium	7,300	-	6,000	-	5,500	115	5,500	110	11,000	-
Potassium	9,400	-	3,000	-	2,400	130	2,200	170	13,000	-
Sodium	4,000	-	1,100	-	700	64	480	51	2,400	-

sludge can be expected to have a similar metal content; lower nitrogen, sulfur, and phosphorus levels; and higher energy, oil and grease, and COD content. The analytical emphasis upon this sludge source was due to the following considerations:

- This would be the product preferentially applied to the land; and
- The multitude and significance of all the various recycles prevents a clear delineation of true raw primary and secondary sludge.

An examination of the heavy metal data shows the metal content of the Jackson Pike sludge is generally 50 to 150 percent greater than the Southerly sludge. The exceptions to this rule appear to be mercury and lead (both plants show similar concentrations), nickel (Jackson Pike shows a concentration about eight times that found at Southerly), and cadmium (Southerly content is approximately 50 percent more than at Jackson Pike).

On one date at each plant, samples were also collected prior to the thermal conditioning system to examine the phosphorus, nitrogen, COD, and metal solubilization brought about by the conditioning process. The samples show a COD and TKN solubilization after thermal conditioning of about 10,000 and 600 mg/l, respectively. Phosphorus solubilization was about 150 mg/l. A soluble phase increase of an order of magnitude or more was noted for chromium, nickel, and zinc. The rise in the latter two appears to be somewhat dependent on the original mass present. Soluble iron levels essentially doubled after thermal conditioning.

Samples were also collected from each plant's ash lagoon and the digested sludge lagoon at Jackson Pike. In general, the relative metal content of the ash should increase due to the volatile solids loss during incineration. The notable exception to this generalization is mercury, which is normally released as an atmospheric emission, the magnitude of which is influenced to some degree by the adequacy of the scrubber.

The sludge samples were also analyzed for representative organic compounds of environmental interest. Only the cyanide content of the Jackson Pike sludge was uniquely high when comparing the single analyses for this compound at both plants. The Columbus sludges were examined for two representative PCB's (Arochlor 1248 and 1254). Neither was found at the detection limits of the analyses.

Chlorobenzene determinations were limited to a grouping of para- and ortho-dichlorobenzene and trichlorobenzene. Chlorinated benzenes are extensively used in industry. Para- and ortho- dichlorobenzene are manufactured in large quantities (1972 U.S. production figures are 77 and 62 million pounds, respectively). Over 90 percent of the para-dichlorobenzene consumed in the U.S. function through vaporizing applications, such as in moth repellant, mildew retardant, and space deodorizer. A common application is the deodorant cakes used in public urinals. Ortho-dichlorobenzene is used in cleaning solvents for engine parts, heat transfer media, rustproofing, degreasing agents, solvents for lacquers and resins, dye intermediates, pesticides, insecticides, and odor control at sewage treatment plants. Trichlorobenzenes are used as solvents of oil soluble dyes and grease, dielectric fluids, lubricative oil additives, and insecticides.

These benzene compounds are as toxic as some of the PCB formulations, and are known to be mitostatic poisons causing disorders of cell division which lead to inhibition of cell wall formation and binucleate or multinucleate cells. Their common use in society poses fundamental environmental questions concerning man's impact upon the natural environment. To date, they have received little attention. EPA will be evaluating the plant toxicity and plant uptake potential of the chlorobenzenes identified in the Columbus sludges in its Office of Pesticides Programs laboratories in Beltsville, Maryland. These studies should establish in the final EIS whether or not the concentrations of these chlorobenzenes in the Columbus sludge pose a problem for the land application alternative with regard to adverse impacts.

A study of pesticide disposal in a sewage sludge incinerator[1] indicates that "DDT and 2, 4, 5, - T (2, 4, 5 - trichlorophenoxyacetic acid) can be safely destroyed by coincineration with sewage sludge in a multiple hearth furnace. It appears probable that other pesticides with a similar chemical nature to DDT or 2, 4, 5 - T could also be safely destroyed via this technique."

Although studies have shown the presence of these benzene compounds in human tissue,[2] in many cases the exact mechanism

(1) "A Study of Pesticide Disposal in a Sewage Sludge Incinerator," EPA 68-01-1587, USEPA, 1975.

(2) Young, David R., and Heeser, Theodore C., "Inputs of Chlorinated Benzenes," Annual Report for the Year Ended 30 June 1976; Southern California Coastal Water Research Project, El Segundo, California.

which caused them to appear and their source is not always well understood. The volatility of these compounds, particularly in relation to PCB's, causes some experts to question whether they are stable enough to constitute as great a hazard as PCB's.[1] Mention is provided in this report simply to point out the magnitude of these trace organics and the possibility of their becoming an environmental concern in the future. Further, their presence serves to illustrate the point that many potentially harmful trace organics can be concentrated in the waste solids from municipal wastewater treatment plants. The isolation of only one of these compounds at certain concentrations, as has been the case with PCB's, could totally exclude the application of the waste solids in agricultural applications until the concentration of that substance can be reduced to a level considered to be safe for application on farmland.

4.3.2 Codisposal Opportunities

The ideal waste solids management program for a jurisdiction as large as the Columbus Metropolitan Area should consider all of the joint processing opportunities for the wastes and refuse generated within the City's service area. The Columbus Department of Public Service, which includes the Divisions of Water, Sewerage and Drainage, Solid Wastes, and Electricity, has the existing management structure to implement a broad-based codisposal program should a viable opportunity be identified. This section examines the feasibility of several codisposal alternatives that could be managed under the present Departmental system.

(1) Wastewater Solids

Table IV-7 summarizes the approximate chronological development of dry waste solids produced by the two Columbus wastewater treatment plants. The combined dry tonnage of the dewatered sludge cake will be approximately 180 tons/day in the design year.

The nearly completed 8-inch diameter, seven mile long Jackson Pike to Southerly sludge force main offers the

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(1) Personal Communications, Drs. George Fries and Ralph Nash to Dr. John Walker, Physical Scientist, Municipal Technology Branch, USEPA.

Table IV-7
Approximate Chronological Development
of Wastewater Treatment Solids
(Average dry tons per day, nearest 5 tons/day)

Source	Year		
	1980	1990	2000
Jackson Pike			
Dewatered Sludge Cake			
Primary Solids	55	60	60
Secondary Solids	35	35	40
Total Solids	90	95	100
Incinerator Ash	40	40	40
Southerly			
Dewatered Sludge Cake			
Primary Solids	15	20	25
Secondary Solids*	40	50	55
Total Solids	55	70	80
Incinerator Ash	15	20	25
Total			
Dewatered Sludge Cake			
Primary Solids	70	80	85
Secondary Solids	75	85	95
Total Solids	145	165	180
Incinerator Ash	55	60	65

* Thermally conditioned solids - contains all of the secondary sludge and 66% of the primary solids, feed to the thermal conditioning system contains a mixture of 40% secondary solids and 60% primary solids

flexibility of processing some of the Jackson Pike solids at Southerly. The rated capacity of the force main is a nominal 550 gpm, or about 130 dry tons per day of a sludge containing four percent solids. Clearly, this installation has the capacity to transport the average day Jackson Pike conditioned and thickened solids production to Southerly. Thus, the engineering analysis of the proposed Jackson Pike project plan (Section I.4.3) concluded that the maximum day standby incinerator could be eliminated, with Southerly providing all of the solids handling standby capacity needed for both plants. Existing construction commitments for dewatering and incineration equipment at Jackson Pike preclude the establishment of any additional savings through joint processing concepts at Southerly.

If three incinerators are constructed at each plant, an alternative standby capability can be provided by landfilling of sludge.(1) This alternative provides immediate standby reliability for sludge processing (via landfilling during construction of the proposed incinerators) and provides the capability of utilizing the secondary solids on strip mine land when that option becomes viable. In the event the municipal power plant is built, it may be used as an additional facility for standby sludge disposal. Thus, a decision to make the sludge force main operational at a capital cost of $3 to $3.5 million would have to demonstrate that it is more cost-effective than other standby options as well as identify the optimum direction which the sludge will be pumped.

The interconnecting force main does present the additional possibility of a single ash lagoon installation at Southerly to satisfy the joint needs of both treatment plants. This option will necessitate a sludge-flush-ash-flush pumping cycle with special storage considerations at Southerly. It is probably that the first cost of these needs will be less than the construction of new Jackson Pike lagoons, but electrical energy costs will rise in compensation. The overall cost-effectiveness of such an operation will be dependent upon both the location of the ultimate disposal site in relation to Jackson Pike and Southerly and the frequency of lagoon cleaning.

(2) Water and Wastewater Treatment Solids

The City of Columbus is presently served by two major water treatment plants at Morse and Dublin Roads and a small installation at Nelson Road. In 1975, these plants produced approximately 100 mgd of product

(1) Only thermally conditioned solids are suitable for landfilling from the proposed process sequences, which implies that primary sludges must be preferentially incinerated under standby operation conditions in order to provide both a disposal means for the primary solids and steam for use in thermal conditioning.

water from a 107 mgd supply. Of this total, essentially 70 percent of the supply was furnished by Morse Road, with the Dublin Plant providing most of the remaining 30 percent. The Nelson Road plant processed an average of only about 0.01 mgd. A future 50 mgd Parsons Avenue plant, presently under design, will serve the expanding southern portion of the Columbus service area. Eight remote wells will serve as the raw water source for this facility.

Table IV-8 summarizes the estimated waste water treatment solids production for the 20 year planning period. These estimates were obtained from an examination of the 1975 chemical usages at the Dublin and Morse Road facilities, reported changes in the water quality, and an assumed suspended solids to turbidity ratio of 4:1. In 1975, the Dublin Road installation (treating Olentangy and Scioto River water) was calculated to produce approximately three tons of solids per million gallons of water processed. The yield from the Morse Road Plant (treating Big Walnut Creek water from Hoover Reservoir) was approximately half this value.

The future solids production scenario assumes that the Morse Road and Parsons Avenue Plants will meet most of the future water demand, and that the water supply to wastewater production ratio will change from the 100:77 (1.40) value found in 1975 to a 119:104 (1.14) value in the year 2000. These assumptions reduce the accuracy of the estimates in Table IV-8 to an order of magnitude, with the tolerance increasing as one moves away from the 1975 known conditions.

As can be seen from Table IV-8, Columbus' water treatment plants are predicted to produce over 200 tons per day of waste solids throughout the 20 year planning period. These solids are dominated by nearly equal parts of precipitated calcium carbonate ($CaCO_3$) and captured turbidity. Precipitated hydroxides ($Al(OH)_3$ and $Mg(OH)_2$) make up approximately five percent of the total average day waste solids mass. The Parsons Avenue Plant may exhibit a lower level of turbidity solids with a somewhat compensating gain in $CaCO_3$ if softening is practiced.

Table IV-8
Estimated Chronological Development
of Water Treatment Solids
(Average dry tons per day, nearest 5 tons/day)

Source	Year		
	1980	1990	2000
Dublin Road			
$Al(OH)_3$	Trace	Trace	Trace
$CaCO_3$	55	55	55
$Mg(OH)_2$	5	5	5
Turbidity (1)	35	40	40
Total Solids	95	100	100
Morse Road-Parsons Avenue			
$Al(OH)_3$	5	5	5
$CaCO_3$	55	60	65
$Mg(OH)_2$	Trace	5	5
Turbidity(1)	55	60	60
Total Solids	115	130	135
Total			
$Al(OH)_3$	5	5	5
$CaCO_3$	110	115	120
$Mg(OH)_2$	5	10	10
Turbidity(1)	90	100	100
Total Solids	210	230	235

(1) Assume Suspended Solids: Turbidity= 4:1

Presently, the Division of Water does not plan to attempt $CaCO_3$ calcination and CaO reuse (except at Parsons Avenue) due to energy considerations and the probable variability and low CaO content of the resultant product. The present system is to dispose of the waste solids at an abandoned quarry purchased by the City several years ago. The Dublin Road sludge force main to the quarry was recently completed. The City plans to let an engineering contract for a Morse Road sludge force main to the same quarry in the near future. It was assumed that the future Parsons Avenue solids would also be disposed of in the same manner. At a nominal 110 acre area and depths up to 95 feet, the quarry provides an ultimate water treatment solids disposal site with a usable volume of 2300 million gallons. A practical service life of approximately 60 years has been assumed by the City of Columbus, a value which may be somewhat conservative. (Solids characterization suggests a possible 75 year life.)

The quarry offers an opportunity for ultimate codisposal of the incinerator ash from the wastewater treatment plants. Introduction of a nominal 60 tons per day of ash would lower the service life of the quarry by only about 20 percent. Collection of the quarry's overflow in the Columbus sewerage system would close the cycle and yield a total codisposal plan completely under the control of the Columbus municipal government. Further, the high pH of the mixed concentrate in the quarry would, in time, minimize the solubilization of heavy metals and phosphorus in the incinerator ash.

The availability of the quarry suggests that the City of Columbus consider a means of dry ash storage and handling for both Jackson Pike and Southerly with weekday, daylight conveyance. Other options include force main conveyance of an ash slurry or continuation of the present lagoon storage concept with infrequent contract collection and haul of the ash to the quarry.

(3) Refuse and Wastewater Treatment Solids

A 1974 City/Ohio State University School of Public Administration Task Force recommended the phasing out of the present municipal power plant and the construction of a new facility fueled primarily by residential, commercial, and industrial refuse. Accordingly, in

1975 the City commissioned A.E. Stilson and Associates to develop and evaluate the feasibility of such an installation. The Feasibility Report determined that a 90 megawatt capacity would be required by 1995, and recommended the initial construction of a full ultimate capacity facility as opposed to a staged construction alternative.

The estimated refuse quantities generated in the planning area are summarized in Table IV-9. The proposed plant will provide an outlet for the residential refuse generated in the City and 50 percent of the remaining portion of Franklin County, and all area industrial/commercial refuse. Projected refuse quantities can satisfy 62 and 79 percent of the plant's energy requirements in 1980 and 2000, respectively. Coal will provide the remaining raw energy source. It was assumed in the Feasibility Report that the maximum amount of refuse that can be burned in combination with coal is 80 percent of the required fuel heat value, and that the facility would use shredded refuse with ferrous metal removed. The shredded refuse will be routed from the City's three new pulverizer stations, all of which obtained operational status in 1975. Boiler and turbine efficiencies were assumed at 75 and 32.5 percent, respectively, giving an overall net efficiency of about 24 percent.

If the proposed plant is constructed, it will eliminate approximately 90 percent of the City's future landfill requirements for refuse disposal. On a City and County basis, the total landfill requirement is reduced by about 60 percent. An ash disposal area of 3.3 acres at a depth of 10 feet is the estimated annual requirement for a daily dry ash production of about 160 tons composed of refuse and coal residuals of 10 and 5 percent, respectively. The proposed application site adjacent to the power plant would be adequate for more than 20 years of plant operation. However, the concept is in conflict with current OEPA policy.

The Stilson Report examined both SO_x and particulate emissions. It concluded that flue gas desulfurization will not be necessary to meet either the anticipated emission limit (2.4 pounds of sulfur oxides per million BTU of heat input) or the ambient air quality standards for the average operating day. The report recommends using low sulfur coal or additional refuse to maintain the SO_x release within the required standards during peak generating periods. Ground level

Table IV-9
Estimated Refuse Quantities for 90 Megawatt
Refuse/Coal Fired Power Plant*
(Average dry tons/day, nearest 5 tons/day)

Source	Year		
	1980	1990	2000
Residential			
City	610	835	1090
County	330	465	610
Total	940	1300	1700
Industrial/Commercial			
Total	640	780	955
Total	1580	2180	2655
Residential To be Burned			
City	610	835	1090
County	165	230	305
Total	775	1065	1395
Ind./Com. to be burned			
Total	320	390	480
Total	1095	1455	1875
Minimum Refuse to be Landfilled	495	725	780
Maximum Ash Production			
Refuse Residue	110	145	190
Coal Residue	10	15	10
Total	120	160	200

*"Summary Report on Phase I-Feasibility of Refuse/Coal Fired Generating Facility" Prepared for the Columbus Department of Public Service by A. E. Stilson and Assoc. Consulting Engineers (December, 1975)

sulfur oxide levels will be minimized by venting the flue gas through stacks 250 feet high. The particulate emission standards will be met by a serial arrangement of medium pressure drop multiclone collectors and electrostatic precipitation polishing.

The location of the proposed power plant adjacent to the Jackson Pike Wastewater Treatment Plant presents the possibility of using the wastewater sludge cake as an additional fuel source. Table IV-10 was developed to examine the potential impact of this alternative. The results indicate that the contribution of the wastewater solids to the total energy usage of the power plant is only about three percent if all of the Jackson Pike and Southerly solids are used, allowing a coal usage reduction of about eight to twelve percent. For this benefit, the power plant would experience a nine to eleven percent increase in input dry solids load and an ash production rate increase of 30 to 50 percent. The percentages reduce by slightly less than one-half if only the Jackson Pike solids are used at the power plant. Another one-half reduction is obtained if only the primary or secondary Jackson Pike solids are used.

It can be concluded that the only significant codisposal impact at the power plant would be in terms of additional ash production. On the other hand, the impact upon the wastewater treatment plants could be substantial, since the cost of conveyance would undoubtedly be less than the cost of constructing, maintaining and operating an incineration and ash disposal complex at both plants. Here, the optimum program would reverse the flow in the sludge force main by providing a new pumping station with Jackson Pike providing complete sludge conditioning and dewatering for the wastes solids from both treatment plants.

Unfortunately, this potential codisposal program of wastewater solids and refuse does not address the present realities of the Columbus situation. Both Jackson Pike and Southerly are presently producing about 80 percent of their year 2000 solids design value, and the refuse/coal fired power generation plant will not be considered by the voters of Columbus until late 1977. Plans for the disposal of the Jackson Pike and Southerly waste solids must continue to assume that the power plant will not be available. However, the

Table IV-10
Comparison of Energy Value of Wastewater Solids with Anticipated Needs

	Year		
	1980	1990	2000
1975 Stilson Report			
Avg. Generation Rate - megawatts	47	59	64
Refuse Usage - ton/day	1,095	1,455	1,875
(1) - megawatt	120	160	206
Coal Usage - ton/day	240	270	180
(2) - megawatt	73	82	55
Total Usage - ton/day	1,335	1,725	2,055
- megawatt	193	242	261
Megawatt Equivalent of Wastewater Solids (3)			
Jackson Pike			
Primary Solids - ton/day	55	60	60
- megawatt	2	2+	2+
Sec. Solids - ton/day	35	35	40
- megawatt	1+	1+	2
Total Solids - ton/day	90	95	100
- megawatt	3+	4	4
Southerly			
Primary Solids - ton/day	15	20	25
- megawatt	+	1	1
Sec. Solids - ton/day	40	50	55
- megawatt	2	2	2
Total Solids - ton/day	55	70	80
- megawatt	2+	3	3
Both Plants			
Primary Solids - ton/day	70	80	85
- megawatt	3	3	3+
Sec. Solids - ton/day	75	85	95
- megawatt	3	3+	4
Total Solids - ton/day	145	165	180
- megawatt	6	7	7+

Net recoverable energy per ton of dry solids prior to boiler and turbine.

(1) 4,500 BTU/lb.
(2) 12,500 BTU/lb.
(3) 1,700 BTU/lb., neglects steam production requirement for thermal conditioning.

design and layout of the required improvements at the wastewater facilities should consider that at some time in the future codisposal may be a viable option, with the recommended onsite incineration complex providing backup reliability and steam for the thermal conditioning system.

(4) Refuse, Water and Wastewater Treatment Solids

Effective, permanent ash disposal is a common concern for the water and wastewater treatment plants and the proposed power plant. It seems reasonable that the quarry being used for disposal of water treatment sludges be given serious consideration for ultimate disposal of ash from all municipal sources. If it is so used, the estimated effective life of the quarry as a disposal site will be reduced by about 50 percent from that anticipated for water sludge disposal alone.

4.3.3 Energy Recovery

Energy is the most available resource in the wastewater solids. It is this energy that is used during the incineration process to reduce the volume and mass of the waste solids. The amount of the latent energy that can be recovered is a function of the moisture content of the sludge cake, while the total amount of energy that can be recovered is a function of the flue gas temperature reduction achieved through the heat exchanger.

The proposed project plans for the Columbus Wastewater Treatment Plants have two potential sources for energy recovery. The first is the digester gas produced from anaerobic stabilization of the thermally conditioned sludges. The second is the waste heat in the incinerator exhaust. Table IV-11 was prepared to examine the significance of these sources in terms of their energy yield and collective potential for energy recovery. It is believed that the assumptions are conservatively stated; however, it should be noted that some digestion gas may be unavoidably lost. This loss could be easily compensated for by going to a waste heat recovery temperature differential of 750^{o} F, which will increase the recoverable energy from the incinerated solids by 50 percent. Collectively, it is believed that the cited values for the steam energy available for electrical power production are realistically but not over optimistically estimated. The higher steam usage at Southerly is due to the assumption that two 200 gpm thermal conditioning systems will be used at all times to process all of the secondary solids with about two-thirds of the primary solids; on the average design day at Jackson Pike only secondary solids receive thermal conditioning.

Table IV-11
Energy Yield and Potential Recovery
at the Columbus Wastewater Treatment Plants

Source - Consideration \ Plant / Year	Jackson Pike			Southerly		
	1980	1990	2000	1980	1990	2000
Digester Gas Production(1)						
MCF /day	0.57	0.60	0.63	0.32	0.40	0.48
Recoverable Energy-MBTU/hr	14.2	14.8	15.6	8.0	10.0	12.0
Incinerated Solids(2)						
Tons/day	90	95	100	55	70	80
Recoverable Energy-MBTU/hr	12.8	13.5	14.2	7.8	9.9	11.3
Total Recoverable Energy-MBTU/hr	27.0	28.3	29.8	15.8	19.9	23.3
Energy Recoverable as Steam(3) -MBTU/hr	20.2	21.2	22.4	11.8	14.9	17.5
Energy Usage as Steam(4) -MBTU/hr	6.9	7.3	7.6	9.6	12.0	14.4
Net Steam Energy Available -MBTU/hr	13.3	13.9	14.8	2.2	2.9	3.1
Recoverable Energy as Electrical Power(5) -MBTU/hr	4.3	4.5	4.8	0.7	0.9	1.0
-MW equivalent	1.2	1.3	1.4	0.20	0.26	0.29
Percent of Plant Load	14	14	15	2	2	2

(1) Assume 18 CF/LbVS destroyed, 600 BTU/CF of gas
(2) Temperature differential of 500°F is approximately equal to 1700 BTU/Lb Solids
(3) Boiler efficiency = 75%
(4) Heating Needs for Thermal Conditioning = 36,000 BTU/hr·gpm(65°F net temperature change + 10% loss)
(5) Turbine Efficiency = 32.5%
Note: Typical heat losses for an anaerobic digester correspond to about 1°F/day; with a twenty day detention time, a 110°F feed sludge will need no additional digestion heating.

The priority of energy recovery and use is to first consider steam usages and then the production of electrical energy. Both Jackson Pike and Southerly should make use of waste heat recovery boilers to generate steam for the thermal conditioning system. Table IV-11 shows that the gas production from the anaerobic digesters could potentially satisfy all of the energy needs of the thermal conditioning system at Jackson Pike. At Southerly, due to the conservative assumptions of the analysis and the presumed mode of operation, this is not the case. The analysis suggests that incineration at Southerly cannot be eliminated if successful thermal conditioning of 400 gpm of waste sludge is the processing goal. Other uses of steam energy include building heat and steam driven major equipment items (e.g., blowers and major process stream wastewater pumps). It was assumed that building heat is provided by steam (although not specifically mentioned in the Facilities Plan) and that steam drives are unattractive due to existing equipment, space, redundancy, and maintenance considerations.

Table IV-11 shows that the potential of steam generation of electrical power is most attractive at Jackson Pike, where it can satisfy approximately 15 percent of the average day load. Since a utility will not normally allow parallelism between a customer's and the utility's generated power, the design would have to include the extra electrical hardware to physically isolate a bank of equipment from the outside power source when an inplant power source is in use.

Unit size is also a consideration. A review of one manufacturer's (Thermo Electron Corporation) literature shows their smallest packaged closed-cycle condensing steam power plant to be 0.5 megawatts; a value some 0.20 megawatts higher than confidently predicted at Southerly. Thus, it would appear that inplant power production is limited in its attractiveness to the Jackson Pike Facility. A preliminary present day cost of producing one megawatt of power at Jackson Pike using two operating and one standby 0.5 megawatt turbine generators is estimated at about $0.03/KWH (using a first cost of $2.4 million and an annual operational cost of $70,000); a value some thirty percent higher than for purchased power in 1976.

The preceding considerations point to the conclusion that energy recovery beyond steam production is not economically attractive under present conditions; especially so at Southerly. Although electrical power generation may be attractive at Jackson Pike in the future, the proposed adjacent refuse/coal fired power plant with the potential

opportunity of codisposal appears to serve the same end with a far greater economy scale. Therefore, it is recommended that neither Southerly nor Jackson Pike consider the use of inplant electrical power generation in the immediate future. However, should the proposed power plant be voted down, it is suggested that the City examine generated power in detail for Jackson Pike.

4.3.4 Nutrient Recovery

The nitrogen and phosphorus content of wastewater sludges offers a source of macronutrients as a replacement or supplement to commercial fertilizers. These nutrients are fractionally recovered when a crop is produced on receiving lands.

Municipal wastewater sludges may contain, in addition to nutrients, constituents which may limit their use, such as environmentally incompatible trace organics, infectious organisms, and heavy metals. Concentrations of environmentally incompatible trace organics, such as chlorobenzenes described in Section 4.3.1, can be controlled by public awareness and legislation. Infectious organisms can be reduced or eliminated by process design. Heavy metals may be marginally to significantly controlled by enforcement of industrial pretreatment standards. At this time, it is generally recommended that municipal wastewater sludge applications be limited to field crops (corn, soybeans, and small grains) or grasses (fescue, lovegrass, bermuda grass, and perennial ryegrass).

The engineering study that developed the recommended Columbus Project Plan for waste solids management and the subsequently prepared Environmental Assessment considered nutrient recovery schemes in detail. A common system, evaluated by both incorporated thermal conditioning, dewatering, and sludge cake application to the land with nutrient recovery in the form of field corn.

The following points demonstrate that the incinerator alternative is superior to nutrient recovery for total disposal of waste solids:

- The generation of some 145 to 180 dry tons of waste solids which must be disposed of on a daily basis from the two wastewater treatment plants;

- The responsibility of the municipality to provide the most cost-effective, environmentally sound, and dependable method of waste solids disposal;

- The probable resistance of other political jurisdictions to accept Columbus' sludge; and

- The need to implement a waste solids management program today which will provide a reasonable assurance of day-to-day success for the next twenty years.

The foregoing suggests that a nutrient recovery scheme for total waste solids management is difficult to implement on a large scale for a municipality of a million or more people without coordination of the institutions (State and Federal) which encompass county and municipal boundaries. This coordination will require a firm commitment to the municipality to accept all waste solids produced (at a definable solids concentration) for a full twenty years (based upon known characteristics). In Ohio, management agencies would certainly include the present Department of Natural Resources, Department of Agriculture, and the Ohio Environmental Protection Agency.

The preceding comments should not be construed as disallowing all forms of sludge disposal for nutrient recovery. The ideal sludge product for nutrient recovery should be processed by some positive means for pathogenic organism reduction or elimination. Thermal sludge conditioning, with its high temperature and pressures, provides a method for pathogenic organism control far superior to pasteurization, although probably not to the point of complete sterilization. The nitrogen and phosphorus content of biological (secondary) sludge is at least twice that found in the coarse primary

sludge. Although thermal conditioning can cause a significant solubilization of the nitrogenous fraction found in waste secondary sludges, the nitrogen content of the final dewatered product remains comparable to that of conventional primary solids. Thus, it is believed that the thermally conditioned, secondary solids produced at the Columbus plants should be preferentially used in any nutrient recovery scheme.

Table IV-12 shows the estimated secondary sludge quantities available for nutrient recovery. Only a fraction of the thermally conditioned secondary sludge mass from Southerly is available for nutrient recovery due to the need to assure an autogenous sludge cake for incineration and enough steam for thermal conditioning. The Columbus plants could yield a total of approximately 60 to 70 dry tons of thermally conditioned solids for a nutrient recovery scheme. This amounts to some 40 percent of the average day waste solids mass of the two plants. The incinerator ash remaining for disposal would be reduced by a similar amount if these conditioned solids were applied to the land.

Table IV-13, using the characterizations obtained from Tables IV-5 and IV-6 to one significant figure with the anticipated nitrogen, phosphorus, and aluminum content of the waste solids, compares the anticipated Columbus sludge characteristics against recently proposed guidelines for the metal content of sludges destined for nutrient recovery. Metal concentrations in excess of the guideline value would limit the use of the waste solids to supplemental nutrient applications. It is noted that the Southerly cadmium concentration is at the cited guideline limit. However, it is probable that the future will bring a reduction of this concentration and all heavy metal levels as industrial pretreatment ordinances are implemented and enforced by the City.

The rate of sludge application in a nutrient recovery scheme is based upon the nitrogen requirement of the crop grown, the metal content of the sludge, and the cation exchange capacity (CEC) of the soil. The prospective areas near Columbus for solids application commonly contain Blount and Morley soils with a nominal CEC of 15 to 25 meg/100 gms. The recommended limits for five important metals at this CEC and an in-situ pH greater than 6.5 are listed in Table IV-14. These values determine the maximum total load which can be applied to the land before an alternate site must be used.

Table IV-12
Approximate Daily Dry Tonnage of Wastewater
Solids Remaining for Nutrient Recovery

Source	Year		
	1980	1990	2000
Jackson Pike			
Primary Solids - tons/day	55	60	60
Secondary Solids - tons/day	35	35	40
Total Solids - tons/day	90	95	100
Solids Used for Steam Production - tons/day	55	60	60
Secondary Solids for Nutrient Recovery - tons/day	35	35	40
Ash for Disposal - tons/day	25	25	25
Southerly			
Primary Solids - tons/day	15	20	25
Secondary Solids - tons/day	40	50	55
Total Solids - tons/day	55	70	80
Solids Used for Steam Production - tons/day	30	40	50
Secondary Solids for Nutrient Recovery - tons/day	25	30	30
Ash for Disposal - tons/day	10	10	15
Total			
Total Solids - tons/day	145	165	180
Solids Used for Steam Production - tons/day	85	100	110
Secondary Solids for Nutrient Recovery - tons/day	60	65	70
Ash for Disposal - tons/day	35	35	40

Table IV-13
Comparison of Columbus Sludges with
Allowable Metal Content Guideline

	mg/kg of Dry Solids at 30-35% Solids Cake		
	Jackson Pike	Southerly	Guideline ψ
Metals			
Aluminum *	80,000	60,000	-
Arsenic	8	3	-
Boron	400 (0.1)	30 (<0.1)	-
Cadmium	30	50	50
Chromium	800 (1)	400 (1)	-
Copper	700	400	1,000
Gold	0.02	0.03	-
Iron	20,000 (90)	8,000 (50)	-
Lead	400	400	-
Mercury	4	5	-
Nickel	400 (1)	50 (0.2)	500
Silver	30	30	-
Zinc	3,000 (1)	2,000 (0.5)	5,000
Nutrients			
Nitrogen	40,000 (6000)	40,000 (6000)	
Phosphorus*	60,000 (200)	40,000 (200)	
Sulpher	8,000	7,000	
Organics			
Arochlor 1248 & 1254	<7	<7	
Chlorobenzenes			
Ortho- and Para-	10	10	
1,2,4-Tri	1	1	
Cyanide	40	8	
Oil and Grease	200,000	200,000	
Phenolics	70	60	
Salts			
Calcium	7000 (20)	5000 (20)	
Chloride	700 (200)	700 (200)	
Magnesium	7000 (100)	4000 (100)	
Potassium	1000 (100)	1000 (100)	
Sodium	200 (50)	200 (50)	

* Increased over measured value to reflect phosphorus removal by aluminum addition

( ) - approximate soluble phase concentration, mg/l

ψ Application of Sludges and Wastewaters on Agricultural Land: A Planning and Educational Guide, North Central Regional Research Publication 235 (October, 1976).

Table IV-14
Land Needs for Nutrient Recovery with
Columbus Sludges (1)

I. Maximum Load of Dry Plant Solids

A. Life of Disposal Site (Heavy Metal Limitations)

Parameter	Recommended Heavy Metal Limit (tons/acre)	Applicable Load (tons/acre) of Plant Solids from Jackson Pike	Southerly
Cadmium	0.01	330	200
Copper	0.25	360	620
Lead	1.00	2500	2500
Nickel	0.10	250	2000
Zinc	0.50	170	250

B. Annual Basis

1. Cadmium limit (0.001 ton/acre)

Jackson Pike = 33 tons/acre·year
Southerly = 20 tons/acre·year

2. Nitrogen limit

First Year = 6.7 tons/acre·year
Seventh Year = 4.7 tons/acre·year

Average Annual for 20 Years = 5 tons/acre·year

II. Land Requirement (1990 Basis)

Jackson Pike = (35)(365)/4.7 = 2720 acres
Southerly = (30)(365)/4.7 = 2330 acres

III. Approximate Life of Land in Nutrient Recovery Scheme

$$\text{Jackson Pike} = \frac{170-5(20)}{4.7} + 20 = 35 \text{ years}$$

$$\text{Southerly} = \frac{200-5(20)}{4.7} + 20 = 41 \text{ years}$$

(1) Procedures utilized reflect concepts developed in North Central Regional Research Publication 235 (October, 1976). The pertinent section of that report is reproduced as Appendix L.

As can be seen, with the present metal characteristics of the Columbus sludges, zinc is the controlling metal for Jackson Pike, while cadmium is the controlling metal for Southerly. The allowable ultimate heavy metal loads are reduced by 50 and 75 percent for cation exchange capacities of 5 to 15 and 0 to 5 meq/100 gm of soil, respectively. (See Appendix L.)

The annual loading rate of waste solids is determined by either cadmium or nitrogen loading considerations. As can be seen in Table IV-14, the nitrogen limitation controls for Columbus sludges. The allowable nitrogen load was determined from the average Ohio corn yield (100 to 125 bushels per acre) and its average annual nitrogen requirement of about 140 pounds per acre. The estimated initial and equilibrium availability is based upon the procedures contained in the referenced publication with the assumption that all of the particulate nitrogen in the waste solids exists as organic nitrogen and all of the soluble nitrogen exists as ammonium nitrogen. This gave an initial nitrogen availability of 26 percent, with a long-term equilibrium availability of 37 percent achieved some seven years later. Therefore, to use forty percent of the Columbus waste solids in nitrogen-limiting nutrient recovery scheme, a land area of about 5,000 acres will be required. A given acre of land could have, on a nitrogen-limiting basis, sludge applied to it for a period of 35 to 40 years based on present guidance and the chemical composition of Columbus sludges.

The Columbus waste solids analyses presented in Table IV-13 reveals the following fertilizer analysis:

Nitrogen as N -	4%	(assume 37% available)
Phosphorus as P_2O_5 -	12%	(assume 100% available)
Potassium as K_2O^5 -	0.1%	(assume 100% available)

The retail value of this product is about $55 per ton with the assumed availabilities. Approximately 90 percent of this value is associated with its phosphorus content. Its P_2O_5 value would be reduced to about three percent without phosphorus removal at the level anticipated at the Columbus plants. In turn, this will reduce the retail value of the product to about $20 per ton.

In the twenty year project period, approximately 1.2 to 5.0 tons of phosphorus per acre will be applied to the land with a nitrogen limiting nutrient recovery program, depending upon the continuing need for a phosphorus removal or reduction program at the wastewater treatment plants. Of this 125 to 500 pounds/acre·year phosphorus application rate, only 25

pounds per acre will be removed in the anticipated annual harvest of corn. The impact of this heavy phosphorus load may be exhibited as it is fractionally returned to local waterways either via erosion or leaching with runoff. Alternately, it may build up in the soil to the point that phosphorus toxicity to crops occurs.

The minimum land-based program which could be implemented for the disposal of the conditioned secondary solids would be one in which the City of Columbus simply hauls the sludge to farmers willing to accept it. The responsibility for the actual application of the sludges would rest with the individual farmer. Capital expenditures necessary for such a system would involve, at a minimum, the purchase of a suitable fleet of hauling vehicles and sufficient storage and materials handling capabilities to allow for flexibility in scheduling sludge deliveries. The overall present worth of such a system would be approximately $1.5 to $2 million greater than that of the proposed incineration system. Although this is not an insurmountable cost differential, the implementation considerations of such a system tend to work further against its selection. Sufficient numbers of farmers would have to be willing to sign long-term (20 year) agreements to accept sludges, while the City must be able to guarantee sludge analyses and deliveries.

Far greater problems in terms of cost and implementation arise when a land disposal scheme which is totally managed by the City of Columbus is envisioned. Even if the owners of 5,000 acres of nearby farmland (a minimum requirement) can be convinced to sell the City their land, the legal problems involved in the overall settlement of displacement costs, inventory buyouts, building values, etc. will likely push implementation of the disposal system well past 1980. Costs incurred in property purchase considerations will be in addition to those involved for hauling and storage under the first management concept discussed.

4.3.5 Land Recovery[1]

It has been estimated that about 1.25 acres of land per person are required at the present time to feed the U.S. population its high calorie-high protein diet. In comparison, the total arable land per person throughout the world is only about 0.9 acres. About 81 percent (380 million acres) of the arable land in the U.S. is under cultivation. During the past 200 years, about 236 million acres in the United States (or over half of the acreage presently under cultivation) have been lost from crop production due to soil erosion and urbanization of quality farmlands.

Sediments carried by water runoff represent the dominant form of soil loss in the United States, delivering some four billion tons of sediment per year to waterways in the 48 contiguous states. Three-quarters of the sediments are derived from agricultural lands and are deposited in reservoirs, rivers, and lakes. Natural topsoil formation under normal agricultural conditions is about 1.5 tons per acre per year, while the average annual loss from agricultural land is about 12 tons per acre. Direct costs due to sediment damages are estimated at over $500 million annually and are largely associated with dredging and loss of reservoir life. Far more substantial costs are involved in the loss of soil nutrients and productivity ($700 and $800 million, respectively) and reduced productivity and survival of valuable aquatic ecosystems.

In spite of the violations of the natural environment, crop yields have increased over the last sixty years due to the abandonment of marginal land, the planting of highly productive crop varieties, and the increasing use of production inputs (e.g., nitrogen fertilizer uses have increased

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[1] The generalized statistics utilized in this section were obtained from "Pimentel, et al, "Land Degradation: Effects on Food and Energy Resources". Science, Volume 194, No. 4261 (October 8, 1976).

by 10 to 20 times). An estimate for 1970 conditions yields an energy commitment equivalent to about 50 million barrels of oil annually (4 percent of the nation's 1970 oil imports) to offset declining yields, increase production, and reduce labor.

To date, about 40 million acres of land in the United States have been converted to urban uses; about half of this land was once arable. An additional 32 million acres have been covered by highways and roads. Recent years have seen a net annual loss of about 1.25 million acres of arable cropland. Man's exploitation of the natural environment through mining, construction, and logging further eliminates potential cropland and increases erosion.

The previous paragraphs have attempted to show a need for land conservation and recovery with a view towards increasing assets rather than continually experiencing environmental debits. Again, the implications impact far more people than those in the Columbus metropolitan area. The needed management institution and commitment is the same as previously described in Section 4.3.4. A two phase program that initially addresses land reclamation and then offers a natural means of erosion control on farmland would be needed. The control agent to be used is the sludge from wastewater treatment. Central Ohio, with its agricultural base and legacy of strip mining, is a perfect demonstration site.

(1) Strip Mine Reclamation

Today, strip mining directly disturbs at least 150,000 acres per year. The area affected by historic and existing surface mining activities can be three to five times more widespread than the area actually exploited as the acid drainage and eroded sediments pollute the downstream watercourse. Landspreading of wastewater sludges on lands with little or no vegetation and organic content in the soil offers an opportunity for beneficial use of municipal wastewater sludges. Studies at Pennsylvania State University; Fulton County, Illinois; Palzo, Illinois; and elsewhere have indicated the practicality of the concept.

In southeastern Ohio, more than 370,000 acres of strip mined land need reclamation, with nearly 50 percent of this total in need of a major effort. In recognition of this need, the State established a Board

on Unreclaimed Strip Mined Lands under the provisions of Section 1513 of the Revised Code, the Ohio Strip Mine Law. This Board and the Ohio Department of Natural Resources (ODNR) - Division of Land Reclamation, have developed a recommended plan to reclaim the abandoned strip mined land by utilizing waste products such as sewage sludge, power plant fly ash, or dredgings from the Ohio River. At this time, the Board and the ODNR have identified three "quick start" reclamation projects where a high degree of success and favorable benefits are anticipated. These projects are as follows:

- McMahon Creek Abatement Area (Belmont County);
- Huff Run Abatement Area (Stark County); and
- Brush Creek Abatement Area (Muskingum County).

The Brush Creek Abatement Area, just south of Zanesville, is about 50 miles from Columbus. The City of Columbus could participate in the Brush Creek project, but its size limits the futurity of City participation. The impacted strip mining areas in Muskingum County are largely scattered in small parcels.

On the other hand, conversations with the ODNR also indicated that Perry County (50 miles due east of Columbus) contained over 4,000 acres of strip mined land suitable for reclamation by wastewater solids. It is this area that appears to offer the greatest potential outlet for the Columbus sludges (and ash). Further, this area offers the implementation attraction of public ownership of the majority of the barren lands.

Government grants relating to the first cost for sludge disposal are presently available to the City of Columbus. These grants do not provide for operation and maintenance expenditures. The possibility of obtaining financial assistance to offset these expenditures exists through the various Federal and State agencies associated with abandoned strip mine reclamation. For example, the Appalachian Regional Commission can provide up to 75 percent of the cost of restoration, while the State of Ohio has allocated use of its mineral severance tax for mined land reclamation. Thus, it is evident that financial aid potentially exists to fractionally defer the City's operational costs for strip mine reclamation.

At this time, exploratory conversations with the ODNR's Division of Land Reclamation have indicated a strong interest but a lack of resources for full implementation under an institutional arrangement which has the City of Columbus deliver its waste products to a central receiving site (or sites) with a public agency responsible for solids application, site management, and monitoring. However, it should be noted that the ODNR's Division of Land Reclamation does have authority to let contracts for spreading the sludge on the land.

Due to the importance of this means of resource recovery and waste solids utilization, the concept of delivering the waste secondary solids (sludge) from Columbus to the Perry County abandoned strip mines was taken to the point of preliminary costing. It should be noted that this concept is restricted to the same waste quantities identified in Table IV-12 for nutrient recovery. Actually, the magnitude of this mass could increase if the secondary solids thermal conditioning system is abandoned in the future (but only after installation of new capital facilities and conditioning chemical expenditures), allowing the subsequent introduction of the remaining primary and secondary solids. Further increases may be possible with the inclusion of incinerator ash and all or some of the water plant wastes. The latter material would be of particular value in strip mine reclamation due to its alkaline nature.

The selected allowable application rate of 250 dry tons of secondary solids per acre was suggested by ODNR representatives based upon their field experience. The procedure to be incorporated would work the 250 dry tons of solids into the land as fast as possible (perhaps over a two day to two week period). Such a high value is predicated on the need to overcome the acid nature of the barren strata. It corresponds to an application depth of about six to seven inches and subsequent working of the sludge into the soil to minimize runoff problems and obtain full use of the enrichment properties of the sludge.

Table IV-15 summarizes the results of a preliminary budgetary estimate for three land recovery schemes which assume application of 60 tons/day of dry Columbus secondary solids to the Perry County site. As can be seen, project costs are reduced with size, but a minimum net additional expenditure of $45/ton over that required for incineration is projected for even an optimum land recovery system.

Table IV-15
Budgetary Estimate for Strip Mined Land Reclamation
(1974-1975 Conditions)

Parameter	Application Period of 50-70 dry tons of Secondary Solids Per Day*					
	Spring and Fall (Two Months/Year)		Summer Season (Six Months/Year)		Year Round	
Hauling Operation						
First Cost-$	$300,000		$300,000		$300,000	
Annual Cost-$/Year	100,000		300,000		600,000	
Equipment Replacement	200,000 @ 5 years		200,000 @ 3 years		200,000 @ 2 years	
Spreading Operation						
First Cost-$	$600,000		$700,000		$900,000	
Annual Cost-$/year	200,000		400,000		700,000	
Equipment Replacement-$/Year	200,000 @ 5 years 100,000 @ 8 years		200,000 @ 3 years 100,000 @ 5 years		200,000 @ 2 years 100,000 @ 3 years	
Potential Savings Developed at Wastewater Treatment Plants						
First Cost-$		0		0		$3,400,000
Annual Cost-$/year		$100,000		$200,000		300,000
At i=6 3/8%, n =20 years	w/o savings	w/savings	w/o savings	w/savings	w/o savings	w/savings
Present Worth-Hauling, $	$1,700,000	$ 600,000	$ 4,300,000	$2,100,000	$ 8,100,000	$ 1,000,000
-Spreading, $	3,200,000	3,200,000	6,000,000	6,000,000	9,900,000	9,900,000
-Total, $	$4,900,000	$3,800,000	$10,300,000	$8,100,000	$18,000,000	$10,900,000
Uniform Series-Total,$/year	$ 440,000	$ 340,000	$ 930,000	$ 730,000	$ 1,620,000	$ 980,000
Land Recovered - Acres	14.5 ac/yr=290 acres		45 ac/yr= 900 acres		90 ac/yr=1800 acres	
Annual Cost per Recovered Acre- $/acre	$30,000	$23,000	$21,000	$16,000	$18,000	$11,000
Annual Cost per Ton - $/ton	$ 122	$ 94	$ 85	$ 65	$ 74	$ 45

* assume nominal 5 day per week operation, 30 to 35 percent cake solids

under the least cost alternative, which takes full credit for elimination of one new incinerator at Southerly and the elimination of one operating incinerator from both plants.

From the standpoint of society, a sterile, unattractive tract of land has been recovered for the beneficial use of subsequent generations. When viewed in this context, the value of the land and its relationship to the total environment is truly infinite, and the cost of reclamation is fully justified.

It is suggested that the City officials and representatives of the ODNR meet to establish clear lines of responsibility and commitments for Columbus's participation in the Brush Creek Abatement Project, with a view towards future land reclamation in Perry County. If the situation is favorable, Columbus should seek to purchase a fleet of 16 cubic yard vehicles with appropriate auxiliaries for use on the project concurrent with its plant expansion program.

(2) Farmland Erosion Control

With the purchase of a fleet of conveyance vehicles, a commitment to participate in a strip mine reclamation program, and the backup reliability provided by an incineration complex, it would be possible for Columbus to initiate a reasonable program of applying wastewater solids on farmlands as a means of erosion control and partial nutrient replenishment.

Columbus, through agricultural extension agents and other means of informing local farmers, should seek to develop a farmland outlet for some of its waste solids as a supplemental fertilizer source and soil enrichment agent for mitigating soil losses by erosion. With appropriate commitment and scheduling actions on the part of the farmers and the City, it is possible to visualize a scheme that responds to a scheduled demand at a three to five year frequency with an application rate that satisfies the single year's need of the crop. The anticipated program would deliver the waste product to the farm with the farmer providing distribution. Charges for this service to recover the costs of municipal operation and management could be on an advertised schedule that varies as a function of load and distance. The optimum area of influence would be Franklin County and three counties lying to the east (Fairfield Co.), south (Pickaway Co.), and west (Madison County) of the two Columbus wastewater treatment plants. The City of Columbus may want to simultaneously examine the marketability of its incinerator ash as a source of phosphorus.

4.3.6 Mineral Recovery

The incinerator ash from a wastewater plant contains the inert residues of the influent sewage. Table IV-16 summarizes the anticipated characteristics of the ash from the Columbus plants during the planning period with the assumption that both plants are achieving phosphorus removal by aluminum addition. Other than this consideration, no credit was taken for any change in the pollutant release patterns of the service areas. It is estimated that under prolonged exposure in the natural environment, about 15 percent of the original mass of the ash will be solubilized. Thus, the original 60 to 70 tons per day of ash production from the entire sludge stream at both Columbus plants will be reduced to a 50 to 60 tons per day residual following prolonged storage or disposal.

The data in Table IV-16 shows that approximately 25 to 35 percent of the ash is composed of metals and nutrients. The remaining fraction will largely consist of the fused oxides of the metals and mineral salts. Aluminum, iron, and phosphorus dominate the characteristics of the final product. At this time, phosphorus is probably the most valuable component of the residue. (Phosphorus reuse from incinerator ash has been previously discussed in Section 4.3.4.)

Table IV-16
Anticipated Ash Characteristics of Wastewater Solids

	Percent Retained in Ash(1)	Percent Ultimately Soluble(2)	Anticipated Dry Ash Characteristics - %			
			Jackson Pike		Southerly	
			Initial	Final	Initial	Final
Metals						
Aluminum	100*	0*	7.0	8.0	12.0	14.0
Arsenic	100	25*	0.002	0.002	0.0009	0.0008
Boron	100*	50*	0.09	0.05	0.009	0.005
Cadmium	80	10	0.006	0.006	0.01	0.01
Chromium	100	40	0.2	0.1	0.1	0.07
Copper	100	5	0.2	0.2	0.1	0.1
Gold	100*	0*	0.000005	0.000006	0.000009	0.000010
Iron	100	0*	5.0	6.0	2.3	2.7
Lead	95	0	0.09	0.1	0.1	0.1
Mercury	5	100*	0.00005	Trace	0.00007	Trace
Nickel	100	10	0.1	0.1	0.01	0.01
Silver	100	15	0.007	0.007	0.009	0.009
Zinc	95	5	0.7	0.8	0.6	0.7
Nutrients						
Nitrogen	<1	100*	0.08	Trace	0.09	Trace
Phosphorus	100	25	8.0	9.0	11.0	13.0
Sulphur	60	25*	1.0	0.9	1.0	0.9
Total Ash		15	-	-	-	
Percent Accounted For			22	25	27	32

(1) "Middletown Incineration Study". Internal Havens and Emerson Memorandum (August, 1975).
(2) Citrate solubility reported in "A Plan for Sludge Management" prepared for the Boston Metropolitan District Commission by Havens and Emerson (June, 1973).
*Assumed value, all others rounded to nearest five percent

The characteristics of the ash show a wide variety of trace metals. The present refined combined value of the copper, gold, lead, silver, and zinc is nearly $16 per ton of ash; silver contributes essentially 50 percent of this total. The value of minerals in the ash is approximately 60 percent of the phosphorus value of the ash, or roughly equivalent to the wet cake fertilizer value. At this time, however, an attempt at reclaiming and refining any of the sludge metals is economically unattractive in comparison to metal production by conventional means.

Another possible use of incinerator ash is as an additive in the production of lightweight synthetic aggregates that could be used in concrete. The feasibility of such an application has been demonstrated at the Japanese National Research Institute for Pollution and Resources in Tokyo on a laboratory scale. In this study, the municipal sludge incinerator ash was first mixed with crushed shale. Water and binding agents were then added, and the mixture was heated to 2,200°F and molded into 0.4-inch diameter balls. The specific gravity of this product aggregate was about 1.2, as compared to the average 1.5 of other available synthetic aggregates. If not used in concrete preparation, sludge-based aggregates of this sort may find a potential use in roadway applications, either as a surface media for minor roads at the plant site or as an additive to the subsurface or pavement media of major highways.

4.3.7 Landfill Disposal

The land is the ultimate recipient of the final residue of wastewater treatment, whether it be incinerator ash or dewatered sludge cake. Various total or partial landfill disposal schemes were examined in the Columbus Facilities Plan, the Environmental Assessment, and a special report prepared to evaluate landfill application as a temporary means of sludge disposal. The following paragraphs briefly review the findings of these documents with a closing section that provides additional data on existing landfill sites. Further discussion can be found in Appendix I, Section I.3.

(1) Facilities Plan for Solids Handling

Four of the seven alternatives studied for solids handling involved some form of landfilling of product solids. Only one alternative considered the actual landfilling of sludge, while the other three proposed varying degrees of incinerator ash disposal by landfill.

Few final disposal problems present themselves for alternatives which consider landfilling of ash. Volumes to be hauled are relatively small, and the ash itself exhibits no characteristics which would preclude its application to a landfill, assuming proper location and leachate control practices.

Landfilling of stabilized and dewatered sludge does not fare so well as an alternative in the Facilities Plan. Although most cost parameters are rated as good, such a plan suffers several drawbacks in implementation. Foremost of these is the likelihood of insufficient suitable landfill sites close enough to the treatment plants to economically justify sludge hauling. Even if sites with sufficient capacity were available, control of final sludge disposal would most likely not be under the authority of the City of Columbus, a situation which casts doubt upon the long term reliability of such an alternative.

(2) Environmental Assessment of Sludge Handling Facilities

A solids handling alternative incorporating total landfill disposal of stabilized and dewatered sludge survived the preliminary screening process of the Environmental Assessment, and was one of four solids handling alternatives to be analyzed in detail. Although not ultimately selected as the preferred method, the low consumptive land use, when compared to other land-based alternatives (17 acres), and relatively low energy costs, when compared to onsite disposal methods (525 BTU/day), caused landfill disposal to not be totally precluded as a possible future alternative by the Environmental Assessment.

(3) Engineering Study for Temporary Sludge Disposal

Temporary disposal alternatives for use when construction activities disrupt normal solids handling at both wastewater treatment plants were investigated by consultants to the City of Columbus. Landfilling of sludge was chosen as the preferred temporary disposal method over a dry land disposal system.

A study was undertaken to locate a disposal site near Columbus which would be suitable for landfilling of sludges in terms of local water table heights, soil types, topography, access, and remoteness from developed areas. It was determined that the most favorable area

for a landfill location was in the southern portion of Franklin County, west of Hoover Road and south of Orders Road. No landfills presently exist in this area, meaning the City of Columbus would have to purchase the site and obtain the necessary governmental approvals to create and operate a landfill.

(4) Existing Landfills in the Columbus Area

The State of Ohio lists 19 licensed sanitary landfill sites in Franklin and adjoining counties (including Fayette). Haul distances to these facilities range up to 40 miles with most within 20-30 miles of the Columbus wastewater facilities.

An attempt was made to contact responsible persons at each landfill to determine site size, capacity, remaining life, and type of wastes presently received. Fourteen operations were actually contacted. Table IV-17 summarizes the pertinent data obtained from each.

Only two of the landfills contacted (City of London and Richwood) are willing or able to accept wastewater sludges. Most operations are primarily concerned with refuse disposal for the areas adjacent to the site. If suitable arrangements could not be made with either the City of London or Richwood landfills, it would appear that the City of Columbus would have to undertake the development and operation of their own facility to allow the implementation of any alternative incorporating landfill disposal of sludge.

An overview of a landfill disposal scheme shows certain basic realities for the Columbus situation. They are:

- A concurrent need for refuse and solid waste disposal which potentially dwarfs any municipal wastewater sludge disposal consideration;
- A resistance to the receipt of raw, nonbiologically stabilized sludge cake;
- A final average operating year ash consisting of 65 tons/day in a volume of about 0.02 mgd against a sludge cake of 180 tons/day in a volume of about 0.12 mgd.

Table IV-17
Existing Licensed Landfill Operations
in the Central Ohio Area

City or County	Name	Distance-miles	Comments[1]
Columbus	New Columbus Landfill, Inc.	0-5	Five year estimated life, will accept some sludges
Columbus	City of Columbus Landfill	5-10	Pulverized refuse only
Delaware	City of Delaware Landfill	20-30	Twenty year estimated life. Currently accepting 150 ton/day total, not willing to accept sewage sludges at the present time
Fairfield	Crown-Zellerbach Corp.	20-30	No outside wastes accepted
Fairfield	Modiglass Fibers Division	20-30	No outside wastes accepted
Fairfield	Baltimore Village Landfill	20-30	Under contract to accept villages solid wastes only
Fayette	Fayette County Landfill	30-40	150 acre site with a projected 40-50 year life. Presently not accepting sludge, but ash would be acceptable
Franklin	Bedford Landfills #1 and #2	5-10	Site #2 is essentially full, Site #1 has an estimated 3-4 year life. Will not accept fly ash or any substance with more than 10-15% water.
Franklin	Franklin County Landfill	0-5	190 acre site with an eleven year estimated life. No sludges accepted, may take ash.
Madison	Tri-Township Landfill	20-30	Site is less than 5 acres and serves township residents only

Table IV-17
Existing Licensed Landfill Operations
in the Central Ohio Area

City or County	Name	Distance-mile	Comments[1]
Madison	Monroe & Pike Township Landfill	20-30	Same as Tri-Township site
Madison	City of London Landfill	20-30	200 acre site which accepts all non-toxic wastes, including liquid and/or dewatered sludges. Liquid sludge is applied to grassland.
Union	Richwood Landfill	30-40	62 acre site with a 35 year estimated life. Will accept biological process sludges.

(1) estimated lives quoted do not envision substantial new future waste sources

The above points suggest that if a sludge cake landfill scheme is to be viable for Columbus, the City will have to own and operate its own site and the wastewater treatment facilities will have to be revised to eliminate or dilute the putrescible fraction within the product sludge. Thus, it is believed that landfill options should only be considered for ash disposal, which offers a dry mass reduction of about 65 percent with an attendent volume reduction of about 85 percent. A permanent commitment to landfilling of the sludge cake would preclude the potential use of affected land resources in a more valuable manner, and would require additional energy use for a sludge disposal program less reliable than that presently proposed.

A continuation as a permanent backup system of the temporary landfill disposal proposed by the City's consultants suffers from disadvantages perhaps even more significant than those encountered in a total landfill disposal scheme. Although some other method (such as incineration) would be the primary means of sludge disposal, auxiliary equipment must be provided to supply the conditioning needs required for landfilling. This would require the use of not only the present anaerobic digesters (negating their possible value as storage and recycle treatment facilities as discussed in Appendix J), but would necessitate new digester construction. The use of a backup landfill disposal system is therefore not recommended at Columbus.

4.3.8 Composting

Composting is another form of dry land disposal of sludges that was investigated in the Facilities Plan and the Environmental Assessment. Basic requirements for a composting system include dewatering devices, an aerated reactor for partial sludge stabilization and a maturing area to further pathogen and volatile solids destruction prior to land application. A carbon carrier, such as wood chips, is required in the reactors as a vehicle for solubilized nutrients, as is the capability of returning composted sludge to the reactor.

Many of the drawbacks noted for the dry sludge land disposal in a nutrient recovery system are present in a composting plan. Toxicity and phosphorus limitations are similar, as are the amounts of land required for sludge spreading. The one advantage of a composting system over the nutrient recovery scheme of Section 4.3.4. is the ability to eliminate thermal conditioning and, if primary solids are included, incineration.

Costs per ton for composting, as stated in the Facilities Plan, range from $95 to $103 per ton for a total disposal

system. On a per ton basis a smaller, sporadically used backup system would be even less cost-effective.

The first, and most obvious problem with composting is that the elimination of the conditioning and incineration complexes does not represent a cost savings but rather would be an abandonment of existing, usable facilities. Another significant difficulty with composting as a total sludge disposal alternative is in the lack of suitable backup facilities. If the operation of such a system were interrupted at any time for any reason, little real backup capabilities would exist due to the nonstabilized nature of the input sludges, which have only been dewatered before being introduced to the composting reactor.

Although not viable as a total disposal system, composting could serve as an alternate means of providing backup sludge disposal capabilities. Land requirements for a backup system would be reduced and, unlike the landfill option, additional capital facilities affecting the main process stream (anaerobic digesters) would not be required to allow for its implementation. However, to truly serve as a backup facility it would still require an initial allocation of a composting area, purchase of aeration and mixing equipment, a store of a suitable carbon carrier and, most fundamentally, a viable outlet for the composted product.

4.3.9 Conclusions

An examination of the nature of the Columbus waste solids and the variety of different management goals associated with their ultimate disposal reveals the following:

- Analyses of the waste solids at Columbus show chlorinated benzene compounds to be the most potentially significant trace organic substance (in terms of quantity) present.

- The interconnecting Jackson Pike to Southerly sludge force main presents the opportunity for coincineration of sludges from both plants and/or costorage of ash. Present construction precludes full development of this potential beyond the elimination of a maximum day, standby incinerator at Jackson Pike. The elimination of Jackson Pike's ash lagoon should be given serious consideration during design.

- The quarry which is scheduled to receive all of Columbus' water plant wastes should also be considered as the final disposal site for the wastewater sludge incinerator ash. The high pH condition of the mixed concentrate would minimize the leaching of heavy metal and phosphorus back to the environment. From a design standpoint, dry ash truck conveyance or slurry force main conveyance should be considered before the construction of large ash storage lagoons at the treatment plants.

- The proposed 90 megawatt refuse/coal-fired municipal power plant adjacent to the Jackson Pike Plant offers the potential for fractional disposal (about 35 percent) of both wastewater treatment plant's waste solids, with a beneficial return in terms of producing some power and reducing coal requirements. Both of these possible returns to the power plant are relatively insignificant. The main return would be in terms of eliminating future operating personnel at both wastewater treatment plants. The main liability at the power plant would be a significant increase in ash production. The power plant should consider ash disposal at the quarry to be used for municipal water plant sludges, especially if wastewater sludges are incinerated. Further design of the improvements at the wastewater treatment plants and the design of the power plant should address this codisposal opportunity.

- Energy recovery at the wastewater treatment plants beyond the point of steam generation for process needs and building heat is not presently attractive. It is anticipated to remain so at Southerly. At Jackson Pike, the future production of electrical energy from waste heat may be attractive if the proposed municipal refuse/coal fired power plant does not become a reality. If this should happen, it is suggested that the City examine in detail the opportunity to derive operational savings through the use of inplant steam generated power.

- The present metal characteristics of the Columbus sludges do not preclude land application of the available secondary solids fraction in a nitrogen limiting nutrient recovery (crop harvest) scheme.

- Reclamation of barren strip mines in Perry County (50 miles southeast of Columbus) appears to be an attractive outlet for municipal wastewater sludges, assuming a State institution willing to respond in a similar manner as previously described in the nutrient recovery program. Again, the concept is strong environmentally, for it reclaims a resource (land) that has been exploited to produce an exhaustible energy source (coal) with a renewable resource (organic secondary wastewater sludges). It is recommended that Columbus initiate exploratory conversations with the Division of Land Reclamation of the Ohio Department of Natural Resources in terms of establishing clear lines of responsibility and commitment for participation in the "quick start" Brush Creek Abatement Project in Muskingum County. If the situation is favorable, Columbus should seek to purchase a fleet of 16 cubic yard vehicles with appropriate auxiliaries for use on this project at the same time as the initiation of the wastewater plant expansion programs.

- Due to their organic content, municipal wastewater sludges can provide a valuable means of farmland erosion control with additional benefits in terms of nutrient replenishment. It is recommended that Columbus explore this use of secondary sludge cake in portions of Franklin, Fairfield, Pickaway, and Madison Counties if the City participates in the previously discussed strip mine reclamation program. The proposed disposal mechanism envisions the actual sludge application to the farmland by the owner.

- Recovery of minerals in the sludge ash (excluding some potential for phosphorus) is not economically attractive at this time. Potentially, ash may be used as a lightweight aggregate or in limited roadway construction and maintenance capacities.

- Landfill disposal of Columbus sludges should only be considered as an interim, stop-gap measure due to the realities of land availability, concurrent needs for solid waste disposal, and reliability. Landfilling for the duration of the planning period is considered viable only for incinerator ash.

- Composting, although not attractive as a primary means of sludge disposal, may have future applicability as a backup disposal system.

4.4 INTERNAL UNIT PROCESS ALTERNATIVES

Appendix J to this report examines the resource savings that may be available through the use of alternate treatment technology at the Columbus plants. Its emphasis is not upon the alternatives examined by the City's consultants during the course of preparing the Facilities Plans, but rather upon the technology which has come into additional exposure or acceptance over the intervening years. A synopsis of the analyses and conclusions of Appendix J is provided in the following paragraphs. Trade names are mentioned when no truly equivalent systems are available. This mention is not to be construed as an endorsement of or a recommendation for a particular manufacturer's product.

4.4.1 Phosphorus Removal

The Linde Division of the Union Carbide Corporation is vigorously marketing the proprietary "Phostrip" phosphorus removal system through onsite bench and pilot demonstrations. In essence, this system relies upon the luxuriant uptake of phosphorus within the activated sludge culture (whether the uptake is metabolic or a precipitated complex is not clearly established) and subsequent phosphorus desorption from a fraction of the return sludge in an anoxic stripping tank. The stripper is designed as a thickener with a detention time of some 10 hours. The thickened solids are returned to

the aerator, and the phosphorus-enriched decantate is treated with lime to precipitate a calcium phosphate complex. The precipitated solids are dewatered and introduced into the ultimate disposal process of the wastewater treatment plant.

Preliminary cost estimates were developed to evaluate the proposed Facilities Plan phosphorus removal concept of metal salt addition against a "Phostrip" system. This evaluation was conducted at both the assumed influent phosphorus levels for the present conditions and the calculated influent concentrations if a statewide detergent phosphorus ban was in effect (assuming a two-thirds reduction of the soluble baseline domestic, commercial, and industrial phosphorus load).

The latter consideration was included in the analysis since legislation supporting a phosphorus ban as a builder in detergents is now pending in both Ohio and on the Federal level. This legislation has the full backing of the State Environmental Protection Agency, and, to the extent that Ohio lies in the Great Lakes Drainage Basin, it is also advocated by the International Joint Commission and Region V of the Federal EPA. On August 4, 1977, the United States Senate voted overwhelmingly to amend the water pollution laws to ban the sale of phosphate detergents in all of the Great Lakes States. House approval is expected.

The results of the present worth analysis revealed no significant economic advantage with either system under present conditions, with a clear economic advantage of the metal salt system at lower influent phosphorus levels.

Given the probability of a future phosphorus detergent ban and the lack of a significant cost advantage for either system under present conditions, it is recommended that metal salt addition be the means for phosphorus removal at Columbus.

4.4.2 Intermediate Sedimentation

Preliminary design and costing of the two stage system at Jackson Pike with and without intermediate sedimentation was also undertaken in Appendix J. The results indicated that the net impact of eliminating the intermediate sedimentation system is an economic liability in terms of both first cost and operating expenditures. It is the high operating solids mass or cell residence time required for nitrification that ultimately dictates the retention of the intermediate settlers as a cost-effective treatment alternative.

4.4.3 Oxygen Production and Dissolution

Generalizations concerning the economics of oxygen versus air activated sludge are difficult to draw, since costs for the two systems are close and individual circumstances affect economics to a large degree. The original economic studies of the main stream treatment Facilities Plan showed the proposed trickling filter-air activated sludge system, with a total operating horsepower of about 14,800, to have an annual cost advantage of about one million dollars over the trickling filter-pure oxygen activated sludge system with a total operating horsepower of about 12,100. A review of pure oxygen versus air system costs produced no significant disagreement with the Facilities Plan estimate. Thus, at an assumed motor efficiency of 90 percent, the price of electrical energy would have to increase to approximately $0.05 per KWH before it would be advantageous to go to the pure oxygen alternative. Since it is believed that the proposed aeration and/or final sedimentation expansion can be eliminated or significantly reduced with an optimized project plan at both plants, the overall economic liability of the pure oxygen alternative at Columbus will only increase. Thus, it is recommended that Columbus retain air activated sludge systems.

The conceptual commitment to air activated sludge at the Columbus treatment plants suggests an examination of the oxygen dissolution system. The present sock diffusion system offers the potential of efficient fine bubble oxygen transfer, a theory which is not fully realized due to rapid clogging and development of a high back pressure. The existing system suffers from the need for a manpower-intensive cleaning program. It is reported that this amounts to some 1400 manhours per year for a biannual cleaning program at both plants. The manpower cost is incurred at an overtime rate, since it requires an intensive short-term effort on the part of the plant staff in order to minimize the down-time of an aeration tank and the consequent drop in overall plant performance.

Primarily due to the maintenance considerations, it is obvious that the sock diffusion system at both Columbus plants should be replaced. Several alternatives exist which more or less maximize the use of existing equipment (blowers and air headers) while minimizing the energy input in a system that responds economically through the five to seven fold change in oxygen transfer needs (winter minimums without nitrification to summer maximums with full nitrification

requirements). Four feasible alternatives were examined with budgetary estimates for installation in 1975 and a sliding price for electrical energy. The first two alternatives used either coarse or fine bubble aeration to assure mixing with mechanical aerators satisfying the remainder of the oxygen demand. The third alternative incorporated fine bubble diffusion (ceramic tubes or domes) to the full extent of the existing plant blowers with only a minor addition of mechanical aeration. The fourth and final alternative considered the use of a directional mix jet aeration system as manufactured by the Pentech Division of Houdaille Industries.

The present worth analysis of Appendix J shows that jet aeration is within 11 percent of the least cost system evaluated under the energy price, 1.5¢/KWH, used in preparing the Columbus Facilities Plans. However, with increasing energy expenditures it becomes progressively more attractive. It is recommended that jet aeration be given a detailed evaluation for application at Columbus by the design consultant that prepares the plant improvements. The City may wish to conduct a jet aeration demonstration/evaluation to derive operational experience with its own staff and to derive a firm quantification of the actual energy requirements for oxygen dissolution before commencing with final design activities. The final EIS will consider the results of such an evaluation (if they are available) in the selection of a proposed dissolution system.

4.4.4 Secondary Solids Thickening

The Facilities Plan for the Columbus Plants recommends the use of centrifugation and dissolved air flotation for waste secondary solids thickening at Jackson Pike and Southerly, respectively. The type of centrifugation is not mentioned nor is the reason for differentiation between the two plants. The 200 gpm sizing of the centrifuge suggests a preliminary selection of a scroll or decanter type. This unit is certainly more economical than smaller basket alternatives and probably more dependable than the larger disc nozzle alternatives. Whether or not it is more economical than dissolved air flotation is a matter of conjecture without a detailed engineering evaluation. It is certain that centrifugation offers advantages in terms of product solids concentration, first cost, and space. It is equally certain that dissolved air flotation offers an advantage by eliminating the pretreatment needs of centrifugation (degritting and/or screening with subsequent residual solids management and disposal),

and savings in terms of operation and maintenance expenditures. Both thickening alternatives can be designed to achieve similar levels of applied solids capture with polymer applications limited to maximum loading periods. It is recommended that the City consider a side-by-side comparison of representative centrifugation and flotation units prior to selection of the preferred unit process. At a minimum, the design engineer should perform a detailed evaluation of the two before making a final commitment to either alternative at Jackson Pike. The present dissolved air flotation system should be adequate at Southerly.

4.4.5 Conditioning and Dewatering

The Columbus plants, for all intents and purposes, are fully committed to thermal conditioning to obtain a dry cake and minimize, if not eliminate, the need for auxiliary fuel during incineration. When this commitment was made in the early seventies, the engineer and the City had little choice but to select thermal conditioning to achieve the sludge processing goals. Today, this is no longer true.

In the past two to three years a variety of belt press configurations for waste solids dewatering have been introduced. These systems have the potential of competing with thermal conditioning as a means of achieving an autogenous cake (30 to 35 percent cake solids) both alone and as a post-dewatering step following conventional centrifugal or vacuum filtration procedures. Elimination of thermal conditioning, of course, reintroduces the need for chemical conditioning by either inorganic (lime and ferric) or organic additives. The potential for post-dewatering is nearly unlimited, but full-scale experience is essentially nonexistent. Certainly, it will have none of the recycle management problems found with thermal conditioning, and it is difficult to imagine how its operation and maintenance requirements could be as severe. The City should maintain the option of abandoning or gradually phasing out the thermal conditioning system through a staged conversion should its operation become untenable. Abandonment of the thermal conditioning system is not recommended without a long-term trial evaluation of a prototype chemical conditioning - conventional dewatering - belt pressing system to assure that a positive improvement in plant operation will be derived.

4.4.6 Recycle Management

The Facilities Plan for the Columbus Wastewater Treatment Plants proposed an isolated air activated sludge system to stabilize the recycled liquors derived from the decanting and dewatering processes that follow the thermal conditioning units. Plant practice has found that this technique, although effective, results in the greatest generation of odors due to the stripping of the concentrated organics from the recycle mixed liquor into the air. Superficially, the enclosed reactor configuration of a pure oxygen activated sludge alternative would appear attractive, but hydrocarbon stripping would remain, and the potential for shut-down would increase. Technical journals and literature offered by the manufacturers note no such pure oxygen application to date. The odor potential would still remain as off-gases are released to the atmosphere, but their reduced volume and concentrated source might make deodorization a feasible consideration.

It would appear that aerobic stabilization of the concentrated liquors would be most applicable with attached growth systems, such as a rotating biological contactor, which have minimum liquid stripping. These units could be enclosed and the building air deodorized prior to release to the atmosphere. However, deodorization of large air volumes is an expensive proposition. It is probable that the most economical means of aerobic treatment when odor control is a vital concern will be co-processing with the raw wastewater on a programmed basis, i.e., return to the main flow stream during non-peak loading periods.

The previous remarks have centered on aerobic stabilization of the concentrated liquors. With organic concentrations of several thousand milligrams per liter, it is probable that the preferred treatment concept should incorporate anaerobic stabilization with subsequent aerobic polishing of the residual pollutant fraction. Investigations recently reported at the 49th Annual Conference of the Water Pollution Control Federation by Dr. R. T. Haug and his co-workers at the Los Angeles/Orange County Metropolitan Area Regional Wastewater Solids Management Program have shown the validity of this concept. Although Dr. Haug's goal was to improve the digestibility of waste activated sludge by thermal preconditioning prior to anaerobic digestion, the results of his bench and prototype investigations have similar applicability to minimizing the recycle impact of the liquors derived from thickening and dewatering the thermally condi-

tioned sludge. The observations of the California investigations for a 60 percent volatile activated sludge applied to a thermal conditioning system and subsequent anaerobic digestion are as follows:

- Volatile solids destruction increased from 30 percent in the control to 50 percent.
- The dewaterability of the solids remained only marginally less than the undigested thermally conditioned product.
- Digester heating requirements will be reduced if not totally eliminated.
- Odorous compounds were largely destroyed during digestion.

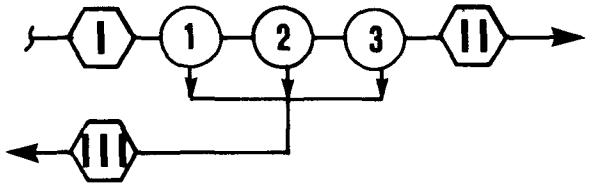
Figure IV-1 shows the recycle management alternatives that could be considered at Columbus. Alternative A may have future applicability, but can be considered theoretically implementable today. Alternative B2 summarizes the concept proposed in the Facilities Plan. The differentiation between Alternatives C1 and C2 is whether the entire thermally conditioned product or only the subsequently derived liquors receive anaerobic stabilization. In each case a storage reservoir could be provided for the product liquors derived from thickening and dewatering the thermally conditioned sludge for a programmed pumped return to the main flow stream.

The presence of the existing anaerobic digestion systems (which were to be delegated to a storage service) at the Columbus plants presents the opportunity to implement Alternative C1 without the economic consequences of new digester construction. The implementation of this concept is strongly recommended as soon as possible to determine its practical application. If fully implemented, the needed improvements would consist of some new piping to allow thermally conditioned sludge to be fed to the first stage digester, new pumps and/or piping to allow the return of settled digester sludge to the first stage digester for direct management of the cell residence time, and programmed return of the supernatant to the main flow stream (roughing trickling filter and activated sludge influent options) during non-peak periods. If this concept proves invalid, then the plant operation should return the nonstabilized liquors through the supernatant return system. Construction of the isolated aerobic activated sludge system for the thermally conditioned sludge liquors is not recommended for the Columbus plants at this time.

Figure IV-1

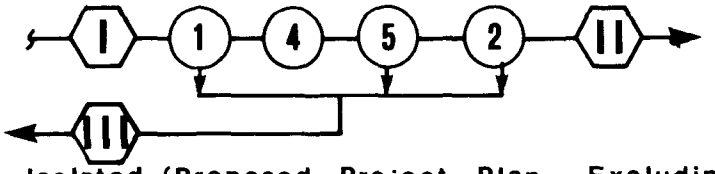
Recycle Management Alternatives

(A.) No Thermal Conditioning – Additional Physical Dewatering

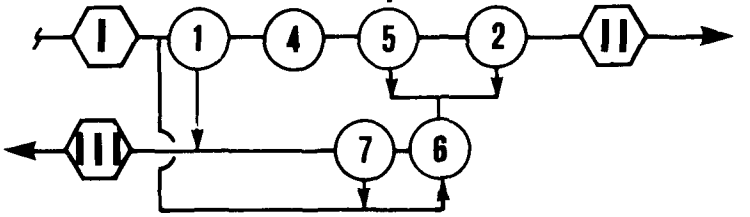


(B.) Thermal Conditioning – Aerobic Stabilization

1. Concurrent

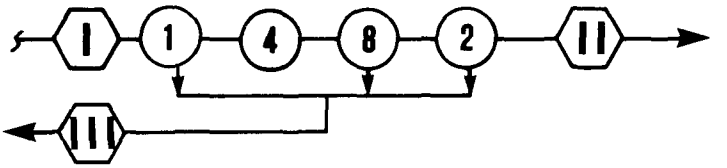


2. Isolated (Proposed Project Plan – Excluding Primary Sludge Addition)

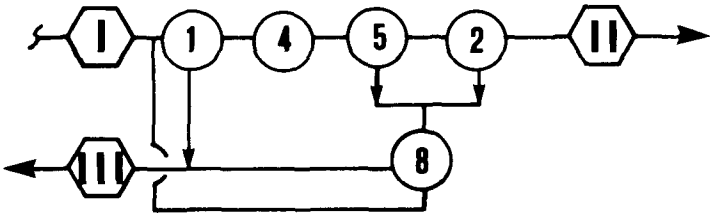


(C.) Thermal Conditioning – Anaerobic Stabilization

1. Complete



2. Liquor Limited



CODE

(I)	Secondary Solids	(1)	Thickening	(5)	Decanting
(II)	Sludge Cake	(2)	Dewatering	(6)	Aerobic Stabilization
(III)	Recycles to Main Flow Stream	(3)	Post Dewatering	(7)	Sedimentation
		(4)	Thermal Conditioning	(8)	Anaerobic Stabilization (Primary & Secondary Digestion)

4.4.7 Pyrolysis

Much has been written about sludge pyrolysis in the last year or two. Engineers and municipalities increasingly face the question of incineration or pyrolysis for disposal of municipal wastewater sludges. Presently, the Eimco BSP Division of Envirotech and Nichols Engineering and Research, among others, are actively engaged in research and development of what they term to be pyrolysis systems. It should be noted that these systems do not represent true pyrolysis (a chemical change brought about by heat alone) but rather starved-air combustion (a chemical change resulting from the controlled presence of oxygen with heat). Regardless, a successful full-scale demonstration project has been conducted with a converted multiple hearth furnace (MHF) at the Central Contra Costa Sanitary District. The conversion of an existing MHF to a starved air combustion reactor is reported to involve only minor changes, with costs dependent upon the existing system and air pollution criteria. Retrofitting needs are described as follows:

- Addition of an afterburner (required to burn exhaust for heat recovery or release to the atmosphere - exhaust gas has a heating value of about 10 percent of natural gas).
- Additional instrumentation and controls.
- Reduction of fan speed or damper position connection to provide less air to the system.
- Modification of scrubbing system to maintain high efficiency with reduced air flow rates.
- General "tightening up" of furnace system.

The manufacturers presently list the following advantages and disadvantages for starved air combustion versus incineration as a result of their test works:

Advantages:

- Operation is more stable and easier to control.
- More feed capacity per equivalent area for incineration.
- Less air pollutants and easier particulate size to scrub.

- Lower sludge solids content required for autogenous combustion.
- Slightly lower operating costs.

Disadvantages:

- Afterburner requirement may limit use in existing installations due to space problems.
- More instrumentation.
- Must be very careful of bypass stage exhaust due to high hydrocarbon content which may be combustible in air. Thus, bypassing may be possible only following afterburning with appropriate emergency controls.
- Exhaust gases are more corrosive.
- Combustibles in ash (up to 30 percent with up to 10 percent fixed carbon) may create ultimate disposal problems.

At this time, it cannot be concluded that starved-air combustion necessarily represents a superior option to incineration. Preliminary conclusions, based upon limited operational experience, show it to be competitive with, but not a replacement for, incineration. Starved-air combustion appears to be attractive only in those situations where a firm commitment to recover energy exists. Without this final recovery of energy, the system will produce some 50 percent more waste solids residue for ultimate disposal with special considerations involved in the selection of the disposal site.

As applied to Columbus, starved-air combustion cannot be recommended at this time. At Jackson Pike, this recommendation is somewhat flexible, with further study required if the adjacent power plant is not constructed. At Southerly, the recommendation is based upon the limited excess energy available once the steam requirements of the thermal conditioning system are satisfied.

4.5 INTERNAL OPTIMIZATION

As the concluding section of this chapter, a variety of optimization concepts with possible applicability to the Columbus treatment plants are explored. The intent of this

section is to assure an optimum commitment of existing and future resources in the proposed improvements to the two wastewater treatment plants.

4.5.1 Flow Equalization

The cyclic nature of wastewater flows in terms of volume and strength is well recognized. It is not unreasonable to expect improved efficiency, reliability, and control when wastewater flows are processed at, or near, uniform conditions. At an existing plant, flow equalization may be an upgrading technique; at a new plant, it can reduce the required size of hydraulically-dependent downstream treatment facilities.

At present there is little operating data comparing the performance of wastewater treatment plants with and without flow equalization. The data that is available is normally restricted to small plants (less than 10 mgd) with one or more of the following conditions:

- stringent effluent standards;
- a collection system relatively free of storm inflow; and
- a dominant industrial waste load.

These facilities have the greatest opportunity to derive first cost and operational savings through flow equalization.

Equalization of wet weather flows from combined and sanitary sewers, which represents the task for the present Columbus situation, requires the use of very large storage basins. The design of these basins requires special knowledge of the collection system, precipitation patterns, topography, and numerous other factors not directly related to wastewater treatment.

The present Columbus situation is somewhat undefined, with a sewer system evaluation survey study currently underway in the combined sewer areas attempting to define the magnitude of storm induced inflow. A recent $30.7 million commitment for sewer separation will also ultimately affect the influent hydrograph at both wastewater treatment plants during precipitation events. The sewer separation project will potentially allow the use of the Alum Creek and Whittier Street storm water retention tanks as flow equalization devices in the future. Appendix I of this report (Section I.4.1 (1)) recommended that all Jackson Pike flows in

excess of 200 mgd be diverted through the 32,000 lineal feet of 150- to 156-inch diameter interconnecting sewer to Southerly. This conduit provides a storage capacity of about 30 million gallons which, through flow level sensing and gate opening management, could serve to dampen the flows routed to and/or normally received at Southerly.

Present records at the wastewater treatment plants do not allow a quantification of storm induced flow peaks. In an effort to define the severity of the inflow problem at each plant, the precipitation record for 1975 was examined and the runoff calculated for the combined sewer areas using the rational formula and an assumed runoff coefficient of 0.45. These rough calculations revealed that 56 percent of the 1975 precipitation events could cause runoff flows in excess of the 200 mgd Jackson Pike hydraulic capacity. Similarly, 19 percent of the 1975 precipitation events could cause runoff flows in excess of the 230 mgd hydraulic capacity at Southerly.

Clearly, both plants experience inflow rates far in excess of their hydraulic capacity. Equally clear is the fact that design hydraulic peaks at the two facilities cannot be appreciably reduced due to the presence of these storm flows, which would rapidly fill any reasonably sized equalization basin. Further, as applied to the plant improvements required to achieve the NPDES restrictions, an upstream flow equalization tank would only return savings in the intermediate sedimentation tanks at Jackson Pike and the final effluent filters at both treatment plants. A savings here will only result in a downrated processing capability for the entire plant with less than full utilization of its existing hydraulic processing capability.

Thus, the wisest flow peak management program for Columbus appears to be one that awaits the results of the sewer system evaluation and sewer separation project in order to rationally define the future benefits to be derived with a flow equalization strategy that makes full use of existing capabilities and considers the full potential of upstream storage within and external to the collection system. This strategy will maximize the City's pollution abatement program in the near term, and offers the potential to fully realize the treatment capability contained in the Columbus plants over the foreseeable future.

Although flow equalization tanks are not presently recommended for the main flow stream at the Columbus plants, they are recommended for the Anheuser-Busch waste flow prior to the proposed pretreatment facility. These tanks should

be of sufficient capacity and operated in a manner that will cause the brewery's ultimate pollutant release to conform to the reverse image of the normal domestic pattern of wastewater generation. Operation in this manner, i.e., release of two-thirds of the pollutant load in the 6 p.m. to 6 a.m. time period, will dampen the pollutant mass peaks experienced at the Southerly treatment works and yield a more stable operation.

A programmed return of the liquors derived from treating and concentrating the thermally conditioned sludges has also been recommended for both plants in Section 4.4.6. This nitrogen-enriched broth could also serve to easily satisfy the nutrient requirements of the nitrogen-deficient brewery waste at Anheuser-Busch should the industry be interested in avoiding the purchase of nitrogen and phophorus supplements. Finally, a flow equalization (or surge control) tank is considered mandatory for the backwash derived from the final effluent filters; if left undampened this return could amount to an instantaneous flow peak of 60 mgd for the filters proposed in the Facilities Plan. The normal, optimum operation of the filters would be to provide a daily backwash during the low flow, early morning hours of plant operation.

4.5.2 Reduction of Electrical Energy Charges

A wastewater treatment plant is a large concentrated user of electrical energy. Accordingly, anything that it can do to reduce demand peaks and move some operating needs to an off-peak period will potentially result in some savings. These considerations are examined in this section for the existing and probable future Columbus situation.

Presently, the rate structure of the Columbus and Southerly Ohio Electric Company and the City's Division of Electricity offers little stimulant to incorporate either peak shaving equipment or off-peak operation at the treatment plants. Demand charges (based upon the maximum 30 minute integrated kilowatt demand recording of an integrating demand meter or the highest registration of a thermal type demand motor) are presently determined in any month as not less then the greater of:

- the maximum recorded demand for the current month;
- the minimum billing demand, if any, specified in a contract;

- 50 percent of the highest demand recorded in the last eleven months; or

- 80 percent of the highest demand in the last eleven months during the summer period (June through October).

From the above, it is obvious that if the wastewater treatment plant cannot shave their peak consistently in the summer months, they derive no savings in demand charges. One potential way of reducing this peak is to provide standby power generating equipment for operating the raw sewage pumps during the maximum 8 hours of plant operating demand. A brief analysis of this mode of operation revealed that the savings in demand and energy charges would essentially compensate for the cost of diesel fuel, yielding an operation with a net liability due to the original cost of the power generating equipment and the manpower required to maintain and operate it. This conclusion will remain valid in the future, since it is reasonable to expect that diesel fuel costs will rise at a rate equal to or greater than the cost of purchased electrical energy. Further, it is concluded that the only potentially economical in-plant power generation system is the one that makes use of a "free" resource, such as waste heat.

A recent concept in the production and sale of electrical energy is "time-of-day" pricing, which incorporates increased rates during peak daytime hours and lowered rates during off-peak periods (generally weeknights from 9-10 p.m. to 6-7 a.m. the following day). Although this pricing concept is not presently in effect at Columbus, its eventually is probable, especially since the energy bill recently passed by the U.S. House of Representatives and pending in the Senate requires utilities to offer time-of-day rates to any customer willing to pay for a special meter. Time-of-day pricing makes the flow-load equalization concepts mentioned in Section 4.5.1 even more attractive, since they will not only stabilize plant operation but allow the removal of some oxygen demanding pollutants at a lower unit of energy charge.

4.5.3 Activated Sludge System

Wastewater treatment by an activated sludge system designed for nitrification opens up a variety of influent flow application alternatives. The optimum configuration is determined by the controlling consideration- either cell residence time or nitrification load. The first case is

normally found when treating a raw or presettled wastewater. Here, the operating solids mass in the aerator required to achieve a nonlimiting cell residence time is greater than that required to oxidize the available nitrogen. The second case is normally found when treating a biologically stabilized and clarified influent. Here, the operating solids are normally controlled by the nitrogen available for oxidation, since a nonlimiting cell residence time is fairly easy to achieve.

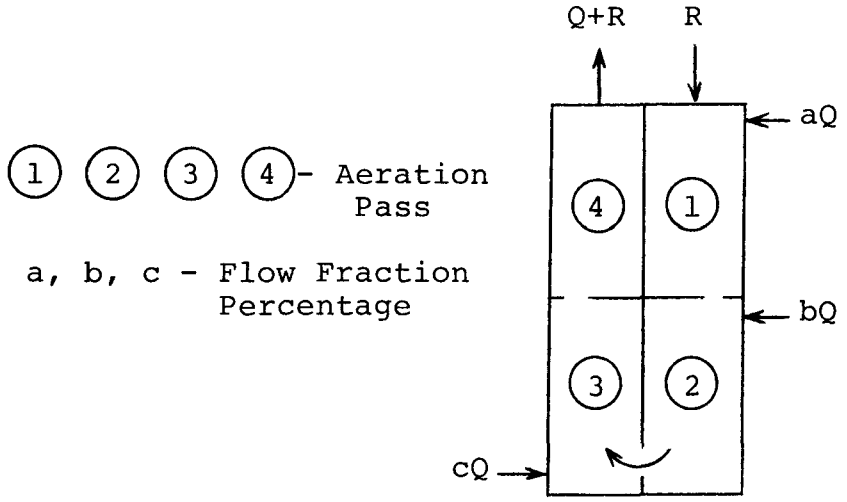
Table IV-18 was prepared to illustrate the changes in the operating solids mass that can be derived through the use of alternate influent feed points. The proposed Facilities Plan at Columbus recommends a configuration that applies all of the flow at the beginning of the aeration tank. As shown, by manipulating the magnitude of the influent flow applied to the head, quarter-point, and midpoint of the reactor, the operating solids may be changed threefold while maintaining the same recycle and solids loading rate on the final settlers.

A feed pattern which incorporates an even flow split to each of the three previously mentioned feed points is recommended at Jackson Pike. This pattern will more equally distribute the incoming load which, in turn, will allow easier maintenance of a nonlimiting dissolved oxygen level (2 to 3 mg/l) throughout the entire aeration tank. Although they may have to be improved, the present aeration tanks have the required feed points and baffling. It is recommended that flow sensing devices be incorporated to monitor the flow split and that the adequacy of the present baffling in preventing back-mixing be field checked to ascertain whether improvements are necessary. Finally, if at all possible, it is recommended that the Jackson Pike secondary system be improved to allow the entire aeration effluent to be applied equally to all of the final sedimentation tanks. This will allow some of the aeration tanks to be taken out of service without a concurrent loss of final sedimentation capacity. Other potential ways of controlling the extent of nitrification include manipulation of the operating solids and influent feed points, considerations which do not affect capital funding.

At Southerly, an aerator feed pattern between that defined for dissolved oxygen and cell residence time considerations is recommended. The Southerly plant will also need similar improvements in its aeration tank baffling and feed point system to assure against back-mixing and to monitor the flow split achieved.

Table IV-18
Optimization Considerations In
A Nitrifying Activated Sludge System

I. Aerator Configuration



II. Range of Potential Operating Solids
Assumptions: Return Sludge = 10,000 mg/l
R/Q = 0.25 @ $MLSS_4$ = 2,000 mg/l

Nitrification Comments	a	b	c	Mixed Liquor Aeration Solids-gm/l				
				1	2	3	4	Average
(1)	100	0	0	2.0	2.0	2.0	2.0	2.0
	75	25	0	2.5	2.0			2.1
	50	50	0	3.3	2.0			2.3
	50	25	25	3.3	2.5			2.5
(2)	33	33	33	5.0	2.7			2.8
	25	75	0	4.3	2.0			2.8
	25	50	25	5.0	2.5			2.9
	25	25	50	5.0	3.3			3.1
	0	100	0	10.0	2.0			4.0
	0	75	25	10.0	2.5			4.1
	0	50	50	10.0	3.3			4.3
	0	25	75	10.0	5.0			4.8
(3)	0	0	1.0	10.0	10.0	2.0	2.0	6.0

(1) Best for design when nitrogen is controlling.
(2) Best for design when dissolved oxygen is controlling.
(3) Best for design when cell residence time (solids) is controlling.

4.5.4 Effluent Filtration

The final effluent filter complex has an operating horsepower requirement that approaches ten percent of the total average day operating condition of each treatment facility. Operation of this system more than is required to meet the NPDES restrictions or to preserve the downstream water quality results is an expenditure that can be avoided. It is recommended that the filtration systems at both plants be designed to process flow volumes up to about eighty-two percent of the rated hydraulic capacity (including recycle considerations). A design for this condition, with an assumed 5 and 45 mg/l effluent suspended solids from the filter and final clarifier, respectively, will yield the 12 mg/l final effluent suspended solids NPDES permit limit for the maximum seven day average. This corresponds to a recommended design peak at the filters of about 180 and 205 mgd at Jackson Pike and Southerly, respectively. Once placed in service, the filters should receive no more flow than required to assure consistent obtainment of the NPDES restriction for average operation. The exception to this suggestion is during the low stream flow summer months, when the plant should seek to produce the best possible effluent at all times in order to preserve downstream water quality.

We are in agreement with the Ohio EPA's guidelines for tertiary filtration systems, which suggest the use of Hydro Clear's Pulse Bed, Air-Mix Filter at a maximum rate of 5 gpm/SF with one unit out of service. The guidelines also propose that other tertiary filtration systems on today's market be limited to a maximum rate of 3-1/3 gpm/SF with one unit out of service. The following auxiliaries are also strongly suggested:

- air scour;
- capability for polymer addition to the filter influent;
- isolation, i.e., free of any bypassed flow introduction, of a portion of the chlorine contact tank to serve as a backwash reservoir with the capability to receive potable water as an emergency backwash supply;
- descaling and degreasing capability; and
- provision of a backwash surge reservoir with a gradual return capability to the main flow stream.

4.5.5 Waste Solids Processing

The remaining optimization considerations deal with waste solids processing at the two Columbus plants. These considerations are better addressed following the full development of design quantities for an optimized project plan that reflects the collective conclusions and recommendations the Facilities Plan evaluation contained in Appendix I and the preceding text of this Chapter. Chapter V, which develops the "Recommended Alternative" to the proposed Columbus Facilities Plan, contains this information and addresses the final optimization considerations.

4.5.6 Conclusions

Exploration of a variety of broadly based optimization concepts has led to the following conclusions:

- Flow equalization of all influent wastewater flow is not presently recommended at either wastewater treatment plant. Flow equalization is recommended for Anheuser-Busch's pretreatment system and for the recycle of the liquors derived from the thermally conditioned sludges. Flow equalization is also recommended for the backwash derived from the final effluent filters.

- The present electrical rate structure found in Columbus appears to offer few means of realizing an operating savings through periodic shaving of electrical demand unless it can be achieved each and every day throughout the year. Use of diesel electrical generators during the peak loading period is not economically attractive. Although the utilities do not presently offer a "time-of-day" pricing schedule, it is believed that such a rate structure is inevitable. Accordingly, the plant operation should seek to move as much of their controllable power demand (Anheuser-Busch waste load, satisfaction of the oxygen demand of the thermally conditioned sludge liquors, effluent filter backwashing, etc.) to the low flow, low loading periods during the late night and early morning hours. Such an operation may return some savings in present demand charges and in future time-of-day pricing concepts.

- The existing activated sludge system should be designed for an optimized capability that incorporates a multi-feed point concept. Such a design will realize potential first cost savings in aerator and sedimentation tankage as well as in recycle requirements.

- Effluent filtration is recommended only to the extent that is necessary to maintain the NPDES effluent restrictions. A maximum design hydraulic capacity of 180 and 205 mgd is recommended for the filters at Jackson Pike and Southerly, respectively. A maximum design rate of 5 gpm/SF with one unit out of service is recommended, assuming proper selection of the effluent filtration system.

CHAPTER V

FINAL ALTERNATIVE SELECTION FOR THE WASTEWATER TREATMENT FACILITIES

V. FINAL ALTERNATIVE SELECTION FOR THE WASTEWATER TREATMENT FACILITIES

This chapter begins with brief consideration and then total rejection of the no action alternative for improvements at the Columbus wastewater treatment plants. It then proceeds to identify the goals and needs of a preferred treatment alternative, and to briefly restate applicable conclusions and recommendations from the previous chapter. This preferred alternative is then developed using the design influent characteristics established in Appendix I with pretreatment of the Anheuser-Busch industrial discharge prior to release to Southerly, and the results of the internal unit process alternative and optimization analyses of Chapter IV and Appendix I. The next section provides a side-by-side comparison of the selected alternative with the originally proposed project plan to identify the estimated project costs and potential operation savings. The chapter concludes with a brief examination of a variety of implementation considerations.

5.1 THE NO ACTION ALTERNATIVE

The normal Environmental Impact Statement requires consideration be given to a no action alternative. No action in terms of improvements at the Columbus wastewater treatments is considered untenable. Failure to correct the present situation would represent a disregarding of not only the natural environment but of the laws of the State of Ohio (in the form of NPDES permits), and of the spirit and intent of Public Law 92-500.

5.2 GOALS AND NEEDS OF A PREFERRED TREATMENT CONCEPT FOR COLUMBUS

In this section, the goals (or recommendations) associated with an ideal wastewater management program are listed along with their implementation needs. The goals are divided into two categories: short to long term, and immediate to short term. The immediate to short term goals are achievable within the City's present administration structure, or by the City providing the initial stimulus with subsequent approval by the governing agencies involved.

5.2.1 Wastewater Collection and Influent Pollutant Characteristics

Table V-1 cites the goals and implementation needs for a variety of concerns which influence the magnitude of flows and pollutants received at the wastewater treatment plants. These considerations ultimately dictate the unit process sizing contained at each facility and, to some extent, the ultimate disposal concept for the waste solids. In terms of a preferred alternative, it is fundamental that the City divert Jackson Pike flows in excess of 200 mgd to Southerly via the nearly completed interconnecting sewer. This will avoid a 25 to 50 mgd hydraulic expansion of the entire Jackson Pike plant and allow more effective utilization of the present hydraulic capacity contained at Southerly, while providing an immediate use for the interconnecting sewer. This recommendation will allow a hydraulic capacity some 2.2 times the average annual daily flow anticipated at the two plants at design conditions. If the present sewer separation project is at all successful, the future peak to average daily flow ratio should increase as combined flows are diverted out of the existing collection system.

5.2.2 Wastewater Treatment and Discharge

Table V-2 summarizes the goals and implementation needs associated with wastewater treatment and discharge. As can be seen from this Table, a major future consideration is the use of the Jackson Pike effluent to satisfy the majority, if not all, of the cooling water needs for the proposed municipal refuse/coal fired power plant. It is also believed that the treatment plants should be designed to achieve the water quality standards of a warm water fishery if, as predicted, the proposed improvements do not accomplish this objective at all flow regimes. It is recommended that the City initiate detailed stream surveys to document and predict cause and effect oxygen sag relationships in order to determine if technology beyond that presently proposed is necessary to attain water quality standards.

5.2.3 Waste Solids Management and Disposal

Table V-3 summarizes the goals and implementation needs associated with waste solids management and disposal. The short to long term goals retain the possibility of codisposal of Jackson Pike's solids at the municipal refuse/coal fired power plant with application of dewatered thermally conditioned secondary solids on selected strip mine acreage. Immediate standby facilities for sludge disposal can be provided by landfilling.

Table V-1

Wastewater Collection and Influent Pollutant Characteristics: Goals and Implementation Needs

I. Short to Long Term Goals

- Monitoring and elimination of persistent toxic organics

- Minimization of influent phosphorus levels
  - Needs City, State or Federal legislation to require synthetic detergent reformulation to exclude or minimize phosphorus content.

II. Immediate to Short Term Goals

- Minimization of heavy metal load from controllable sources with particular attention given to cadmium, nickel, and zinc at Jackson Pike, and cadmium at Southerly.
  - Needs city to promulgate Federal and State approved industrial pretreatment/sewer use ordinances with subsequent enforcement.

- Pretreatment of brewery wastes at Anheuser-Busch to minimize release of soluble oxygen demanding pollutants
  - Needs cooperative City and industrial effort. Flow equalization is also suggested at the brewery with release during the low flow, low load periods at Southerly.

Table V-1 (Continued)

II. Immediate to Short Term Goals (Continued)

- Realize total hydraulic capacity of Jackson Pike and Southerly for wastewater treatment before expanding either facility or incorporating flow equalization concepts.
  - Requires diversion of excess Jackson Pike flows above 200 mgd to Southerly through the nearly completed interconnecting sewer.
- Develop cost-effective storm flow pollution abatement strategy
  - Needs results of current storm sewer evaluation survey and evaluation of impact of current sewer separation project before commitment of additional money. Combined sewer overflow pollution abatement program, through impact-cost/effective analyses, should then establish most effective use of existing collection system, upsystem storage treatment system, and site-adjacent treatment strategies at Jackson Pike and Southerly.

Table V-2

Wastewater Treatment and Discharge:
Goals and Implementation Needs

I. Short to Long-term Goals

- Use of Jackson Pike effluent to completely or fractionally satisfy cooling water needs of the proposed municipal refuse/coal fired power plant.
  - Power plant is dependent upon bond issue passage and environmental analysis concerning its operation.
  - The design of the Jackson Pike chlorination-dechlorination system should address the possible eventuality of this service and facilitate its implementation through bulkhead provision and the maintenance of a clear transport route for effluent from Jackson Pike to the power facility.

II. Immediate to Short-term Goals

- Treatment facilities should be designed to address the NPDES requirements and water quality standards.
  - Both plants need dechlorination and post aeration capabilities.
  - City should initiate detailed seasonal stream surveys to document and predict cause and effect oxygen sag relationships derived from wastewater releases and determine if technology beyond that presently proposed is necessary to attain water quality standards.

Table V-3

Waste Solids Management and Disposal:
Goals and Implementation Needs

I. Short to Long-term Goals

. Seasonal to continuous application of dewatered secondary sludge solids to reclaim barren strip mines and to farm lands as a positive means of erosion control (with ancillary nutrient benefits).

- Cooperation with the appropriate State and Federal agencies appears to be necessary in order to implement a program of strip mine recovery.

- If exploratory City-State Department of Natural Resource Conservations are positive from the standpoint of participation on the "quick start" Brush Creek Reclamation Project, Columbus should purchase an appropriate fleet of vehicles with appropriate supportive auxiliaries under the construction contract for Southerly improvements for use on the project and future application in Perry County.

- The City and ODNR should also address the possibility of codisposing some fraction of the alkaline water plant wastes with the secondary solids on the strip mines (this plan would require water plant solids dewatering before implementation).

Table V-3 (Continued)

I. Short to Long-term Goals (Continued)

- Partial use of Jackson Pike incineration facilities with dewatered cake applied to refuse/coal fired power plant.

  - Power plant is dependent upon bond issue passage and environmental analysis concern- its operation.
  - The design of the Jackson Pike dewatering system should address the eventuality of cake conveyance to the power plant. Its thermal conditioning system could consider the use of power plant steam rather than that generated from waste heat recovery boilers at the wastewater treatment plant. Cost to the power plant will be minimal in all areas except ash disposal, while savings to Jackson Pike will be considerable under such a system.

- The City may want to consider a management scheme capability which centralizes primary sludge dewatering at Jackson Pike (for codisposal with refuse) and secondary sludge dewatering at Southerly (application to strip mines). Minimum needs would share the existing Jackson Pike to Southerly sludge force main with a new pumping station and auxiliaries at Southerly.

II. Immediate to Short-term Goals

- Immediate standby solids disposal capacity for Southerly and Jackson Pike can be provided by landfilling the sludge. The vehicle fleet recommended for land application of sludge to strip mine land will be available to provide the standby capability required.

Table V-3 (Continued)

II. Immediate to Short-term Goals (Continued)

. Incinerator ash should be disposed of in the same quarry as the water plant wastes.

- A possible system would incorporate force main conveyance from Southerly to Jackson Pike, Jackson Pike to the quarry (by itself, or with water plant wastes from Dublin Road Plant). An alternative to this system is truck conveyance of dry ash, either on a continuous of delayed basis from the ash lagoons. Jackson Pike system should ultimately address the disposal needs of the power plant ash. Existing or newly constructed ash lagoons can be used for backup support. Quarry overflows should be returned to sewer except during precipitation events.

. Incinerator ash as source of phosphorus levels. (Viability somewhat limited by influent phosphorus levels and magnitude of plant phosphorus removals.)

- Consider local four county marketing strategy for incinerator ash as source of phosphorus for nearby farmlands. Ash would be applied as needed to requesting areas.

5.3 THE RECOMMENDED ALTERNATIVE

Figure V-1 schematically describes the recommended facilities for the Columbus wastewater treatment plants. Conceptually, with the exception of the total elimination of the isolated aerobic activated sludge system for stabilization of the broths associated with thermal conditioning and the addition of a dechlorination and post aeration facilities, the proposed Jackson Pike facilities are not uniquely different than the proposed project plan found in the Columbus Facilities Plans. Its uniqueness is found in the recommended sizing of the attendant unit processes. At Southerly, with the abandonment of the first stage pumping station, roughing trickling filter, and sedimentation system made possible by the recommended pretreatment of Anheuser-Busch wastes, a more substantial deviation from the Facilities Plan has occurred.

The following paragraphs describe the recommended Columbus plant improvement program in more detail.

5.3.1 Design Quantities

Appendix K summarizes average day process stream characterization for both treatment facilities at the year 2000 design conditions for the proposed process chains shown in Figure V-1. All sizings and costs developed in the remainder of this Chapter are based upon this process stream summary.

5.3.2 Unit Process Sizing

Table V-4 summarizes the changes in unit process sizing derived from the recommended project plan in comparison to the improvements originally proposed in the Columbus Facilites Plan. Where no change from the originally proposed project plan is indicated, the reader is referred to Appendix I for the unit process's sizing. Additional discussion of the rationale leading to the final recommendations can be found in Appendix K.

Figure V-1
The Preferred Alternative

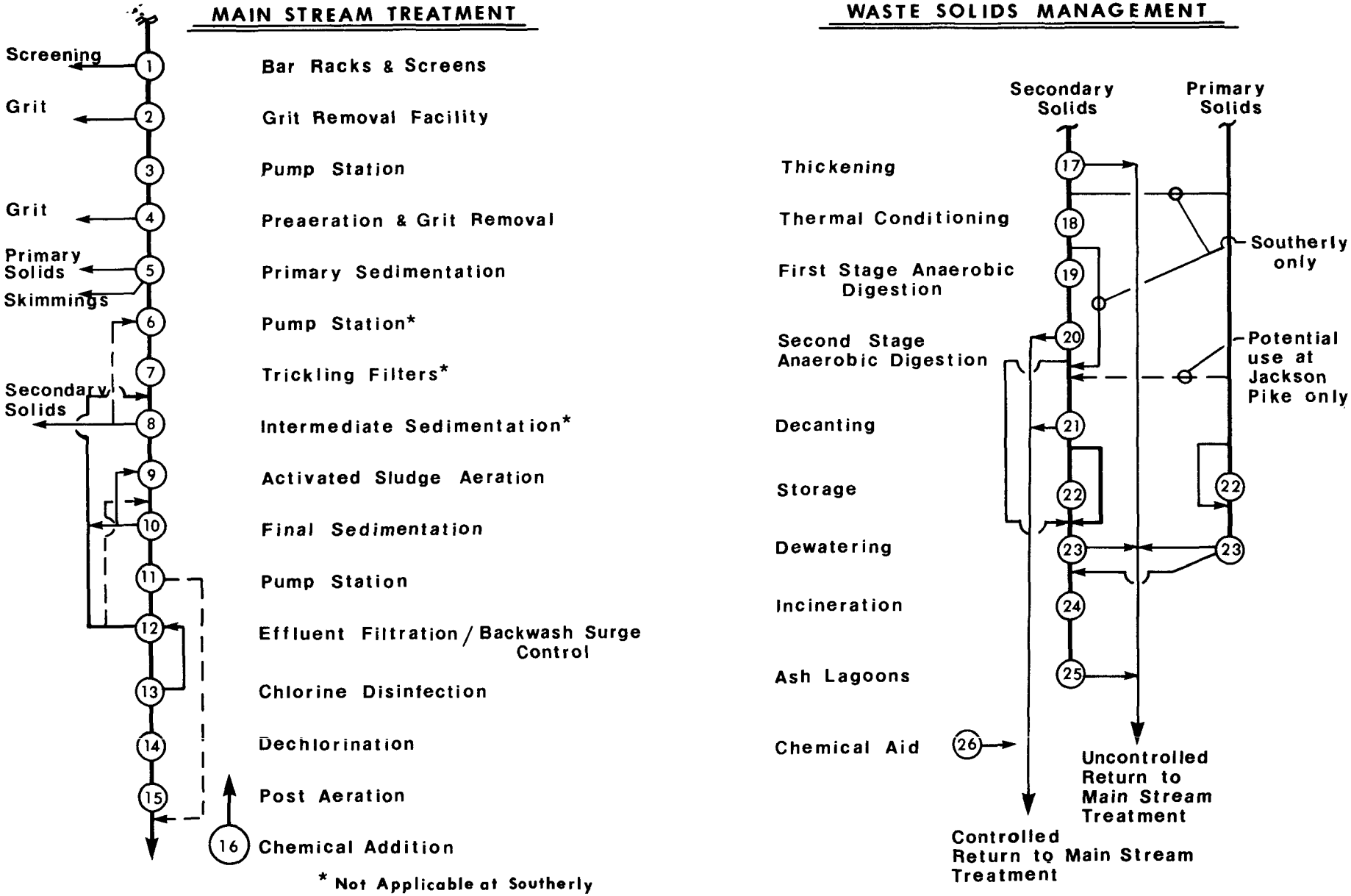


Table V-4

Changes Associated with the Recommended Project Plan

Unit Processes (Refer to Figure V-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
1. Bar Racks and Screens	x							x						
2. Grit Removal	x							x						
3. Pump Station	x									x				
4. Preaeration/Grit Removal	x							x						
5. Primary Sedimentation	x							x						
6. Pump Station			x											x
7. Trickling Filters				x										x
8. Intermediate Sedimentation			x											x
9. Activated Sludge Aeration		x		x					x		x			
10. Final Sedimentation				x							x			
11. Pump Station			x							x				
12. Effluent Filtration/Backwash			x		x					x		x		
13. Chlorine Disinfection			x							x				

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Table V-4 (Continued)

Changes Associated with the Recommended Project Plan

Unit Processes (Refer to Figure V-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
14. Dechlorination					x							x		
15. Post Aeration					x							x		
16. Chemical Addition					x							x		
17. Thickening				x							x			
18. Thermal Conditioning	x								x		x			
19-20. Anaerobic Digestion						x							x	
21. Decanting	x							x						
22. Storage				x							x			
23. Dewatering	x										x			
24. Incineration		x		x							x			
25. Ash Lagoons	x							x						
26. Chemical Aide					x							x		

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Note: Recommended alternative calls for complete elimination of the proposed isolated activated sludge system for stabilization of the product liquors derived from concentration of the thermally conditioned secondary solids.

(1) Pretreatment and Primary Sedimentation

With the exception of an expansion of the Southerly influent pumping station to provide a firm pumping capacity of 230 mgd (Facilities Plan proposed 185 mgd), no expansion of the two plant's pretreatment and primary sedimentation facilities is recommended. The pumping station at the terminus of the 156-inch diameter interconnecting sewer, with a firm capacity of 70 mgd, is also considered adequate.

It should be noted that the reason Jackson Pike's pretreatment system is considered adequate is due to the presence of the interconnecting sewer, which allows all flows above 200 mgd (1.8 times greater than the average annual design flow) to be diverted to Southerly. Failure to use the interconnecting sewer would necessitate a design hydraulic capacity of at least 220 mgd at Jackson Pike. Although a flow peak of this magnitude could be easily incorporated in the new Jackson Pike structures and conduits, its selection may force a major revamping of the existing transfer conduits within the plant. Therefore, the soundest decision appears to be one that makes maximum use of the rated hydraulic capacity of both plants and the interconnecting sewer.

As noted in Appendix I, rehabilitation of the four 120 feet by 60 feet by 15 feet side water depth primary sedimentation tanks at Jackson Pike is not a strong requirement for successful wastewater treatment. It was decided to recommend rehabilitation of these tanks and their associated collector mechanisms in order to provide a modernized facility with all tankage suitable for service. The primary sedimentation surface areas in the improved facilities will then be 125,000 square feet at both Jackson Pike and Southerly. It is proposed that the screenings and grit be disposed of at either remote or onsite landfill operations and that skimmings be concentrated and applied to the incinerator. As an alternative, the City may wish to incinerate the grit as well.

(2) First Stage Biological Treatment

The first stage biological treatment system is limited to Jackson Pike. It incorporates a pumping station, synthetic media trickling filtration, and intermediate sedimentation.

The recommended pumping station will have a minimum firm capacity of 220 mgd. This sizing reflects

the firm capacity of the plant plus a 20 mgd credit for recycled flows. The original Facilities Plan did not consider recycles in its pump station sizing.

The recommended trickling filter complex will consist of eight (8) 78-foot diameter by 21.5-foot deep filter units. The anticipated removal of soluble substrate through the filter is on the order of 65 percent. It is recommended that the installation be designed with the flexibility to divert flow around the filter. This improvement may allow operational savings when complete nitrification is not a treatment requirement by avoiding the energy associated with pumping the wastewater.

The proposed intermediate settling complex will provide a total area of 88,000 square feet, with each of the eight (8) tanks provided coupled to one of the trickling filters. It is recommended that the system be designed with the capability to supply waste sludge to the influent to either the trickling filter or the activated sludge system for process flexibility. The Facilities Plan proposed 84,400 square feet of sedimentation area at Jackson Pike.

(3) Second Stage Biological Treatment

The design of an activated sludge system entails an optimized interrelated blend of aeration and sedimentation tankage. Up to a certain point, hydraulic surface overflow rates are secondary to successful performance. The key to successful sedimentation is to maintain a reasonable solids loading with sufficient return sludge capacity. Both are related to the operating mixed liquor suspended solids (MLSS) applied to the sedimentation system. The operating MLSS is related to the cell residence time (or nitrification requirements), the mode of applying both flow and return sludge to the aerator, and the aeration tankage.

In Section 4.5.3, it was recommended that the activated sludge systems at the Columbus plants be optimized to incorporate a modified step feed aeration pattern in order to avoid an expansion of either the existing aeration or sedimentation systems at Jackson Pike. At Southerly, the most cost effective design is to provide the additional 5.2 million gallons of aeration tankage defined in the Facilities Plan. The

proposed improvements at Southerly will allow one 5.2 million gallon aeration system to be completely committed to return sludge aeration. This commitment will allow successful obtainment of a nonlimiting cell residence time during the critical winter condition. The return sludge system at Jackson Pike should be revamped for ease of operation, with return to the beginning of each aeration tank.

As mentioned in Appendix J, total revamping of the Columbus plant's oxygen transfer capacity is also recommended. The calculated oxygen demands for design load satisfaction are given below:

	Design Oxygen Demand to be Satisfied, lbs/day	
	Jackson Pike	Southerly
Average Day		
Carbonaceous	35,000	120,000
Nitrogenous	90,000	75,000
Total	125,000	195,000
Maximum Day		
Carbonaceous	50,000	118,000
Nitrogen	135,000	130,000
Total	185,000	310,000

The firm oxygen transfer capability at both plants should address these needs. It should be noted that the maximum day values take no credit for load dampening due to the controlled release of either the recycles at both plants of the pretreated brewery waste in the Southerly collection system.

(4) Final Effluent Filtration

The considerations associated with the final effluent filtration system were developed in Section 4.5.4. The recommended project plan will provide 1,860 square feet of filter surface area at both Jackson Pike and Southerly through the installation of 16 units at each site. The maximum flow applied to the filter complexes will be 180 mgd at Jackson Pike and 205 mgd at Southerly. A firm air capacity of 3,700 cfm must be provided at each plant, along with a 0.19 million gallon backwash storage volume. As mentioned in Chapter IV, all filter sizing has assumed an installed system the equivalent of that offered by the Hydra-Clear Company.

(5) Effluent Disinfection, Dechlorination, and Post Aeration

The Facilities Plan did not include dechlorination or post aeration. The suggested contact time for the entire sequence of these two treatment concepts is 20 minutes at the hydraulic peak. This yields a total volume of about 3.0 and 3.5 million gallons at Jackson Pike and Southerly, respectively. The suggested maximum chlorination capacity at both plants is 12,000 pounds/day, which will allow the breakpoint elimination of 1 to 1.5 mg/l of ammonium nitrogen under average daily flow conditions. The recommended dechlorination feed capacity for SO_2 should be a similar order of magnitude as the chlorine capability.

(6) Secondary Solids Thickening

The Facilities Plan for the Jackson Pike Plant recommended waste activated thickening by centrifugation. The nominal sizing for each centrifuge is 200 gpm. At this unit size, the recommended project plan requires a total of 12 units, with two standby, for the maximum day condition. This selection is recommended for the Jackson Pike installation, since the waste secondary solids are dominated by sloughed filter humus (which should be at a solids concentration of one percent or higher), and since it is possible to realize a greater hydraulic capacity for a scroll centrifuge without a significant sacrifice in solids capture through the addition of organic polyelectrolytes.

The Southerly Facilities Plan recommended two additional dissolved air flotation units at 1900 square feet each for waste secondary solids thickening. This 50 percent expansion is unnecessary with the recommended project plan, since the existing 7,600 square feet of thickening area will yield an average and maximum day solids loading of 10 and 14 pounds/SF.day, respectively; values well within normal design limitations. A standby polyelectrolyte addition capability is recommended as a contingency should one or more units be out of service under maximum day conditions.

(7) Thermal Conditioning

The Facilities Plan recommended one additional 200 gpm thermal conditioning system be added to the existing two units at Jackson Pike and three units at Southerly.

The recommended project plan does not differ with this selection at Jackson Pike, as both the average day and maximum day needs require the use of two 200 gpm systems. It does differ with the recommendations at Southerly, since the average and maximum day requirement is also for two units. Here, it is believed more sound to provide extra standby auxiliaries (i.e., grinders, high pressure pumps, high pressure compressors, etc.) and extra dewatering capacity rather than one complete standby heat exchanger and reactor for the maximum day condition.

(8) Anaerobic Digestion, Decanting, and Storage

Anaerobic solids destruction of the thermally conditioned solids is recommended at both plants in the recommended project plan. The primary digestion capacity, less the cone volume, at Jackson Pike and Southerly is 6.3 and 4.3 million gallons, respectively. With a design volumetric displacement time of about 20 days, the Jackson Pike capacity matches the system needs perfectly. At Southerly, only 36 percent of the average design day thermally conditioned solids can be applied to the anaerobic digestion system; the remainder must be decanted and directly dewatered or stored.

The second stage anaerobic digester volume at Jackson Pike and Southerly totals 8 and 2.2 million gallons, respectively. It is recommended that two of the eight second stage digesters at Jackson Pike and one of the two second stage digesters at Southerly be committed to decanting and thickening the digested thermally conditioned secondary solids.

The remaining existing digestion and decanting capacity at the two plants is as follows:

	Jackson Pike	Southerly
Digestion	6 tanks @ 85 feet diameter, 6 million gallons, 34,000 sf	1 tank @ 85 feet diameter, 1.1 million gallons, 5,670 sf
Decant Tanks	3 tanks*, 0.37 million gallons, 3,500 sf	4 tanks @ 35 feet diameter, 0.39 million gallons, 3,800 sf

* includes proposed additional unit

These tanks can provide the necessary storage capabilities at both wastewater treatment plants.

The decant tanks at Jackson Pike can be committed to fractional or complete primary sludge thickening uses if the need so arises. At Southerly, the decant tanks should remain in service to concentrate (and store) the thermally conditioned solids bypassed around the anaerobic digestion system.

Thus, the recommended plan proposes to more fully develop the use of existing equipment at both wastewater treatment plants. Implementation of this alternative will necessitate both major and minor piping changes, additional pumping capabilities to derive an optimum controlled return of the digester supernatant and decanting liquors, and "as required" rehabilitation of the existing digesters. Particular attention should be given towards efficient mixing in the primary digesters and the capability to return settled digested solids to the first stage digester. Heating requirements of the digesters will be lessened due to the elevated temperature (100 to 120°F), of the thermally conditioned feed sludge. (The advantages of incorporating the anaerobic digestion system in the project plan are developed in Appendix J.)

(9) Dewatering and Incineration

The dewatering and incineration capabilities of any plant are intimately related. Often, the incineration capability of a plant is limited by its upstream dewatering capacity and the routing of dewatered sludge to any incinerator. Care should be exercised to assure that the capacity of an incinerator and the capability of a dewatering system effectively match. If at all possible, a given incineration system should be designed to share the product solids from two banks of dewatering equipment. Coupled with these considerations is the reality that normal recommended operation will require the programmed shutdown of an incinerator two to three times a month for inspection. Typically, this inspection requirement will encompass two to three days due to slow cooling and heating considerations as the unit is taken out of and then returned to service.

In previous sections of this report, use of the nearly completed Jackson Pike to Southerly sludge force main as a means of eliminating the standby incinerator at Jackson Pike has been mentioned. The price for completing this force main with the provision of two stage pumping is about the same as a new 200 wet ton/day incinerator, while the committed investment for the force main totals on the order of $300,000. The extra existing 5 million gallons of storage volume at Jackson Pike to further reduce the potential peak of sludge transfer makes this option even more viable. However, the potential codisposal of sludge solids with refuse at the proposed municipal refuse/coal fired power plant suggests that use of the force main be delayed until the preferred direction of flow and cost-effectiveness is established. The Southerly incineration needs under the minimum maximum day, even with a possible 50,000 pound/day diversion from Jackson Pike, remain at three incinerators (including back-up) whether or not the force main becomes operational. A total of three incinerators should be provided at Jackson Pike, two with a capacity of 170 wet tons per day and one with a capacity of 200 wet tons per day. Standby solids disposal capacity without the force main must be provided at both plants through handling of any thermally conditioned and dewatered sludges which cannot be incinerated to either strip mined or landfill sites. Firm recommendations as to a standby system must await investigation of the implementability of the options available.

A final consideration concerning dewatering needs is whether or not the existing Southerly vacuum filtration system should be expanded or replaced with centrifugation, as recommended in the Facilities Plan. With an assumed yield rate of 5 pounds of dry suspended solids per hour per square foot of vacuum filtration area, the existing vacuum filtration complex would have to be expanded by 50 percent for design loadings. This need translates to two new 425 square foot filters or two new 65 gpm

centrifuges with a 6.5 percent feed sludge concentration. Provision of either of these two options would require a new structure to house the new units. With total abandonment of the vacuum filtration system and subsequent replacement with centrifugation, it may be possible to fit the required eight (8) centrifuges in the existing dewatering structure.

This option would result in significant first cost savings by eliminating the requirement for a new building. Expansion needs will be immediate upon provision of the recommended main stream facilities, meaning an early decision has to be made as to whether the existing filters are to be retained and a new building constructed for new dewatering equipment, or if the filters should be abandoned and the existing space used for a centrifuge complex. Other salient advantages derived from replacing the vacuum filters with centrifuges are as follows:

- The present 10 year old vacuum filtration facility will be near the end of its effective life by the time the improvements are provided. Extensive rehabilitation of the filter and replacement of many of its auxiliaries is likely as a design requirement to assure a reliable operation for another twenty years of service.

- The centrifuge, with its enclosed means of sludge dewatering, is aesthetically attractive, especially when processing thermally conditioned solids.

- A total centrifugal dewatering capability will minimize operator training considerations and the needed spare part inventory required at Southerly. These benefits will also facilitate the transfer of operation and maintenance personnel between the two plants as well as allow the pooling of spare parts between the two installations.

Thus, this review is in agreement with the recommendation that the Southerly vacuum filter system be replaced with a centrifugation complex. The final recommended improvements at both facilities are as follows:

	Jackson Pike	Southerly
Dewatering Centrifuges	6 @ 55 gpm 3 @ 65 gpm (two standby) at maximum day	6 @ 55 gpm 2 @ 55 gpm (two standby) at maximum day
Incinerators	2 @ 170 wet tons/day 1 @ 200 wet tons/day (one backup) at maximum day	3 @ 200 wet tons/day (one backup) at maximum day
Miscellaneous	Possible completion of interconnecting sludge force main if shown to be cost-effective, provision of polyelectrolyte addition capability for "as required" use.	

Presently, Jackson Pike makes use of a lagoon to relieve its inadequate solids handling facilities. This lagoon has been a source of odor complaints, and its eventual abandonment is recommended. The question remains as to how to dispose of this historic inventory of partially stabilized digested solids. It is recommended that after the provision of the required sludge handling improvements for Jackson Pike, Southerly, and the interconnecting sewer, the solids be left in place. The lagoon should then be backfilled and compacted with suitable cover made available during the Columbus improvement program. Displaced liquid should be returned through a temporary drainage ditch (and, if needed, a temporary pumping station) to the main processing stream at Jackson Pike.

5.3.3 Comparison with the Originally Proposed Project Plan

(1) First Cost

Table V-5 compares the first cost of the recommended project plan with the originally proposed project plan for Columbus. The recommended project plan is seen to contain an additional expenditure of some $8 million, the majority of which is associated with the expanded effluent filtration system. It is believed that the recommended improvements are necessary for reliable

Table V-5

First Cost Comparison of Original Project Plan with the Recommended Project Plan
(Millions of Dollars)

Processing Concept	Jackson Pike			
	Original Project Plan	Net Additional Cost	Net Cost Savings	Recommended Project Plan
Pretreatment and Primary Sedimentation	$ 8.6	0	0	$ 8.6
Chemical Addition	2.3	$0.3	0	2.6
First Stage Biological Treatment	16.8	0	$1.1	15.7
Second Stage Biological Treatment	14.8	0	9.1	5.7(3)
Effluent Polishing	13.7	2.8	0	16.5(4)
Subtotal (1)	$56.2	$3.1	$10.2	$49.1
Solids Thickening	$10.5	0	$ 2.7	$ 7.9
Solids Conditioning	4.9	0	0	4.9
Recycle Management	6.8	0	6.1	0.7
Solids Dewatering	1.2	0	0	1.2
Solids Incineration and Transport	12.3	0	3.4	8.9(5)
Ash Disposal	0.6	0	0	0.6
Subtotal (1)	$36.4	$0.0	$12.2	$24.2
TOTAL (1)	$92.6	$3.1	$22.4	$73.3
REVISED TOTAL (2)	-	-	-	$91.6

(1) 1974-1975 Basis
(2) July, 1977 Basis, Factor = 1.25
(3) Reflects installation of Jet Aeration System
(4) Reflects installation of Hydro-Clear Filter
(5) Does not include standby costs

Table V-5 (Continued)

First Cost Comparison of Original Project Plan with the Recommended Project Plan
(Millions of Dollars)

Processing Concept	Southerly			
	Original Project Plan	Net Additional Cost	Net Cost Savings	Recommended Project Plan
Pretreatment and Primary Sedimentation	$ 0.1	$ 0.1	$ 0	$ 0.2
Chemical Addition	1.2	0.3	0	1.5
First Stage Biological Treatment	15.5	0	15.5	0
Second Stage Biological Treatment	6.0	0	1.3	4.7 (3)
Effluent Polishing	12.9	4.6	0	16.6 (4)
Subtotal (1)	$34.8	$ 5.0	$16.8	$23.0
Solids Thickening	$ 3.1	$ 0	$ 3.1	$ 0.0
Solids Conditioning	2.2	0	2.0	0.2
Recycle Management	7.0	0	6.3	0.7
Solids Dewatering	7.2	0	0.7	6.5
Solids Incineration and Transport	12.0	0	3.4	8.6 (5)
Ash Disposal	0.1	0	0	0.1
Subtotal (1)	$31.6	$ 0.0	$15.5	$16.1
TOTAL (1)	$66.4	$ 5.0	$32.3	$39.1
REVISED TOTAL (2)	-	-	-	$48.9

(1) 1974-1975 Basis
(2) July, 1977 Basis, Factor = 1.25
(3) Reflects installation of Jet Aeration System
(4) Reflects installation of Hydro-Clear Filter

operation, and are prudently sized. The recommended project plan also offers over 54 million dollars in first cost savings. The majority of these savings are derived by more optimum sizing and use of biological reactors and their attendent solids-liquid separation systems, and the economic return derived with pretreatment of the brewery waste applied to Southerly, which allowed the elimination of the originally proposed first stage treatment system. It is believed that the associated recommendations also represent realistically sized alternatives.

Thus, the recommended project plan offers a net capital savings of over $46 million in comparison to the original project plan. This savings, slightly in excess of 29 percent of the original Facilities Plans first cost estimate, remains significant even in the context of the costing accuracy normally found in Facility Planning documents. It should also be noted that the recommended project plan offers a wastewater treatment system which integrates the liquid handling capabilities of both plants, which allows a combined hydraulic capacity some 50 mgd more than originally proposed.

(2) Operating Cost

The operational costs associated with the recommended project plan were determined by reducing or increasing the costs of the original project plan by the assumed impact of the proposed alternative. This was necessary since the differences in the basis of design for influent flow and pollutant mass noted in Appendices I and K would have a rippling impact upon the operating costs for the integrated liquid and solids processing capability of the Columbus plants. Thus, this cost comparison more accurately reflects relative differences rather than true definite costs.

Table V-6 compares the estimated operating costs of the recommended project plan with the original Columbus project plan for the average operating year in the twenty year planning period. On a 1974 to 1975 pricing basis the recommended alternative is seen to offer an operating advantage approaching eight percent. Slight reductions are offered in each costing category, with the reduction in operating power most significant. This is due to the assumed selection of a more efficient oxygen dissolution system and the elimination of the energy intensive isolated activated sludge system for recycle management. At Southerly, it was found that with pretreatment of the brewery waste and the elimination of the trickling filter, the additional aeration horsepower was nearly equivalent to the 1050 horsepower savings derived by eliminating the first stage biological treatment system. As shown at the bottom of the Table, the scenarios which apply waste solids either to the power plant or the strip mines have a relatively small impact upon the total operating budget of the Columbus plants.

5.4 IMPLEMENTATION

5.4.1 Procurement

It is recommended that all major equipment items common to both plants be bid at one time directly to the City. This will assure uniformity in equipment at both plants, minimize the spare part inventory, and allow maximum exchange of operational and maintenance personnel. Prebidding of the equipment will facilitate further design of auxiliaries and structures as each installation can then be custom-built for known physical requirements, rather than general, representative needs.

5.4.2 Operation and Maintenance

The heart of any wastewater treatment plant is its operation and maintenance staff. The age of equipment and/or operating problems at the Columbus plants has resulted in a unavoidable decline in employee enthusiasm for the charge at hand.

Table V-6

Operating Cost Comparison of Original Project Plan
with the Recommended Project Plan
(Millions of Dollars)

ORIGINAL PROJECT PLAN

	1974-1975 Basis			Present Day
	Jackson Pike	Southerly	Total	Total
Chemicals	$1.96	$2.01	$ 3.97	$ 5.96
Power	1.38	1.36	2.74	4.93
Personnel	1.29	1.23	2.52	3.35
Maintenance	1.05	0.94	1.99	2.49
Total	$5.68	$5.54	$11.22	$16.73

RECOMMENDED PROJECT PLAN *

	1974-1975 Basis			Present Day
	Jackson Pike	Southerly	Total	Total
Chemicals	$1.98	$1.84	$ 3.82	$ 5.73
Power	1.21	1.07	2.28	4.10
Personnel	1.29	1.16	2.45	3.26
Maintenance	0.97	0.85	1.82	2.28
Total	$5.45	$4.92	$10.37	$15.37 (1)
		Savings	$ 0.85	$ 1.35
		Percent Reduction	7.6	8.1

* Assumes on-site waste solids handling and disposal

(1) Elimination of incineration at Jackson Pike with application of the dewatered solids to the refuse/coal fired power plant will yield about $0.45 million of savings in power, personnel, and maintenance

(2) Application of thermally conditioned solids to strip mine lands will increase net expenditures in power and personnel. With year round hauling, the estimated rise in cost is about $0.6 million.

It is probable that the future will bring either greater numbers of lesser skilled individuals or lower numbers of higher skilled employees into plant operation. A good argument can be made for each case. However, in maintenance, there will be no substitute for a highly skilled and paid staff. The close proximity of the two Columbus plants presents the possibility of savings in terms of employee numbers for maintenance. Here, a shared maintenance capability is a distinct possibility. The number of employees for this task should reflect not only normal preventative needs but also a noncommitted time for random repair and maintenance.

5.4.3 Pilot Plant and Demonstration Program

The Facilities Plan recommended a pilot plant to evaluate the effectiveness of the proposed two-stage trickling filter air-activated sludge system in solving the bulking activated sludge problem at Southerly. With pretreatment of the brewery waste to the level prescribed herein (60 to 70 percent removal of the soluble oxygen demand associated with a total applied load of 60,000 pounds of BOD_5 per day), it is likely that the bulking problem will be eliminated.

Although it is not recommended that a pilot plant study be conducted to evaluate the entire sequence of main stream biological treatment and solids separation, there are concepts suggested which are worthy of full-scale evaluation. These concepts, anaerobic digestion of thermally conditioned secondary solids and jet aeration, are discussed below.

Jackson Pike is the recommended site for evaluation of anaerobic stabilization of the thermally conditioned solids. In conducting this program, an appropriate primary and secondary digester complex should be isolated and gradually brought to the proposed design conditions of 20 days detention in the primary digester. At this loading rate, equilibrium conditions are not approached until an elapsed period of nearly two months. Thus, a start-up and conditioning period of at least three months is suggested prior to any evaluation. The conclusions derived from the evaluation should be qualified to the extent that the solids processed now will not be the same as anticipated in the future in that they will be free of spinaround problems and dominated by sloughed trickling filter humus either with or without the precipitates associated with phosphorous removal.

The second process evaluation proposed deals with a full-scale evaluation of a jet aeration system, which could potentially reduce the operating horsepower of the activated sludge system by 30 to 40 percent. Again, Jackson Pike is the recommended demonstration site due to its present capability to completely isolate an aerator and matching sedimentation tank. Ideally, this evaluation should be conducted through the full extreme of temperature conditions with sufficient time to identify potential maintenance problems. Conclusions in terms of maintenance should be qualified to the extent that the present primary effluent characteristics will represent a far more severe duty than the future situation with upstream trickling filtration and intermediate sedimentation.

CHAPTER VI

PRIMARY ENVIRONMENTAL IMPACTS OF THE PROPOSED WASTEWATER TREATMENT FACILITIES

VI. PRIMARY ENVIRONMENTAL IMPACTS OF THE PROPOSED WASTEWATER TREATMENT FACILITIES

The primary impacts, both positive and negative, of the proposed wastewater treatment facilities will not vary significantly from those described in the Facilities Plans and their associated Environmental Assessments. This chapter will contain a brief summary of those impacts along with some unique to this proposal. (Primary impacts of the proposed regionalization plan can be found in Chapter III.)

6.1 LAND

Land related impacts at the wastewater treatment plant sites will be minimal. All proposed expansion will take place within the bounds of the present sites on areas for which little other beneficial use exists. Construction impacts, such as temporary erosion, will be controlled through provisions in the construction specifications. The construction and repair of sewer lines and treatment facilities can also cause public inconvenience. These impacts are particularly noticable in the maintenance of traffic flow, public and worker safety, and general disruption to business and residential areas from increased noise, congestion and light glare. These construction and maintenance impacts are discussed below.

Perhaps the major land related primary impacts at either site will be associated with the dispostion of the present sludge lagoons. As recommended in this report, excavated material at each site will be used as a cover and fill for each lagoon, with subsequent compaction to ensure stability. Displaced liquid will be routed back to the mainstream treatment process. It may be necessary to supplement the excavated material from the site the quantities obtained elsewhere; a possibility which will have an impact on the disturbed offsite borrow area.

The major off-site land impacts of the proposed plan are found in the ultimate disposal of incinerator ash and in the sludge disposal system utilized as a backup to the incinerator complex. Little adverse impact can be anticipated from landfilling of the incinerator ash, assuming the landfill is properly located and managed. Co-disposal of ash with water assures the minimization of any related adverse impacts.

Negative impacts of the possible backup sludge disposal systems are somewhat difficult to predict. If strip mine recovery were practiced, for example, some experimentation and adjustment of application rates would no doubt have to be undertaken to ensure the retention of all sludges on the application sites and to minimize any adverse surface and ground water effects in water courses receiving runoff or leachate from each site. Similar monitoring programs would be necessary to determine the extent of adverse impacts of any other backup land based sludge disposal scheme which may be implemented, such as composting or erosion control with partial nutrient recovery.

It is unlikely that a strip mine recovery scheme would be discontinued solely due to adverse impacts. Assuming proper control and monitoring, it is difficult to imagine impacts severe enough to offset the positive environmental impact associated with the restoration of land to a state whereby it no longer exerts a debilitating effect on its surroundings. *

6.1.1 Construction and Maintenance Impacts Causing Public Annoyance or Inconvenience[1]

The construction of sewer lines and treatment facilities can create conditions which are annoying to the public during the period of construction or repair and maintenance, however short it may be. Traffic congestion may result where portions of roadway have to be closed for construction purposes. Increased truck and vehicular traffic in certain neighborhoods and along several routes will be experienced as construction equipment, excavated material, workers and pipe are transported to and from the site.

Ambient noise levels will increase at certain times due to removal of pavement, the excavation of trenches, and increased truck traffic. If construction begins in the early morning hours or continues into the evening, glare from night lighting may be annoying to nearby residents.

Public and worker safety are particular concerns as much of the sewer line installations will occur in road and highway right-of-way. Rerouting of pedestrian and vehicular traffic may be necessary which can add time to every trip. Disruption of normal patterns is therefore a potential problem ranging from discouragement of patronage to difficulties in getting stock deliveries.

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1 This entire section 6.1.1 has been added to the original text.

While all these effects tend to be negative, the sewer construction does afford neighborhoods and the city the opportunity to rehabilitate, repair and upgrade rights-of-way which have been neglected or fallen in disrepair. Other utilities may want to repair, relocate or upgrade service, and side walk and shoulder surfaces can be improved. *

6.2 AIR

Impacts to the air as a result of the proposed project will be of two kinds:

- Impacts due to construction and operation of the wastewater treatment facilities
- Impacts due to air emission from sludge incineration.

6.2.1 Impacts Due to Facilities Construction and Operation

Perhaps the most noticeable positive impact of the proposed project plan related to air will be the reduction of the odors which presently plague both treatment facilities. Whether the basic source of these odors is the sludge lagoons (as has been widely reported) or the heat treatment facilities is immaterial, for corrective measures will be taken on both possible sources through filling of the lagoons and positive treatment of the thermal conditioning off-gases. Odors may increase temporarily from the lagoons, however, due to the disturbance of the sludges during the actual filling and covering operations.

Although not presently thought to be a serious negative impact, some concern has been expressed as to the possibility of the aerosols produced at wastewater treatment facilities carrying pathogenic organisms. Research has indicated that although the aerosols do carry such organisms, die-off is rapid and the effect on nearby residents is minimal to indiscernible.

Any backup sludge disposal system which will require transport of sludges to a spreading area will also impact air quality along the travel routes from the treatment facilities; an impact which will be long-term but sporadic in nature.

Some short-term adverse impacts resulting from construction activities which generate noise and fugitive dust will also be experienced. Again, the specifications for the project will include provisions for the minimization of these impacts.

6.2.2 Impacts Due to Air Emissions from Sludge Incineration

Incineration of sludge converts the sludge into ash and gaseous products of combustion. Part of the ash is retained in the incineration chamber, and the rest is entrained in the flue gas in the form of fine particulate matter. Wet scrubbers to be used at both the Jackson Pike and the Southerly facilities will remove the bulk of the particulate matter from the flue gas, which will then be discharged to the atmosphere through a stack. The bulk of the flue gas is made up of excess air used for combustion and CO_2 and water vapor formed during the combustion. In addition to the residual particulate matter, small amounts of SO_2, nitrogen oxides, carbon monoxide, heavy metals, and organic matter can also be present in the flue gas. This section presents a discussion of the sludge and emissions characteristics and the potential impact of specific pollutants.

(1) Sludge and Emissions Characteristics

The sludge from the Jackson Pike and Southerly plants will be dewatered to yield a 32 percent solid concentration. At design capacities, approximately 110 tons/day of dry solids with a heating value of 8,500 Btu/lb are expected to be produced at both facilities. The sludge from the Southerly plant is expected to burn autogenously, whereas the sludge from the Jackson Pike plant will require a small amount of fuel, (1.04 gallons of No. 2 fuel oil per ton of dry solids) for combustion. The composition of the sludge and ash is discussed elsewhere in the EIS.

Data on the flue gas emissions from the existing sludge incinerators at both plants are not available. Therefore, the quantities of pollutants generated were calculated based on the difference in the pollutant concentration in the sludge and the ash. The estimated emission rates (prior to emission control) are shown in Table VI-1. Trace amounts of other pollutants can also be emitted, but accurate data are not available to permit their evaluation.

Currently, emission control standards exist only for particulate matter and mercury emissions from muncipal sludge incinerators. A wet scrubber with particulate removal efficiency of 97.2 percent is planned to be used at the proposed incinerators to meet

the New Source Performance Standard (NSPS)[1] of 1.3 lb of particulate emissions per ton of dry solids incinerated. Such removal is also expected to maintain the opacity below 20 percent as required by the NSPS. Since the estimated mercury emission of 1.0 lbs/day from the Jackson Pike plant under peak conditions and 1.91 lbs/day from the Southerly plant under the worst conditions are well below the emission standard[2] of 7 lbs. per 24-hour period for mercury, no special equipment will be required to control the mercury emissions.

Tests conducted at an existing sludge incinerator indicate that a wet scrubber will also remove 80 percent of the SO_x and 50 percent of the NO_x present in the flue gas.[3] Data on the removal of the other pollutants are not available. The impact of the various pollutants is discussed in the following sections.

(2) Particulate Matter

The presence of particulate metter in the air can have adverse effects on health, visibility, propoerty and vetetation. Ambient air quality standards have been established for particulate matter to protect both the public health and welfare (see Appendix D). The atmospheric modeling study performed by the Ohio EPA to determine the ambient concentration of particulate matter from existing and proposed incinerators at Jackson Pike and Southerly is inconclusive. Additional modeling by the Ohio EPA is necessary to assess the impact of the proposed incineration facilities and determine if additional incinerators may be built and if offsets will be required. Unitl the OEPA study is completed, the impact of the proposed incinerators cannot be reliably predicted. The results of an air quality analysis based on a previous diffusion modeling study

1 Federal Register, Volume 40, pp. 46250, October 6, 1975.

2 Federal Register, Volume 40, pp. 48292, October 14, 1975.

3 Havens and Emerson, Ltd., Interoffice Memorandum Regarding Warranty Tests on the Incinerator at Middletown, Ohio, August 20, 1975. (See Appendix M.)

TABLE VI-1
Estimates of Pollutants Generated During Sludge Incineration
(Prior to Emission Controls)

	Jackson Pike	Southerly
Dry Solids Incinerated[1] (tons/day)		
Average day[2]	110	110
Peak day[3,4]	154	154
Pollutants Produced (lbs/ton dry solids)		
Particulate Matter	45.82	45.82
SO_x[5]	0.51	0.37
NO_x[6]	4.36	4.36
Cadmium	0.011	0.013
Lead	0.037	0.028
Mercury	0.0065	0.0087
Zinc	0.327	0.240

1. Based on the projected capacities to the year 2000.

2. On an average day 2 of 3 incinerators at Jackson Pike and 2 of 3 incinerators at Southerly facilities are assumed to be operating at capacity. The average sludge quantity represents a daily average over one year.

3. On a peak day 3 incinerators at both Jackson Pike and Southerly are assumed to be operating with a total capacity 40 percent in excess of the average day capacity. If only 3 incinerators are built at each site, this would be the worst case.

4. If 4 incinerators at Southerly and 3 incinerators at Jackson Pike are built, the worst case would occur when all four incinerators at Southerly are operating to handle the peak flow and to provide back-up capacity for Jackson Pike, which is assumed to have 1 malfunctioning incinerator. Under these conditions the incineration rate (tons of dry solids per day) would be 110 at Jackson Pike and 220 at Southerly. *

5. Expressed as sulfur.

6. Expressed as nitrogen

TABLE VI-2
Predicted Maximum 24-Hour Average
Ambient Concentration of Particulate Matter
Under the Worst Meteorological Conditions[1]

Plant	Contribution From Incinerator (ug/m^3)	Downwind Distance From Plant (meters)
Jackson Pike with peak flow[2]	25.9	740
Southerly with peak flow[2,3]	25.9	740
Standard	150[4] 37[5]	-

1 The contribution from the incinerator is based on the data from the EcolSciences, Inc. Study, which assumed a wind speed of 1.5 m/sec and the Pasquill stability class D. The EcolSciences results were modified to account for differing sludge input rates.

2 This would represent the worst case if only three incinerators are built at each site.

3 If four incinerators at Southerly and three at Jackson Pike are built, the worst case contribution from the incinerators would be 37.0 ug/m^3.

4 Secondary standard, 24-hour average not to be exceeded more than once a year, which is the most stringent ambient standard.

5 Non-degradation criterion for Class II areas, 24-hour average.

conducted by EcolSciences, Inc. [1] are shown in Table VI-2. This study assumed a wind speed of 1.5 m/sec and Pasquill stability class D as the worst meteorological conditions and estimated the contribution from the incinerators only. Because of lack of background data, the results of this study cannot be used to predict the ambient concentration around the incinerator. Furthermore, because of lack of data on the increment in the background concentration, these results cannot be compared with the Prevention of Significant Deterioration (PSD) Criteria. The PSD regulations call for classifying various areas in the nation into three classes based on the existing air quality, and allow different maximum increments in air quality in each class. Pristine areas such as national parks have been classified as Class I, and the remaining areas have been initially put in Class II. The Columbus area, therefore, falls in Class II, which has a maximum allowable increment in 24-hour particulate of 37 ug/m^3.

The PSD regulations require all new major emitting facilities, which include certain sources with potential to emit 100 tons/year or more of any pollutant and other sources with a potential to emit 250 tons/year or more of any pollutant, to obtain preconstruction permits assuring that the allowable increments in air quality concentration will not be exceeded. Since at both the Jackson Pike and the Southerly facilities, the potential uncontrolled emission rate for particulates is projected to be 1288 tons/year, these facilities will be subject to the preconstruction permit requirements under the PSD regulations.

Irrespective of whether the air quality standards for particulate matter will be met or not, there remains an uncertainty related to the health impacts of the particulate matter emissions. The ambient as well as emission standards for particulate matter are based on the total weight of the particulates in the air and do not consider the particle size and chemistry. There is a growing concern that fine particulates (i.e., those less than several microns in diameter) are primarily responsible for adverse health effects because of their ability to penetrate deeply into the lungs.[2] Although this penetrating ability is independent

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1 EcolSciences, Inc., Environmental Assessment of Sludge Handling Facilities for the Columbus, Ohio-Jackson Pike and Southerly Wastewater Treatment Plants, two separate reports, March 31, 1975.

2 P.F. Fennelly, "Primary and Secondary Particulates as Pollutants, A Literature Review," Journal of Air Pollution Control Association, July 1975.

of the chemical nature of the particles, once they have penetrated, it is primarily their chemical nature that determines their toxicity. There is growing evidence indicating that hazardous trace metals such as lead and cadmium tend to concentrate in these smaller particles. Furthermore, the fine particles have long residence times in the air and are capable of adsorbing significant quantities of toxic gases such as SO_2, thus leading to potentially severe synergistic health effects.

The available control methods to remove particulate matter from flue gas are believed to be less efficient in removing the fine particles than removing the larger and heavier particles. Also the removal methods are believed to be more efficient in removing certain types of particles than others. However, an adequate body of data is not available to evaluate the performance of the particle removal equipment in terms of the particle size distribution and chemistry. EPA is conducting research to obtain more information in this area and to determine the need to set performance standards based on particle size and chemistry.

(3) Heavy Metals

Heavy metals such as those released from sludge incinerators could have adverse environmental effects.[1,2] Occupational health and safety standards have been established to protect the workers from exposure to high levels of these metals in the air. However, ambient air quality standards for the protection of the general public have not been established yet because of the lack of adequate epidemiological data on the effects of long-term exposure to low levels of the metals in the air. The small quantities of metals formed during sludge incineration as shown in Table VI-1, when dispersed in the atmosphere, will result in extremely low ambient concentration of these metals. At such low levels, the metals are not likely to pose an immediate threat to the public health and welfare. But what effect they would have over the long term cannot be reliably predicted at this time. EPA and other research organizations are engaged in research to determine such effects.

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1 National Academy of Sciences, "Geochemistry and the Environment, The Relation of Selected Trace Elements to Health and Disease," Volume I, 1974.

2 Waldbott, George L., Health Effects of Environmental Pollutants, The C.V. Mosby Company, 1973.

(4) Organic Matter

The sludge from the Columbus area contains trace amounts of potentially hazardous organic substances such as cyanides and chlorobenzenes (see Tables IV-5, IV-6). Municipal sludges, in general, also contain small amounts of polychlorinated biphenyls (PCB's) but these were found to be below the detectable limits of the instruments. Test data indicates that chlorobenzenes will probably be destroyed during sludge incineration.[1] Data are not available on the fate of the cyanides, but they are not expected to be a problem because of their low concentration in the sludge.

(5) Other Pollutants

Emission rates of other pollutants such as sulfur oxides, nitrogen oxides, carbon monoxide, and hydrochloric acid are generally so low that they are not likely to have a significant impact on the ambient air quality.[2] With the projected 80 percent removal of sulfur oxides and 50 percent removal of nitrogen oxides from the flue gas by the wet scrubber, the potential impact of these two pollutants would be further reduced.

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1 "A Study of Pesticide Disposal in a Sewage Sludge Incinerator," EPA 68-01-1587, USEPA 1975.

2 U.S. EPA, "Air Pollution Aspects of Sludge Incineration," prepared by Culp, Wesner and Culp, NTIS Number PB-259 457, June 1975.

6.3 WATER

The implementation of the proposed project plan will have its most striking positive impact on the water quality in the Scioto River below the outfall from each wastewater treatment facility. Although the possibility remains that the stream standard for dissolved oxygen may not be maintained under all flow conditions (see Appendix B), the overall improvement in the Scioto River quality will be immense, particularly during periods of low flow.

The occurrence of toxic conditions in the Scioto due to releases of either ammonia or chlorine will be essentially eliminated upon implementation of the proposed project plan components which nitrify and dechlorinate at both treatment sites. Enrichment of the Scioto River due to releases of phosphorus will also be reduced to the point of insignificance.

The proposed project plan will also exert a positive influence simply by continuing to return flow to the Scioto River, thereby maintaining acceptable low flow quantities for beneficial downstream uses by man and river-dependent biological communities. This positive flow maintenance impact will be reversed for streams which now receive effluent from plants which will be phased into one of the Columbus facilities under the proposed plan. The severity of this impact is not quite the same as when flow is removed from the Scioto River since, in most cases, the water source is not the stream which receives the effluent. Therefore, the removal of the waste flows will simply restore the affected streams to a "natural" condition unimpacted by point load or volume releases.

In addition to the substantial upgrading of the normal effluent from each facility, the proposed project plan will ease the stress on both Jackson Pike's hydraulic capability and on the Scioto's assimilative capacity during higher flow periods by allowing the use of the interconnecting sewer to Southerly as an influent flow damping device. Further beneficial impacts during periods of elevated sewer system flow can only be accomplished by optimization of the present system through sewer separation or the provision of combined sewer overflow treatment facilities; activities outside the scope of this Impact Statement.

Positive primary impacts on water quality could also be effected through the implementation of the retained backup sludge disposal systems. Properly managed strip mine recovery should eventually restore the streams which drain

strip mine land to, or near, an unpolluted state. Disposal systems which incorporate erosion control will also have a positive effect on receiving stream water quality in terms of reducing turbidity and sedimentation. Care must be exerted in all land based plans to ensure that adverse impacts do not result from either runoff of improperly applied material or the ultimate transport of soluble pollutants to a receiving body of either ground or surface water.

6.4 BIOTA

Positive impacts on the biota in the areas affected by the project plan will primarily be in terms of the reestablishment or stabilization of suitable habitats. The most obvious of these is the return of the waters of the Scioto River to a receptive environment for the support of a diverse, warm water biological community. Bottom communities can also be gradually re-established as the historic deposits of settleable solids are flushed from the stream.

Again, a positive aspect of the backup strip mine recovery evidences itself in the area of biota impacts. Not only will the streams and channel bottoms draining acid mine areas be improved immensely through pH adjustment and erosion control, but the land itself will be returned to a suitable habitat for wildlife normally encountered in a nondegraded central Ohio field-type environment.

CHAPTER VII

SECONDARY IMPACTS OF THE PROPOSED ACTION

VII. SECONDARY IMPACTS OF THE PROPOSED ACTION

The secondary impacts of a proposed action are "(1) indirect or induced changes in population and economic growth and land use, and (2) other environmental impacts resulting from these changes in land use, population, and economic growth."[1]

Public infrastructure investments such as the construction of new sewer facilities can have secondary impacts which may be even more significant than the primary environmental impacts.

The installation or expansion of public sewer facilities has an important impact on the location, type, and magnitude of development. However, the lack of analytical tools for assessing the relative importance of the many factors, including sewer investments, which affect development decisions, makes it difficult to estimate with certainty the secondary impacts of a proposed action.

In general, identification of the secondary impacts requires the following steps. First, it requires an estimation of the growth which would occur if wastes were handled only through the existing system and additional septic tanks or package treatment plants (the so-called "no action" alternative discussed in Chapter III.) The next step is to estimate the growth which would occur with the proposed action. The increment of growth over and above the no-action scenario is the growth attributable to the proposed facility expansions and improvements. The magnitude and pattern of this growth forms the basis for defining and evaluating secondary impacts. When little or no growth is directly attributable to a proposed action, secondary impacts are, by definition, insignificant. An important objective of the secondary impacts analysis is to identify whether those impacts contravene Federal, state or local environmental laws, regulations, policies, or standards.

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1 U.S. Environmental Protection Agency, Program Guidance Memo No. 50, June, 1975.

This chapter compares the population growth and development patterns anticipated under three scenarios:

- The no action alternative
- The action proposed in the Facility Plan
- The action proposed by the EIS as described in Chapter III.

The analysis makes the following assumptions about the Franklin County/City of Columbus planning area:

- The action is proposed for a major Midwestern metropolitan area which has an excellent transportation network and a complex array of existing city, township, and county provided services
- Existing state and local regulatory policies for environmental and land use controls are likely to persist in the forseeable future
- Local policies such as taxation which affect the provision of public services are also likely to persist.

These assumptions help to assure that the analytical approach accounts for a realistic political and institutional setting.

The analysis concludes that the secondary impacts of the action proposed in the Facilities Plan can be summarized as follows:

- Population increase in Franklin County between 1975 and 2000 is likely to be similar with or without the proposed action.
- In Big Run, the proposed sewer phasing would have a potential for inducing growth in an area which is primarily agricultural and historically has been considered unsuitable and unattractive for development.
- In West Scioto, similar population increase is anticipated with or without the proposed action because of the area's attractiveness; however, the type of development and distribution of the population within the service area's 24,300 acres may differ in each case.

- In Big Walnut, the attractiveness of the Hoover Reservoir area may stimulate growth with or without the proposed action; however, the rate of growth with the sewers may exceed the rate without the sewers.

- In Rocky Fork and Blacklick, provision of public sewer service has the potential to hasten the existing trend in Franklin County of converting vacant and agricultural land to higher uses.

- The ability of the area's economy to support additional population and the adequacy of water supplies may be more significant determinants of population growth and development patterns than availability of public sewer services.

In addition, the analysis documents that the plan proposed in the EIS will not only be responsive to present pollution problems but will significantly reduce the potential for those secondary impacts, discussed above, which might occur under the action proposed in the Facilities Plan.

In order to identify and estimate the population, land use, and development changes induced by the proposed action, this chapter covers the following topics:

- Methodology for secondary effects analysis

- Assessment of the effects of the no action alternative

  - Estimate of growth

  - Evaluation of no-action effects on man-made and natural environments

- Assessment of the secondary effects of the Facility Plan proposed action on the man-made environment

- Assessment of the secondary effects of the proposed action on the natural environment

- Assessment of the secondary effects of the EIS Plan presented in Chapter III.

7.1 METHODOLOGY FOR SECONDARY IMPACT ANALYSIS

This section describes the principal factors which influence patterns of population growth and development.[1] These factors are:

- Land availability and price
- Land use controls
- Income level of existing residents
- Existing levels of access and sewer service
- Housing vacancy rates.

These factors interact in influencing whether a proposed action such as interceptor construction will induce population growth and development above that which could be anticipated without the proposed action. The proposed action may induce growth and development by influencing the attractiveness and prices of land parcels. The amount and distribution of development in turn affects natural and man-made environment characteristics such as air and water quality, the fiscal capabilities of jurisdictions in the study area and the availability of community services. Therefore, an analysis of the planning area in terms of these factors will provide an indication of the extent of secondary effects. To the extent that the data were available, these factors were considered in ascertaining the secondary effects anticipated in each proposed service area.

7.1.1 Land Availability and Price

Developers' decisions on the type and location of building activities shape the pattern of development. Availability of land and the price of raw land are two principal factors influencing developers. In determining the secondary impacts of sewer investments, the important factor to investigate is the impact on the availability and price of land in the proposed service area. Large amounts of low-priced vacant land have a potential for stimulating single-family residential development. On the other hand, higher-priced, scarce land will tend to stimulate multi-family residential, industrial, and commercial development.

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1 Secondary Impacts of Transportation and Wastewater Investments: Research Results, Environmental Protection Agency Report No. EPA-600/5-75-013, dated July, 1975.

7.1.2 Land Use Controls

Land use controls such as zoning codes and subdivision regulations are designed to limit the use of land parcels as well as the density of development on those parcels. Theoretically, communities can utilize these controls to limit and control secondary impacts. The effectiveness of the controls, however, depends on the development of a long-range master plan and rigorous enforcement. The extent to which variances have been granted is, therefore, an indicator of the potential which these controls have to restrict developmental impacts.

7.1.3 Income Levels

There is a relationship between the income level of an area's present residents and developer's decisions regarding the type of buildings to site in the community. For example, in high income neighborhoods, developers appear to prefer to build single-family housing dwellings. In addition, the preferences of high income residents may result in the exclusion of either dense single-family housing or large commercial/industrial development.

7.1.4 Existing Levels of Access and Sewer Services

The availability and levels of service of public sewer facilities and transportation affect the likelihood that investments in new facilities will generate secondary impacts. Beyond a certain point, extension of sewer service in locations where there is a substantial amount of sewered land available is likely to have only a marginal effect on the area's attractiveness for development. In metropolitan areas, the impacts may be moderate and confined to specific portions of the region.

7.1.5 Vacancy Rates

The impact of wastewater investments is closely tied to residential, commercial, and industrial vacancy rates. Vacancy rates serve as market indicators to developers. High vacancy rates generally reflect a lack of demand for existing structures at current prices. Lower vacancy rates reflect market tightness and higher levels of demand. In general, although wastewater investments lower development costs, thereby lowering new housing costs and increasing an

area's attractiveness, the investments do not stimulate demand for new development. Therefore, in cases where vacancy rates are high, new sewer facilities should generate minimal secondary impacts.

7.1.6 Interaction Among Factors

The likelihood of secondary impacts from the proposed action depends on the combination of the above factors. In general, certain combinations are more likely than others. Areas of high accessibility usually are characterized by concentrated activities, small amounts of vacant land, and high land prices. By contrast, areas of low accessibility exhibit a dispersion of activities, substantial amounts of vacant land, and low land prices. The implicit progression in the interaction among factors is from large tracts of undeveloped unsewered land and low prices and access to fully developed, sewered, high priced and highly accessible areas. Exceptions to this pattern are areas which recently have become accessible such as those in proximity to Franklin County's Outer Belt. In those areas, the transportation investment has just begun to stimulate growth and development. The addition of sewers is likely to hasten the conversion of agricultural and vacant tracts in those areas.

Although the sewer investments may occur at specific sites in a metropolitan area, all the communities in an area are interdependent. An understanding of the interactions among a variety of factors which may stimulate or constrain growth is important because in making demand or development decisions, developers, businesses, and individuals weigh the relative attractiveness of one community against another. Availability of public sewer service is only one of several factors influencing demand and development decisions.

7.2 THE NO ACTION ALTERNATIVE

This section supports the conclusion that the total population increase will be similar under the no action and proposed action alternatives. It shows that there is sufficient vacant sewered land to accomodate the estimated growth.[1] In addition it shows that to the extent consumers

[1] This assumes the absence of prohibitions against new tie-ins to the existing system despite the fact that the Jackson Pike Plant is operating near hydraulic capacity and the Southerly plant near treatment capacity because of high strength loadings, and the Reynoldsburg plant is inadequate to protect water quality.

demand residential development in unsewered areas and developers respond to that demand, additional growth could be accomodated with the use of package plants and septic tanks. However, the package plants and septic tanks will require stringent regulations to ensure maintenance of water quality standards. The discussion of the no action alternative focuses on those differences in development and resulting environmental impact which might be expected to occur under the no action alternative.

7.2.1 Potential Growth

The analysis that Franklin County's growth is likely to be similar under either the proposed action or no action alternative is based on the following assumptions:

- The Franklin County population has been served by a combination of municipal sewer systems, package plants, and septic tanks
- The Columbus system has sufficient capacity to absorb population growth
- Growth has occurred even in parts of the county not on central sewer service
- The increased accessibility of fringe areas due to completion of the beltway is likely to result in continued development pressures in those presently unsewered areas
- In the absence of effective regulatory constraints against continued use of septic tanks and package plants, the area's historical propensity toward suburban sprawl is likely to continue
- While the costs of developing vacant sewered land and vacant unsewered land may differ, cost difference alone is not the determining factor in development decisions.

The difference in growth under the no action alternative depends to a large degree on changes in consumer demands and the policies of regulatory agencies such as Ohio EPA and the Franklin County Board of Health. Regulatory policies may affect the costs of development and consumer preferences may affect the extent to which cost of development is the most significant factor in development decisions.

For example, the costs of developing vacant sewered land may differ from the costs of developing vacant unsewered land depending on the following factors:

- The price of vacant, sewered land relative to the price of vacant, unsewered land
- The cost of tie-in to a central sewer system relative to the cost of either septic tank or package plant construction.

However even if the development costsfor unsewered land are higher than those for sewered land, cost need not be the determining factor in developers' decisions. Rather, the determining factors are whether consumer demand and economic conditions are such that the developer can realize a sufficient return on the investment and whether changes in the regulatory climate will result in a distinction between developable and undevelopable land. In the Franklin County area, the demand for middle and high income, single family housing has increased with recently improved economic conditions and suggests that developers will be able to realize sufficient return on investment with or without the availability of central sewer service.

If institutional changes which entirely prohibited septic tank and package plant use in Franklin County were to occur, there would likely be a significant distinction in the development patterns expected under the no action alternative and those expected under the proposed action. It would confine development to already serviced areas, thereby limiting the long-term potential for growth and development. However, the agencies involved in regulatory functions relating to use of septic tanks and package plants could be expected to adopt standards and procedures which would at a minimum protect water quality but not standards which could preclude new development. For instance, stricter standards for installation and maintenance of septic tanks might be formulated to upgrade tank size, lot size, and leachfield, depending upon soil classifications. More sophisticated septic systems might be required to improve effectiveness of operation.

Similar regulatory approaches could be applied to package plants. To ensure that water quality standards of the area's streams and reservoirs are met, regulatory agencies have the following options:

- Requiring that all new package plants provide tertiary treatment to produce such effluent quality that there would, in practice, be no limitation on the number of package plants that could discharge to the area's rivers and streams, provided the plants were operated and maintained properly

- Requiring that, after the assimilative capacity of the receiving water is reached, the proposed discharge not be made to surface waters

- Requiring periodic upgrading of existing package plants

This last alternative is considered the least workable due to the management difficulties involved. Periodic upgrading implies that a process of continual water sampling, effluent monitoring, and plant inspections is maintained and that an agency at either the State or local level would have the authority to enforce upgrading through the NPDES permit system or perhaps through some other regulatory program devised under 208 planning. The tracking of several hundred package plants, according to effluent quality, is administratively more complex than the first two alternative approaches, particularly if the maintenance and operation of the plants is not under contract with a municipal or other public sewer and water authority. If maintenance and operation functions are carried out by professional service firms, the monitoring can become more difficult.

Clearly, the objective of both alternative approaches to the regulation of package plants is to ensure adequate treatment of the discharges from new developments that run into the area's streams, creeks, and rivers, and to protect the water quality of the reservoirs.

Under the no action alternative, implementation of the regulatory options for both septic tanks and package plants is likely to result in widespread use of package plants throughout the planning area. In Big Run, for instance, a high seasonal groundwater table and low soils permeability precludes heavy use of septic tank systems. However, an alternative to septic systems might be on-site aeration systems. Under the no action alternative package plants also would be used widely in Rocky Fork where existing septic tanks and leachfields contribute to surface water contamination and in West Scioto and Big Walnut where septic tanks would contaminate Griggs Reservoir and Hoover Reservoir

respectively. In Blacklick, the no action alternative might seriously constrain growth since the existing sewer system and treatment plant already contribute to contamination of Blacklick Creek.[1]

(1) Cost Impacts of Private Sewage Disposal Systems on Residential Development

A comparison of the relative attractiveness under the no action alternative of different sewered and unsewered areas, requires an identification of the installation and maintenance costs associated with private systems and assessment of the impacts of those costs on both consumers' and developers' decisions. In the Columbus/Franklin County region, the cost of septic tanks range from $600-$700 for a 500 gallon tank serving a one bedroom house to $1,500 for a 1,500 gallon tank and 1,000 square foot leach bed serving a four bedroom house. The costs for aeration systems are higher, starting at $1,500. Continued use of septic tanks for single family detached development will be constrained because of the unsuitability of soils in many parts of the county. Since the Franklin County regulations do not permit tracts of land to be developed with individual sewage treatment or water supply for more than 19 dwelling units or more than 50 percent of the area at three year intervals, septic tank systems are used primarily in single lot and small tract developments. At the present time, regulations to control the installation of new septic systems will not constrain their widespread use under the no-action alternative. Minimum lot size required is only 20,000 square feet or less than 1/2 acre. Although the Franklin County Board of Health requires an installation permit, the installation can be done by either a licensed installer or a homeowner. The County inspects the system upon installation. In addition, although the soils in many parts of the county are poor, prohibitions against both septic tank systems and aeration systems are confined to only a few areas such as the Dublin area.

Estimated costs for package plants are shown in Table VII-1. It is important to note that these figures * do not represent actual costs of existing plants in the Columbus area, as such data was not available. The costs * as modified do show the order of magnitude cost differential that would be passed on to the homeowners served by such systems. The relative costs per residential unit are indicated for small, medium, and large plants along with an estimate of annual operating and maintenance

1 The EIS plan presents an alternative to the Facilities Plan other than the no action alternative.

Table VII-1
Estimated Costs for Package Plants[1]
(July 1977)

PLANT CAPACITY (gpd)	ESTIMATED TURNKEY COSTS ACQUISITION AND INSTALLATION			DEVELOPMENT CONSIDERATIONS		
	SECONDARY TREATMENT	TERTIARY TREATMENT[2]	TOTAL PRICE-TT	AVE. DU's SERVED[4]	PRICE PER UNIT-TT	ANNUAL O&M/UNIT[3]
14,000	$2.75/gal.	$4.15/gal.	$ 58,100	40	$1450	$70
50,000	$1.85/gal.	$2.75/gal.	$137,500	155	$ 890	$64
100,000	$1.50/gal.	$2.30/gal.	$230,000	310	$ 740	$64

1 Costs are based on an October, 1976 Booz, Allen and Hamilton study for the Myrtle Beach, South Carolina area. Costs have been adjusted for inflation and for the regional economic differences between Myrtle Beach and Columbus, Ohio. They should be viewed as demonstrating order of magnitude cost differentials.

2 Current engineering estimates assume a 50 percent cost increase over secondary systems.

3 Assumed at $.55 per 1000 gallons-current average O&M cost.

4 Assumes 3.2 persons per unit and 100 gpd per capita. (Note: OEPA utilizes a design criteria of 400 gallons per home per day regardless of occupancy).

costs. These cost estimates do not reflect the cost of lines as those would be basically the same for a developer whether they were for delivery to the package plant or for a tie-in to the municipal system. Additional costs for package plants would occur if an extended outfall line were required, or if several pumping stations were indicated. Line installation costs average $8 to $10 per foot and pumping stations can vary between $10,000 and $15,000 each. Thus, costs for a system on a per unit or per lot basis can run between $500 to $1200, with total costs running an additional $1000 per unit or lot. Total system costs for low density subdivisions, in contrast to those for high rise structures, are considered equal, as the construction of the outfall line for a high rise project may equal the cost of collector lines in a large subdivision. The incremental cost per unit for package plant system would not be considered prohibitive for marketing residential units in the Franklin County area.[1] The additional cost for the package plant is generally about 1.0 percent of total development cost, on a per unit basis.

(2) Residential Development Patterns

The no action alternative may result in slightly different patterns of development throughout the planning area and within proposed service areas. Developers will attempt to develop parcels of land within reasonable distance from streams and other surface waterways in order to minimize costs, and may try to develop at higher densities to reduce the costs of line installation and reduce the per unit capital cost which is passed on to the consumer. Projects in Big Run, West Scioto, Big Walnut and Rocky Fork are likely to be designed at higher densities than those projects planned under the proposed action simply to satisfy the developers' objective of recovering the cost of treatment facilities. However, any differences in density of development among these areas will be influenced by several factors in addition to the costs of providing private sewage disposal systems. These factors include:

[1] An exception may be the Big Run Area which traditionally has not been an attractive area for development. The added costs of package plants, unless offset by the provision of other amenities will continue to constrain development.

- The allowable single family lot size for septic tanks
- Land cost and parcel size
- The demand for multi-family dwellings
- Capacity and type of community services
- Accessibility of land tracts.

Under either action, densities in Big Walnut and Big Run are likely to be lower than those in Scioto West, Blacklick and Rocky Fork. Most new projects will plan for densities of between one and six units per net acre for single family dwellings and up to 16 units per net acre for low-rise multi-family dwellings.[1] Under either alternative, higher densities for high-rise apartments would be expected primarily in downtown Columbus which already is served by central sewer. Adequate marketability of most new housing developments will depend upon the availability of good schools and other community services. Where a developer must provide community facilities such as recreational facilities in order to market his project, he will probably plan for higher densities than "single family detached" in order to distribute the costs of development over more units. Similarly, developers will seek to distribute the cost of package treatment plants over more units. This probably would result in higher densities than those achieved under the proposed action. The exception might be Big Run and Blacklick. Without central sewers, Big Run will be more costly to develop and will be far less attractive. In the Blacklick area, widespread use of package plants may not be a feasible alternative for new development unless it is coupled with an expansion and upgrading of the existing wastewater treatment plant. Therefore, under the no action alternative, the threat growth poses for water quality may constrain development.

In general, a developer who installs a package treatment plant has two alternatives for disposing of the plant's discharge:

[1] MORPC, A Technical Report on Year 2000 Land Use and Trip Generation Variables, February 1977 (preliminary).

- Open space via spray irrigation
- Rivers and streams.

The cost of system implementation will generally differ under these alternatives and will affect planned densities. In Franklin County, however, there is an insufficient amount of suitable land available for spray irrigation. Therefore, under the no action alternative, additional population growth would be served by either septic tank systems[1] or package plants which discharge to surface streams.

(3) Population Growth

This section explains why growth in the planning area is expected to be about the same for the proposed action and the no action alternative. The following assumptions underlie the no action alternative:

- No regionalization of wastewater treatment facilities
- No expansion of Southerly and Jackson Pike Plants
- No upgrading of Jackson Pike and Southerly beyond normal maintenance requirements
- No expansion or upgrading of the Reynoldsburg Plant beyond normal maintenance
- Use of package plants discharging to area rivers and streams
- Use of septic tanks.

In general, most growth would be accommodated through the use of septic tanks and package plants. In the absence of a prohibition against additional tie-ins to existing interceptors, some growth will be accommodated in the city. In contrast, the proposed action would reduce the need for septic tanks and package plants except in very remote parts of the planning area since most wastewater would be handled through a regional system.

1 In some cases, the Franklin County Board of Health requires aeration or evapo-transpiration systems.

The no action alternative would probably have very little effect on the area's economy and therefore on the economy's ability to support growth. In general, without a central sewer system, an area is much less attractive to industry, particularly to manufacturing. Industries discharging to public facilities need only comply with applicable pretreatment standards and user charges. Without central sewers, each plant would have to design its own package treatment facility in accordance with the NPDES process applicable in the State of Ohio. However, Chapter II has shown that manufacturing has and will continue to decline in its share of the Columbus economy. Chapter III also has shown that sufficient commercial space is available to accommodate needs of existing and new corporations. In addition, the City of Columbus is planning a major redevelopment of the Central Business District. This area, which is already sewered, will provide commercial, retail, recreational, and other service facilities. Therefore, the no action alternative would not significantly alter the area's potential for economic growth.

The demand for new residential units will be much stronger than that for industrial and commercial space under both the proposed action and no action alternative and is the focus of this analysis. The market will consist of two types of development: high density apartments development, concentrated in the central city; and low to medium density single-family, townhouse, and low-rise multi-family units to serve the primary home market. As stated previously, sufficient vacant commercial space is available for growth, and additional space will become available with the redevelopment of the Central Business District. However, in the residential market, nearly all of the early 1970's overbuilding of multi-family units has been absorbed. As Table VII-2 shows, high vacancy rates occur only in the lower rental ranges.[1] IN 1976, construction in the single-family housing market exhibited renewed growth.

In conclusion, the absence of additional centralized sewer facilities is not likely to constrain population growth in the planning area. The no action

[1] The exception is the $300-499 rental range where the high vacancy rate may reflect the size unit surveyed.

Table VII-2
Vacancy Rates by Rental Range[a]

Rental Range	Units Surveyed	Vacant Units	Vacancy Rate (% Vacant)
Under $100	2,274	263	11.56
$100-149	7,283	358	4.92
$150-199	6,551	382	5.83
$200-249	1,556	49	3.15
$250-299	589	8	1.36
$300-350	119	17	14.28
$350-499	101	5	4.95
$500 plus	49	3	6.12

[a] Original data are from the Apartment Vacancy Survey conducted by the Columbus Apartment Association and the City of Columbus, Department of Development, October 1, 1974.

Source: Overall Economic Development Plan, Department of Development, City of Columbus, October 1976.

alternative poses few, if any, obstacles to economic growth and continued residential demand. The following section will illustrate further how the total growth under the proposed action is not expected to exceed the total growth under the no action alternative.

7.2.2 Environmental Effects

To provide a point of reference for evaluating the secondary impacts of the Facilities Plan proposed action, the following discussion summarizes the effects of the no action alternative. It makes the following assumptions:

- As determined previously, county-wide population growth is likely to be similar under the Facilities Plan proposed action or the no action alternative
- Although the Facilities Plan proposed action has some potential to induce population distribution patterns and infrastructure costs which might not have occurred under no action, it is difficult to ascertain the importance of sewer investments relative to other factors in determining growth and development patterns.

(1) Manmade Environment

Under the no action alternative, the rate of growth in the proposed service areas is likely to be smaller than under the proposed action; whereas the rate of growth in areas with existing service is likely to increase. Nevertheless, even in the absence of central sewer service, growth will continue in some sections of Big Run, West Scioto, Big Walnut, Blacklick and Rocky Fork. An estimate of the effects of population distribution on the demand for services and on the costs of providing services must take into account the existing services provided by various jurisdictions in the planning area. Since the growth distribution under the no action alternative is likely to differ from that of the proposed action, the extent to which each jurisdiction is affected may also differ. For example, under the no action alternative, a higher proportion of the demand may be placed on the City of Columbus where the already serviced developable areas are located. In a region where infrastructure is in place only in a central urban area and no services

were available in fringe areas, the no action alternative would appear to result in far fewer additional infrastructure costs than under a plan to invest in central sewer services. However, the metropolitan institutional setting of Franklin County is such that the transportation infrastructure is in place throughout the county; extensive police, fire, educational and other services are provided by jurisdictions other than the City of Columbus; and incorporated areas which already have infrastructures in place continue to annex unincorporated areas. Therefore, it is difficult to estimate whether the man-made environmental impacts under the no action alternative will be substantially less than under the Facilities Plan proposed action. In either case, all jurisdictions may be faced with increased service demands.

(2) Natural Environment

Effects on the natural environmental setting will depend primarily on how well package treatment plants and septic tanks are maintained and operated and how many additional tie-ins there are to the existing system. Although regulatory agencies might require the installation of systems designed to produce a high quality effluent, these agencies such as the Franklin County Board of Health may have difficulty in compelling good operation and maintenance. Therefore, water quality probably would not improve and may well be further degraded. In Big Walnut and Scioto West, surface drinking water supplies may become contaminated in the absence of rigorous regulation. It is also important to note that under the no action alternative, the Southerly and Jackson Pike Plants will not be able to meet their final NPDES permit conditions and will continue to degrade water quality. Air quality impacts are not expected to differ significantly from those under the Facilities Plan proposed action.

7.3 SECONDARY EFFECTS ON THE MANMADE ENVIRONMENT

Construction of the proposed interceptors will not significantly affect total planning area population. However, it is likely to affect distribution of the population and consequently land use and community facilities and services. Under the no action alternative, there is likely to be more in-filling coupled with limited single-family large lot and medium density multi-family unit developments.

Under the Facilities Plan proposed action, there will be less in-filling and a greater propensity to continue the urban/suburban sprawl already characterizing much of the planning area. The Facilities Plan potential for inducing sprawl is accompanied by a potential for inducing infrastructure costs. The extent to which costs are induced, however, is related to the existing level of services and growth pattern which would have occurred in the absence of any action.[1] This section considers the socioeconomic effects of the population distribution patterns attributable to the proposed action.

7.3.1 Demographic and Economic Characteristics

The population of the planning area is projected to reach 1,110,000 by the year 2000 under either the proposed action or the no action alternative.[2] However, the proposed action is likely to have the following impacts on population characteristics of the five proposed interceptor service areas.

(1) Big Run

As explained under the no action alternative, most of the growth projected in Chapter II for the Big Run area is likely to occur as a result of the proposed interceptor. At present, the development potential of Big Run does not appear to be as strong as that of other areas. Traditionally, it has not been considered for other than agricultural development and has few public services to attract new development. Even with the construction of I-270 and I-70, much of the area

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1 The relative costs of infrastructure in newly developing areas are presented in Real Estate Research Corporation, The Costs of Sprawl, prepared for the Council of Environmental Quality; Department of Housing and Urban Development; and Environmental Protection Agency, April 1974. It shows that both public sector and private sector costs rise as sprawl inceases. However, direct application of the study's results is difficult since the study is based on hypothetical communities of a considerably smaller size than the Facilities Plan study area and communities in which no infrastructure presently exists.

2 Chapter II discusses a range of population estimates using several standard techniques and explains the selection of a year 2000 population of approximately 1,110,000.

does not have as good access to the central city as do Blacklick, Scioto West, and Rocky Fork. Nor does the area have the attractive aesthetic and recreational features available in Scioto West and Big Walnut. In the absence of centralized sewage facilities, developers are not inclined to incur additional development expenses in an area with little market demand relative to other areas in Franklin County. Nevertheless, land in Big Run is abundant and inexpensive, and market demand is high in general in the county for single family homes. MORPC estimates that by 1985 demand will also rise for medium density multi-family dwelling units. The installation of centralized sewage facilities would induce developers to provide reasonably priced housing in Big Run to accommodate some of the anticipated county housing needs.

(2) Scioto West

Under either the Facilities Plan proposed action or the no action alternative this area is likely to develop at approximately the same rate. Continued growth even under the no action alternative is anticipated due to the attractiveness of the area, which borders Griggs Reservoir, coupled with its access to the city and the availability of a good school system. The final section of this chapter will address the secondary impacts anticipated as a result of the action proposed in Chapter III.

(3) Big Walnut

Despite this area's relative remoteness from the city, it nevertheless is an attractive area for development due to its proximity to Hoover Reservoir. Therefore, growth is likely to occur under either the Facilities Plan proposed action or no action. However, the rate of growth under the proposed action is likely to exceed that under the no action alternative. Under the no action alternative, development in the area is likely to be on large lots. The area is likely to retain a fairly exclusive character under either alternative.

(4) Rocky Fork

The extent to which the population growth of this area is greater under the proposed action than under the no action alternative will depend to a large degree on the ability of Plains Township to implement and enforce its recently enacted zoning code. The code, which is designed to retain the large lot characteristic of the area immediately outside the New Albany population center, may be easier to enforce under the no action alternative. However, an analysis of zoning applications and present land holdings indicates strong pressures for development in the area.

(5) Blacklick

This area which includes Reynoldsburg is likely to experience development pressures under either alternative, although the Facilities Plan proposed action may induce a moderately higher growth rate. However, as the section on natural environmental impacts shows, continued growth under the no action alternative will lead to further deterioration in the area's water quality. Chapter III presents an alternative to both the Facilities Plan proposed action and the no action alternative.

7.3.2 Land Use

Secondary effects would be the development of currently vacant land induced by population growth attributable to the proposed action. Therefore, the principal land use effects would occur in Big Run and Blacklick. There also is a potential for the Facilities Plan proposed action to induce some land use effects in parts of West Scioto, Big Walnut and Rocky Fork although these effects as well as induced infrastructure costs are likely to be less than the effects in Big Run and Blacklick. Both Big Run and Blacklick are likely to experience considerably greater population growth and therefore residential development under the proposed action than under the no action alternative. In Big Run, the residential development under the proposed action is likely to occur at a somewhat higher density than under the no action alternative when development will be either large lots on septic tanks or a very few multi-family units on package plants. Similarly, the proposed action will permit higher residential densities in Blacklick. Under the no action alternative, existing water quality may preclude

the use of new package plants and constrain the use of septic tanks. Therefore, under the no action alternative, residential development in Blacklick will be scattered single family lots whereas the proposed action will encourage single family subdivisions, planned unit developments (PUDs), and multi-family townhouse and garden apartment units. The construction of the proposed sewage facilities also would facilitate the development of commerical and institutional sites. In the near-term, i.e., before 1985, in Big Run, these sites would be primarily retail establishments and public institutions to serve the residential communities. In the long term, i.e., between 1985-2000, the proposed facilities might encourage the development of office space and storage and warehousing space in proximity to residential population centers. Land use in the three other proposed service areas would be essentially the same with or without the proposed action. In all cases, the development emphasis initially will be on single family residences and later on medium density townhouses and garden apartments. Under both the proposed action and no action alternatives, the redevelopment of the central business district of Columbus will include hotel and convention facilities, office and retail establishments, recreational facilities and high rise apartments.

It is important to note that the Facilities Plan proposes construction of interceptors which would traverse large tracts of vacant and agricultural land. However, it is difficult to quantify the impact of the proposed action on acres of farmland compared to the recommended actions in Chapter III or to provide quantitative discussion of this impact in each service area. First, Franklin County farmland acreage has decreased by 25% between 1959 and 1976, from 199,000 acres to 150,000 acres. The rate at which factors other than sewer investments would induce continued conversion of agricultural land is uncertain. For example, the full effects of completion of the beltway have not been felt. Second, data on agricultural acres by service area is not available for comparing the specific differences in impact of the Facilities Plan and EIS proposals.

7.3.3 Community Facilities and Services

The population projected for the planning area will require that the various local jurisdictions provide additional facilities and services. Since the population distribution under the proposed action may differ slightly from that anticipated under the no action alternative, the

jurisdictions most impacted also may vary. County and community government agencies can identify the types and amounts of additional services required by evaluating the availability, adequacy, and accessibility of existing services. The agencies can identify the improvements needed to meet the needs of the existing population and from that extrapolate the additional requirements to accommodate population growth. Chapter II has identified previous and on-going MORPC efforts to evaluate community services. These studies can provide local jurisdictions with baseline data.

MORPC's recent survey of fire protection services,[1] for example, has identified location of facilities as a significant present and future concern. In some areas, residents feel that services are inadequate, either because annexation disrupted established patterns or because stations belonging to different jurisdictions are not appropriately dispersed throughout the county. Under the proposed action, the increased tendency toward sprawl rather than in-filling may require construction of additional stations. While the report did not make recommendations, it noted a tendency for local jurisdictions to provide additional services in response to actual growth rather than in anticipation of growth. Thus the construction of the proposed facilities need not result in an immediate or unfair economic burden on existing residents. The report did note that "voter support of fire levies in the county has been and still is excellent ..."

The impact of the proposed action on provision of educational services may be quite significant. The analysis already has shown that the proposed action will tend to encourage some additional sprawl and less in-filling. This sprawl will result in either a demand for new schools or a need for busing children from new neighborhoods to existing schools. Either approach will raise the cost of education services. Given recent voter reluctance to support higher school budgets, and the uncertain financial situation of many school systems in Franklin County, local jurisdictions might find it difficult to meet the demands induced by the proposed action. It is important to note, however, that these demands will not entirely disappear under the no action alternative. Significant new growth is still likely to occur in Big Walnut, Rocky Fork and Scioto West. However,

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1 Mid-Ohio Regional Planning Commission, Public Services and Facilities Profile: Fire Protection Services in Franklin County, February 1977.

of the remaining anticipated county growth, some of it would be absorbed in already serviced areas of the city. Thus under the no action alternative the demands for schools at new locations would be less than under the proposed action.

A third service which will be affected differently by the proposed action than by the no action alternative is sanitation pickups. In general, since the proposed action will discourage in-filling, new collection routes will have to be established. There will also be a sharp increase in vehicle miles travelled. This may result in a need for capital investment in new equipment as well as increased expenditures on additional personnel. By contrast, under the no action alternative, some of the in-fill development can probably be served by existing routes and equipment.

The impact of the projected population growth and distribution on transportation facilities should be the same under either the proposed action or no action alternative. As Chapter II noted, the Franklin County/Columbus area has an excellent transportation network. Recent completion of the interstate highway system has improved access between downtown Columbus, suburban, and rural areas. This system together with some additional planned road improvements already have fostered growth and will be sufficient to accommodate additional growth.

In conclusion, the impact of the proposed action on the provision of community services can be summarized as follows. To the extent that the proposed action will encourage sprawl and remove any incentive for in-filling, it will result in a need for capital investment in new facilities and equipment.

7.3.4 Historical/Archeological Sites

There are no significant secondary effects on historical/archaeological sites or on cultural resources in general that can be determined at this time. Normal population growth will affect patronage of cultural resources on an increasing but proportional basis. The sewage treatment system should have no effect upon regional demand for cultural activities per se. To the extent that in filling of development occurs in the central Columbus metropolitan area, then citizen support may be sustained and possibly increased for those cultural resources located downtown and in the close in suburban areas. Such resources would include: theatres, libraries, museums, art galleries, craft centers, YMCA and other young peoples associations, and churches.

7.3.5 Resource Use

Because population growth will occur under either the proposed action or no action alternative resource consumption will increase as a result of either alternative both in the maintenance and operation of facilities, services, and in the construction of houses, schools, and other facilities. To the extent that the proposed action encourages sprawl and therefore additional vehicle miles travelled (VMT) for the transportation of people and goods, fuel consumption will be higher than under no action alternative. Use of other resources such as water should be approximately the same.

7.3.6 Other Planned Projects

The proposed action should have no anticipated impacts upon most of the planned projects cited in Chapter II. Although the potential for the patterns of growth to differ only slightly under either the proposed action or no action alternative exists, the proposed action is not expected to have a significant effect on either the redevelopment of the CBD, the 701 comprehensive planning program, or the proposed I-670 freeway link. The proposed action will, however, have an impact on the 208 Central Scioto Water Quality Management Plan.

7.4 SECONDARY EFFECTS ON THE NATURAL ENVIRONMENT

Because the potential difference between the population growth and distribution anticipated under the Facilities Plan proposed action and no action alternative is moderate, the secondary effects due solely to the proposed action on the natural environmental setting are also expected to be only moderate. This section looks at the "worst-case" scenario by assessing the effects on the natural environmental setting of the total population growth anticipated by the year 2000. The final section of this chapter assesses the secondary effects likely to be associated with the action proposed in Chapter III.

7.4.1 Physical Characteristics

This section assesses the degree to which the total population growth of the area is likely to affect the area's topography and drainage, geology, and soils. In general,

the anticipated population growth and corresponding development is not likely to substantially alter the area's topography. However, a significant increase in development may lead to increased rates and volumes of runoff. In addition, without effective coordination among the many local jurisdictions for land use management, new development may possibly contaminate the water in the area's major potential aquifers. The anticipated growth is not likely to have any major effect on the planning area's geology or soils.

7.4.2 Atmospheric Characteristics

This section presents an assessment of the impact of the total anticipated population and related commercial and industrial growth on the ambient air quality and climate in the Columbus area.

(1) Air Quality

Since the Columbus metropolitan area has been classified as an Air Quality Maintenance Area (AQMA) for total suspended particulates (TSP) the impact of the projected urban growth on the future TSP concentration is assessed in this section.

The major impact of urban growth on the ambient TSP concentration is likely to occur in the proposed new interceptor service areas, where the population is projected to grow from 53,000 in 1975 to 133,900 by 2000.[1] However, it should be noted that the overall population increase in the study area with or without the sewer service is not expected to differ significantly. The analysis presented here, therefore, reflects the impact of the overall population growth, rather than that of the incremental growth with the sewer service. The population growth will be accompanied by an increase in particulate generating activities such as residential and commercial fuel combustion, automotive and exhaust and tire and brake wear, and solid waste burning. The effect of the increased levels will depend primarily upon the local meteorological conditions.

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[1] These areas include Big Walnut, Rocky Fork, Blacklick, Big Run, Scioto West; see Table II-17.

An atmospheric diffusion modelling analysis of the impact of future development upon ambient TSP levels in Franklin County was conducted by PEDCo.[1] This analysis focused on the following areas: Rocky Fork, Blacklick, Scioto West, and Southwestern Franklin County. These areas generally correspond to the proposed interceptor service areas, with the following differences: The upper half of Southwestern Franklin County as defined in the PEDCo report approximately corresponds to the proposed Big Run service area, but the lower half of Southwestern Franklin County is not included in the Facilities Plan; the proposed Big Walnut service area was not analyzed in the PEDCo report. Since all of the areas will be characterized primarily by relatively low density residential development and the projected population growth over the next 25 years in the PEDCo report agrees closely with the currently projected population growth for the same period, the results of the PEDCo analysis are applicable to the proposed interceptor service area. These results are compared with two sets of standards: the non-degradation criteria and the ambient air quality standards.

The PEDCo results indicate that the maximum contribution to annual average TSP concentration in the proposed service area from emissions within the service area would be 9 $\mu g/m^3$ in 1995.[2] This would represent an increase of 6 $\mu g/m^3$ in 1995 over the baseline 1975 contribution of 3 $\mu g/m^3$. This 6 $\mu g/m^3$ increase is well below the applicable non-degradation criteria of 19 $\mu g/m^3$ for Class II areas.[3]

Monitoring data for ambient TSP concentrations in the proposed interceptor service area are not available. However, the measured annual geometric mean TSP concentration in 1976 at two sites located in the Southwestern Franklin County area was 53.36 $\mu g/m^3$ at Dennis

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1 PEDCo-Environmental Specialists, Inc., "Impact of Future Development upon Particulate Air Quality in Franklin County Ohio," prepared for Malcolm Pirnie, Inc., Columbus, Ohio, November 1975.

2 At Site 9 and 10 of the PEDCo study.

3 According to the Federal non-degradation criteria, all parts of the Nation are currently classified as Class II.

Lane in Grove City and 54.74 $\mu g/m^3$ at Norton Avenue in New Rome.[1] The maximum predicted increase in 1995 over the 1975 TSP levels in the areas according to the PEDCo report would be 4 $\mu g/m^2$.[2] Assuming that the 1975 TSP concentration to be the same as that measured in 1976, the predicted maximum annual average concentration in 1995 in the Southwestern Franklin County would be 58.74 $\mu g/m^3$, slightly below the applicable standard of 60 $\mu g/m^3$. Extrapolating the results to the year 2000 indicates the TSP standards would be met in 2000. Extending these results to the proposed interceptor service area, it can be concluded that the particulate emissions resulting from the projected population growth in the proposed interceptor service area by 2000 would not violate the ambient TSP standard there.

(2) Climate

Since the population growth and development are not expected to result in a violation of ambient air quality standards, it is unlikely that the growth will contribute to changes in the area's overall climate.

7.4.3 Hydrology

In the case of hydrology, it is useful to analyze both the effects of total growth and the effects of the different patterns of growth anticipated under the proposed action and no action alternative. Growth will be approximately the same under both alternatives; however, under the proposed action, regionalized wastewater facilities will serve to protect surface and ground water quality.

(1) Water Supply

The population growth anticipated with or without the proposed action will require a significant increase in water supply. Chapter II noted that the 135 mgd which will be available after the completion of construction underway will be sufficient only to meet growth through the mid 1980's. Therefore, the anticipated growth will require the development of new sources.

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1 See Table E-1, Appendix E.

2 At receptor 12 of the PEDCo study.

Two sources under consideration are the water well fields in the southern portion of the County and Upper Darby Creek. However, the Darby which presently is the last free flowing creek in Central Ohio is susceptible to environmental damage from damming. In addition, without effective land use controls, development accompanying the population growth may contaminate the county's underground aquifiers.

(2) Surface Water Quality

Since the total county population projection is likely to be similar under either the proposed action or no action alternative, this section assesses the relative impact on surface water quality of that growth. Under the no action alternative, the sewage requirements of new development will be met in three ways:

- Existing central sewers
- Package plants
- Septic tanks

Since the Jackson Pike, Southerly, and Reynoldsburg treatment plants already have periodic difficulty in handling existing loads, an increased load on the plants is likely to lead to further contamination of the area's rivers and streams. This is particularly true in Blacklick where the existing Reynoldsburg plant is often so overloaded that untreated water is diverted directly to the Blacklick. While the use of package plants need not contribute to a significant deterioration in water quality, the regulatory agencies do not have the monitoring resources to ensure continued operation and maintenance of the plants at a treatment level sufficient to maintain quality. Finally, the widespread use of septic tanks could lead to contamination of drinking water, particularly in Big Walnut and West Scioto. Chapter III proposes actions which are cost effective and will address existing pollution problems.

(3) Ground Water Quality

Under the Facilities Plan proposed action, population growth is less likely to threaten ground water quality. In particular, the availability of interceptors will reduce the demand for septic tanks. Thus

there will be fewer opportunities for ground water contamination from malfunctioning septic tank leach field systems. It is important to note that although soil limitations in parts of the county have resulted in poorly functioning septic tanks, the regulatory policies do not effectively constrain additional septic tank use in these areas.

7.4.4 Biotic Characteristics

The principal biotic characteristics are vegetation, wildlife, and aquatic life. The first two are likely to be impacted similarly under either the proposed action or no action alternative. Aquatic life, however, is likely to be more severely impacted under the no action alternative because without the proposed action, water quality will be harmed.

7.5 SECONDARY IMPACTS OF THE EIS PLAN

The regionalization alternatives to the proposed project plan have been described and developed in Chapter III of this report. The conclusions which deviate from the service areas proposed in the Facilities Plan by the end of the planning period (the year 2000) are as follows:

. Southerly Service Area

- Rickenbacker AFB added
- Service only provided to Reynoldsburg in the Blacklick Creek subarea
- Service only provided to New Albany in the Rocky Fork subarea
- Partial service to the Big Walnut Creek subarea may be necessary by 1985.

Jackson Pike Service Area

- Some portions of Delaware County to be included with the West Scioto subarea;
- Service will not be provided to the Big Run subarea.

Details of recommended changes in phasing, interceptor sizing, and transport routes can be found in Chapter III.

The secondary impacts of the action proposed in Chapter III are likely to be substantially fewer than even the moderate ones anticipated under the Facilities Plan proposed action. This reduced potential for secondary impacts reflects the fact that the EIS proposals focus on the existing pollution problems of existing population centers. By adjusting the phasing in some areas and by proposing pressurized mains instead of interceptors for other areas, the EIS proposed action reduces the potential for public investment in sewer service to induce sprawl and infrastructure costs. In addition, it reduces the potential for sewer investments to induce the conversion of agricultural land to other uses.

CHAPTER VIII

MITIGATIVE MEASURES FOR ADVERSE IMPACTS

VIII. MITIGATIVE MEASURES FOR ADVERSE IMPACTS

This chapter summarizes the more important unavoidable adverse impacts discussed in the preceding chapters and suggests measures to mitigate these impacts. Mitigative measures for primary impacts and secondary impacts are discussed separately.

8.1 PRIMARY IMPACTS

Mitigative measures required during construction will differ from those required for operation and maintenance of the treatment plants. These measures are discussed below.

8.1.1 Mitigating Measures During Construction

Most of the definable, predictable, unavoidable adverse primary impacts are associated with the relatively short-term effects of actual construction activities. Short-term problems may be evidenced in terms of noise, air pollution (primarily from fugitive dust),(1) temporary erosion, increased traffic to and from the plant sites, and effluent degradation if and when construction needs dictate the shut-down of any process capability. The construction specifications should contain mitigative measures for all of these short-term impacts, including a definite scheduling of improvements which will minimize bypass of any present or proposed unit processes.

Examples of the kinds of mitigating measures which could be undertaken to reduce the temporary adverse impacts due to either the construction or repair and maintenance of facilities, particularly sewer lines, are shown below. These measures may be applied either by the City of Columbus or its construction contractors:

(1) Fugitive dust resulting from traffic over unpaved roads, excavation and cut and fill operations, and wind erosion from storage piles and unpaved areas at the construction site can be controlled through an effective watering program, traffic control, and chemical treatment. Twice daily watering with complete coverage can reduce fugitive dust emissions by 50 percent, while restricting vehicle speed to 15 mph on unpaved roads can reduce dust from unpaved roads by 80 percent (U.S. EPA, "Compilation of Air Pollutant Emission Factors," Third Edition, AP-42, August 1977, Section 11.2). Chemical treatment of completed cut and fills and inactive areas can significantly reduce the emissions from wind erosion.

(1) Light Glare

Proper positioning of light fixtures when evening or night emergency work is performed can minimize glare which would affect the surrounding community. The bright lighting, however, can serve a useful purpose in commercial areas as a crime deterrent. High intensity lighting has been used successfully by many cities as a crime deterrent in high-crime-rate districts.

(2) Waste Spillage and Dispersion

Excessive solid waste spillage resulting from loading disposal truck within construction sites can be minimized. Trucks should not be overloaded and the waste material should be dampened as necessary to prevent fugitive dust emissions. Mud and grime from truck wheels will be removed at wheel washes at all truck exists to prevent the spread of these materials to surrounding neighborhood streets and arterials should be made. During the construction phase, the contractor should be made responsible for maintaining the construction sites to ensure they are free from debris and spoil material and for keeping equipment in orderly storage areas with minimum disruption to public activities.

(3) Traffic Congestion

Public traffic flow should be given priority, particularly emergency and public service vehicles. Careful routing and scheduling of trucks hauling equipment and debris should be done to avoid peak travel periods: 7:00 to 9:00 a.m. and 5:00 to 6:30 p.m. Appropriate visible and audible warning systems for construction points of activity should be installed and an overall traffic control plan employed by the contractor. This traffic control plan should be developed and coordinated with Ohio Department of Transportation's District 6 Office. Local jurisdictions should be alerted and approvals should be obtained for planned truck routes and traffic control plans.

(4) Public and Worker Safety

Strict adherence to all safety regulations and employee training programs serves as the most effective means to minimize or prevent injuries to construction

1 This entire section 8.1.1 (1) through (6) has been added to the orginal text.

and operation employees. Proper placement of barricades and explicit siguage for vehicular and pedestrian detour routes should provide for an acceptable level of public and worker safety.

(5) Land Use Alterations

Land owners (private, industrial, and commercial) should be contacted well before construction begins in their respective property areas. The owners should be informed of plans such as proposed truck traffic routes, access requirements, and possible impacts. Other measures which can be used to prevent or mitigate the expected public nuiscance impacts include:

- Public thoroughfares excavated for installation of connecting pipes, collecting structures, and shafts should be repaved or rebuilt to their original condition.

- The Chicago Department of Development and Planning will be advised of the relationship of proposed shaft locations with respect to the Riveredge, New Town, and South Loop plans.

- The City of Columbus should notify the State of Ohio Historic Preservation Office to obtain appropriate approval of proposed sewer lines prior to construction. Once approval has been obtained procedures should be established for halting construction temporarily in the event important artifacts are found or uncovered.

- Excavation workers should be informed of potential value of finds and trained in the rudiments of identifying and preserving artifacts if the Preservation officer or designated representative cannot be present during construction within potentially sensitive areas.

(6) Transportation

Although the number of truck trips during the peak construction period is expected to be a small fraction of the total traffic volume on most truck routes, these routes should be selected on the basis of the least impacts. The planned truck routes should avoid residential areas and other sensitive areas (i.e., hospitals, libraries), as well as congested streets, especially during rush hours.

Since all proposed expansion will take place within the boundaries of the present sites, land related impacts will be minimal. Excavated material at each site should be used as cover and fill for the existing lagoons, with displaced liquid routed back to the mainstream treatment process.

8.1.2 Mitigative Measures During Plant Operation

Long term unavoidable adverse primary impacts due to the implementation of the proposed wastewater treatment facilities should be minimal. The majority of the possible future adverse impacts will relate to temporary upsets in the treatment systems which may occur due to equipment malfunction, shock loadings, occasional operating difficulties, etc. Sufficient backup has been provided for critical unit processes to ensure the minimization of impacts due to equipment breakdown, while the institution of pretreatment guidelines for industries contributing flow and load to the treatment facilities will reduce the likelihood of shock loadings severe enough to impact the performance of either plant.

Additional mitigative measures to abate adverse impacts during periods of elevated sewer system flow (e.g. during storms) can be accomplished by construction of separate sewers or combined sewer overflow treatment facilities. As discussed in Chapter III, an ongoing sewer system evaluation survey is being conducted, and plans are being laid for the separation of some key areas.

Strip mine restoration affected by the use of sludge in the backup sludge disposal system will result in restoration of streams that drain strip-mined land to a natural state. The backup system will allieviate any problems caused by incineration malfunction of future quantities of sludge too large to be handled by the incinerator facilities.

Whether air quality standards for particulate matter are met at both incinerator sites remains to be determined. Be that as it may, these standards are based on total weight of particulates in the air and do not consider particle size and chemistry. Because of evidence indicating that hazardous trace metals tend to concentrate in fine particulates, there is a growing concern that these particulates are responsible for adverse health effects due to their ability to penetrate deeply into the lungs. These particles have

long residence times in the air and are capable of absorbing toxic gases such as SO_2, thus leading to potentially severe synergistic health effects.

An adequate body of knowledge is not currently available to evaluate the performance of the particulate removal equipment in terms of particle size and chemistry. The EPA is conducting research to obtain more information in this area and to determine the need to set performance standards based on these parameters. Long-term mitigative measures for sludge disposal, to prevent degradation of air quality and attendant health problems, include more extensive use of land disposal of sludge both for strip-mine reclamation and for croplands.

8.2 SECONDARY IMPACTS

The construction of interceptors is a factor which may cause adverse secondary impacts by inducing undesirable population growth and development patterns in areas where such growth could not be anticipated without the existence of the sewers. While the construction of the proposed facilities is not expected to significantly affect total planning area population as compared to expected growth with the no-action alternative, it is likely to affect distribution of the population, with consequent environmental impacts due to changed land use patterns. In areas of high accessibility, sewer investments may hasten the progression of the area from urban-rural fringe type to higher density development. The changes to the facilities plan proposed by the EIS, which would provide phased service to certain subareas, will help to preclude the possibility of induced growth where such growth is undesirable. Thus, future growth patterns can be directed and controlled and the potential for adverse secondary impacts will be reduced.

It should be noted however, that there are other major factors (e.g., other community services) influencing development patterns and these may have as much if not more control over growth in the planning area. In fact, the adequacy of water supplies together with the ability of the region's economy to support additional population may be the most significant determinants of future growth and development patterns. Ultimately, control and direction over growth will have to come from environmentally and economically sound areawide planning.

8.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES AND RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND LONG-TERM BENEFICIAL EFFECTS

The proposed action would involve irreversible and irretrievable commitment of capital, material, and labor during the construction and operation of the proposed facilities. No other significant commitment of resources is expected. Their is no need for significant additional commitments of land since the treatment plants already exist and land needed for interceptor construction would eventually be recovered. The treatment plants and interceptor system would help control water pollution in the Columbus area with long-term beneficial effects as discussed in Chapter IV.

APPENDIX A

BASELINE EVALUATION OF THE COLUMBUS, OHIO, FACILITIES FOR WASTEWATER TREATMENT

APPENDIX A

BASELINE EVALUATION OF THE COLUMBUS, OHIO, FACILITIES FOR WASTEWATER TREATMENT

This Appendix provides a baseline evaluation of the Jackson Pike and Southerly Wastewater Treatment Plants. These two facilities serve the city of Columbus, Ohio as well as numerous suburban political jurisdictions. The primary purpose of this section is to define the equipment, influent characteristics, and performance of the two treatment facilities as observed and evaluated in the Spring of 1977.

The first step of such an evaluation is to characterize the service area of each plant, as this is fundamental to an understanding of the influent characteristics found at any wastewater treatment installation. Influent wastewater characteristics are described from 1970 through 1976; this characterization highlights the 1973-1974 data base used to prepare the facility plans and assures that recent load changes are addressed. Next, a current process flow diagram and unit process inventory is provided to assure fundamental understanding of each facility and to provide reference for discussion in the main text of the Environmental Impact Statement. The present performance of each treatment plant is then described in light of the data summarized and the existing unit processes.

A.1 SERVICE AREA

A.1.1 Sewerage System

The Columbus sewerage system occupies some 160 square miles with nearly 2,300 miles of sewers. The percentage distribution of the sewers is as follows: sanitary - 60 percent, combined - 29 percent, and storm - 11 percent.

The 63,000 acre Jackson Pike service area is estimated to contain a population of over 500,000 individuals. Approximately 9,400 acres of this area are served by combined sewers with an estimated tributary population of 146,000 people.

The Southerly service area incorporates 40,000 acres with a base population of some 300,000 people. Its combined sewer area is about 2,400 acres with a population of 29,000 persons.

A.1.2 Users

The Columbus water supply network and wastewater treatment service area are not significantly different. An approximation of the relative volumetric contribution of each sewer user can be obtained from City water supply records. Data from 1976 are shown in Table A-1.

Table A-1
1976 Water Supply Accounts

Category	Accounts	Flow Distribution (%)	Flow (mgd)
Government	1,840	10	8
Commercial	9,870	14	11
Domestic	152,880	54	42
Industrial	970	20	15
School/Church	1,410	2	1
Total	166,970	100	77

Table A-1 reveals the significance of the waste flows that can be developed from the City's numerous governmental agencies and commercial establishments.

The Jackson Pike Wastewater Treatment Plant processed an average daily flow of 72 mgd in 1976. Estimated industrial waste flows at the plant are between 8 and 11 mgd. The largest single industrial waste source is the Fisher Body Plant of General Motors, which can release up to 2.0 mgd of zinc plating wastes. Other industrial wastes of significance are related to plating operations, appliance manufacturing, and food and dairy industries.

The Southerly Wastewater Treatment Plant processed an average daily flow of 46 mgd in 1976. Its total industrial waste flow is on the order of 5 to 7 mgd. In recent years, the waste load from Anheuser-Busch has had a progressively greater impact upon the plant. In January, 1976, the 2.8 mgd release from the brewery contributed approximately 16 and 37 percent of the suspended solids and BOD_5 mass reported in the influent to Southerly.

A.1.3 Major Interceptors

Wastewater arrives at the Jackson Pike Plant by the 108-inch diameter Olentangy-Scioto Interceptor Sewer (O.S.I.S.) and the 72-inch diameter Big Run Interceptor. The plant accepts all of the flow from the Big Run Interceptor but limits its acceptance of the O.S.I.S. flow to the point that the processing capability of the plant will not be violated. The major diversion point for the O.S.E.S. flows is at the Whitter Street Storm Standby Tanks.

Southerly receives the majority of its flow from a 108-inch interceptor, with a small quantity entering via a 156-inch line. It also accepts only the amount of flow that it feels it can successfully proces. Diversion at Southerly occurs through a 108-inch diameter sewer at the plant's influent regulator chamber.

A.1.4 Diversion and Retention Structures

The main interceptors of the City of Columbus were designed to carry sewage and large volumes of storm water. Relief points are common throughout the collection system, with some 23 regulators and 18 overflow structures located in the combined area alone.

The diversion facilities of the City are complemented by the Whitter Street and Alum Creek Storm Standby Tanks, which were designed to provide sedimentation and skimming of the combined sewer overflows. Both facilities are cleaned by backflushing the accumulated debris into the adjacent interceptors. Neither provide more than a token treatment gesture at high flow conditions. The combined three tank capacity of the Whitter Street installation is 4 million gallons; operation of the regulating gates can be done automatically by flow level sensing in the O.S.I.S. interceptor, manually, or remotely from Jackson Pike. The Alum Creek installation contains one underground tank with a capacity of 0.86 million gallons. Appendix H contains a further detailing and analysis of the combined sewer system and overflows.

A.2 INFLUENT WASTEWATER CHARACTERISTICS

A.2.1 Jackson Pike

Table A-2 summarizes the reported Jackson Pike influent characteristics for the last seven years. Superficially, the data show a declining flow pattern, perhaps influenced

Table A-2
Jackson Pike Influent Characteristics: Annual Trends

Year	Annual Precipitation (inches)	INFLUENT					Comment
		Flow	BOD_5		SS		
		(mgd)	mg/l	lbs/day	mg/l	lbs/day	
1970	43	78	210	140,000	240	160,000	
1971	34	87	220	160,000	260	190,000	
1972	46	96	180	140,000	250	200,000	1,200 Hrs. of thermal conditioning (T.C.)
1973[1]	46	92	160	130,000	240	180,000	5,600 Hrs. of T.C.
1974[1]	37	83	190	130,000	270	190,000	5,500 Hrs. of T.C.
1975	39	75	240	150,000	310	190,000	5,200 Hrs. of T.C.
1976	32	72	260	160,000	370	220,000	7,300 Hrs. of T.C., only one incinerator operating, 7 construction contracts let.
1976 LOW[2]	0	66	280	150,000	370	200,000	32 Days
1976 HIGH[3]	18.5	78	210	140,000	370	240,000	39 Days

[1] Used in preparing the Facilities Plan.

[2] Determined by eliminating all days where precipitation was recorded within previous three days and day before precipitation event.

[3] Determined by using all days with 0.5 inches or more of precipitation plus the following day.

by precipitation, and a rising suspended solids (SS) mass. If the average results of 1973 and 1974 (the data years used in preparing the Facilities Plans) are used as a baseline, then two to three years later (1976) an 18 percent decline in flow is observed to accompany a 23 to 19 percent rise in the influent BOD_5 and suspended solids mass. The rise in influent pollutant concentrations is even more striking, with BOD_5 and SS values increasing by 48 and 45 percent, respectively. The question is "are these changes real or are they associated with the nuances of Jackson Pike's operation?" It is believed that the latter is the case, as is described in the subsequent paragraphs.

(1) Flow

An examination of the annual precipitation values against the influent flow values reported in Table A-2 shows little correlation. For example,

- 1970 and 1971 - A nine inch (21 percent) decline in precipitation is observed against a 9 mgd (12 percent) rise in flow.
- 1974 and 1975 - A two inch (5 percent) increase in precipitation is observed with an 8 mgd (10 percent) decline in flow.
- 1971 and 1976 - Annual precipitation values are nearly the same but the 1976 flow has dropped by 15 mgd (17 percent).
- 1976 Low - A 6 mgd (8 percent) decline from the average annual daily flow is observed with a data base that incorporates nine percent of the data days.
- 1976 High - A 6 mgd (8 percent) rise from the average annual daily flow is observed with a data base that incorporates 57 percent of the annual precipitation on 10 percent of the data days.

The 1976 low and high flow observations might be expected with a "tight" collection system but certainly not with an old combined system as exists in Columbus. These flow inconsistencies suggest that unmonitored bypassing is more a cause of the flow decline rather than a dramatic change in the flows produced from the collection system. Qualitatively, this hypothesis is further supported in that Jackson Pike accepts only that flow which it feels it can successfully process. The continued decay of its solids processing capability, culminating in the 1976 failure of one incinerator, suggests that the lower flows may be associated with an inability to successfully handle any additional flow and its associated mass. The highest flow year summarized was 1972; a year which was preceded by an optimism that thermal sludge conditioning might provide the best solution for the solids handling and recirculation problems that still plague the plant. *

Thus, it is concluded that the flow decline observed at the plant is not truly precipitation or user oriented, but rather one of upstream bypassing from the collection system. However, the problem remains to somehow estimate the base-line flow that Jackson Pike would experience if flows consistent with its rated hydraulic capacity were processed. If it is assumed that the true ratio of the plant's low flow to average annual flow is on the order of 0.67 to 0.75 (a common range for plants this size), then the average annual flow is about 88 to 98 mgd. A potential average annual flow of about 90±5 mgd appears realistic for 1976, with an average annual flow estimate of 100±5 mgd corresponding to Columbus' long term mean precipitation of 37 inches per year.

A rough preliminary estimate for the magnitude of the infiltration and inflow can be derived for the Jackson Pike service area through the data and estimates developed in the preceding paragraphs. As shown in Table A-3, infiltration and inflow estimates of 15 and 24±5 mgd, respectively, are obtained for 1976 conditions. The combined infiltration/inflow estimate increases to about 50±15 mgd when the service area experiences the mean annual precipitation observed at Columbus.

(2) Quality

The striking change that has developed in the influent wastewater quality at Jackson Pike over the last two years cannot be attributed to any one of the following reasons:

- changes in sampling and analytical procedures,

Table A-3
Jackson Pike Service Area:
Inflow/Infiltration Estimate

A. 1976 (32 inches annual precipitation)

1. Contribution of Users: Assume consumptive use = private water supply

Industry ---------- 9 mgd

Domestic -- $\frac{500,000}{800,000}$ (42) ---------- 26 mgd

Government, Commercial, School/Church
Assume concentrated in service area
factor = (1+5/8)1/2 = 0.81

------(0.81)(20)---------- 16 mgd

TOTAL 51 mgd

2. Infiltration
1976 Low Flow-Users = 66-51 ---------- 15 mgd

3. Inflow
1976 Estimated Annual Average-(Infiltration+Users)
= 90 ± 5 - (15+51) ---------- 24 ± 5 mgd

B. 1976 with 37 inches of Annual Precipitation

Flow Increase = (100 ± 5) - (90 ± 5) ------- 10 ± 10 mgd

1. Infiltration: Assume 20 percent of the flow increase = (2 ± 2) + 15 ---------- 17 ± 2 mgd

2. Inflow: Assume 80 percent of the flow increase = (8 ±8) + 24± 5 ---------- 32 ± 13 mgd

3. Total Amount of Infiltration/Inflow
= (17 ± 2) + (32 ± 13) ---------- 49 ± 15 mgd

USE 50 ± 15 mgd

- changes in the receipt of scavenger wastes (the plant provided a 'night soil' dump station in 1971, the load from this source probably averages 20,000 to 30,000 gallons per day), or

- changes in the service area in terms or significant industrial discharges.

However, a review of the plant's operation reveals that the decant liquor from the thickening tank that receives the thermally conditioned sludge returns ahead of the influent sampling point. This minor process stream, enriched with both soluble and particulate pollutants, is the source of the sudden quality change. Thus, the plant is 'double inventorying', or including a recycle stream as a part of its reported influent pollution load. The following paragraph provides a more detailed discussion of this phenomenon.

The 200 gpm Jackson Pike thermal conditioning system began operation in June, 1972. At that time (and presumably until sometime in 1974) the decantate was pumped and returned with the digester supernatant to an isolated portion of the secondary aeration system (flow diagrams prepared in 1972 and in the Unit Operations Process Schematics published in 1975 illustrate this operation). However, due to the odors that evolved from the aeration system, the decantate was rerouted to a convenient gravity sewer that drains upstream of the influent sampling point. In 1975, the impact of this recycle, combined with the dilution derived from a high precipitation year and more upstream bypassing, gave the first significant change in the measured influent pollutant concentration. The impact of the decantate recycle became even more significant in 1976 due to a 40 percent increase in the thermal conditioning operating time. (See Table A-2).

Since the precise date of this changeover cannot be identified, it is believed that the plant's influent quality from 1970 through 1972 provides the best estimate of the normal influent pollutant concentration. Influent BOD_5 and SS values of about 210 and 250 mg/l appear reasonable for the 1976 condition. If these estimates are valid, then the recycled decantate caused a 23 and 48 percent increase in the measured influent pollutant mass of BOD_5 and SS, respectively.

(3) Estimated 1976 Potential Influent Characteristics

Based upon the preceding sections, it is possible to summarize reasonable estimates of the true Jackson Pike influent load. These estimates are believed to have a validity of ±10 percent.

	1976 Conditions	
Precipitation, inches/year	32	37
Influent Flow, mgd	90±5	100±5
BOD_5 @ 160,000 lbs/day, mg/l	210	190
SS @ 190,000 lbs/day, mg/l	250	230
Infiltration/Inflow, mgd	40±5	50±15

A.2.2 Southerly

Table A-4 summarizes the reported Southerly influent characteristics for the last seven years. Superficially, the data show little flow change, with a dramatic rise in the influent BOD_5 mass accompanied by a smaller gain in the suspended solids mass. If the average results of 1973 and 1974 (the data years used in preparing the Facilities Plans) are used as a baseline, then two to three years later (1976), a 12 percent flow decline is observed to accompany a thirty percent increase in the BOD_5 mass, while the suspended solids mass stays constant. In the same time frame, the concentration levels of the influent BOD_5 and suspended solids rose by 46 and 7 percent, respectively. In contrast to the situation at Jackson Pike, it is believed that the 1976 pollutant concentrations are correctly stated. However, like Jackson Pike, it is also believed that the average daily flow reported at Southerly is substantially understated. The rationale for these conclusions is developed in the subsequent paragraphs.

(1) Flow

A review of the 1976 plant operating data is indicative of the amount of bypassing that occurs at the Southerly Plant. The low flow data days were 11 fewer than reported at Jackson Pike due to bypassing at the plant's diversion chamber. A more striking observation is that the volume treated on the 38 days when the plant's flow should have been the highest (46 mgd) was exactly the same as the plant's average annual flow.

Historically, it is believed that the 36 mgd low flow reported in 1971 was due to the bypassing associated

Table A-4
Southerly Influent Wastewater Characteristics: Annual Trends

Year	Annual Precipitation (inches)	INFLUENT					Comment
		Flow	BOD_5		SS		
		(mgd)	mg/l	lbs/day	mg/l	lbs/day	
1970	43	43	190	60,000	190	60,000	
1971	34	36	210	60,000	210	60,000	Construction program started.
1972	46	50	190	80,000	200	80,000	
1973(1)	46	53	240	110,000	190	80,000	Start-up of new secondary, bulking sludge.
1974(1)	37	52	280	120,000	240	100,000	Old secondary out of service.
1975	39	49	340	140,000	210	90,000	
1976	32	46	380	150,000	230	90,000	Thermal conditioning on stream in June.
1976 LOW(2)	0	41	370	130,000	220	80,000	21 Days
1976 HIGH(3)	18.5	46	330	130,000	230	90,000	38 Days

(1) Used in preparing the Facilities Plan.

(2) Determined by eliminating all days where precipitation was recorded within previous three days, day before precipitation event, and eliminating days where plant bypassing reported.

(3) Determined by using all days with 0.5 inches or more of precipitation plus the following day.

with expanding the plant's main treatment capability. It is believed that this bypassing continued into 1973 until completion of the construction program. At that time, the brewery load had increased so that the new plant's startup largely coincided with a severe bulking (loss of activated sludge settleability) problem in the secondary system. In 1974, with false confidence, the plant probably accepted close to average annual day flows (Note: a 1 mgd, or 2 percent, flow decline with a nine inch, or 20 percent, decline in precipitation). Final effluent suspended solids for these two years (1973 and 1974) averaged over 90 mg/l. Over the last two years the plant has tried a variety of control techniques such as chlorine and alum addition to the activated sludge system, but none has proved more than marginally successful. Today, the most successful operating technique is to keep the solids loading rate on the final settlers below 15 lbs/SF·day by reducing the influent flow and the mixed liquor suspended solids. Mixed liquor suspended solids control is difficult due to the limits of the solids handling system and continuous recirculation of solids about the plant, a situation caused primarily by operational difficulties and equipment limitations.

Thus, as at Jackson Pike, it is concluded that the flow decline observed at Southerly is not truly precipitation or user oriented, but rather is due to diversions at the plant's regulating chamber. If it is reasoned that the more frequent bypassing at Southerly compensates for its tighter collection system, then the average daily flow is also likely to be about 50 to 25 percent higher than the 1976 low flow. This assumption yields a probable 1976 average annual flow of about 55±5 mgd. The average annual flow associated with Columbus' average annual precipitation of 37 inches is estimated at about 60±5 mgd.

A rough preliminary estimate for the magnitude of infiltration and inflow for the Southerly service area is given in Table A-5. This estimate reveals that 1976 infiltration and inflow were about 15 and 14±5 mgd, respectively. The combined infiltration/inflow estimate for the Southerly collection system is about 35±15 mgd when the annual precipitation matches the long term average of 37 inches.

(2) Quality

Upon review of Southerly's sampling procedures, analytical techniques, and method of operation, it is

Table A-5
Southerly Service Area:
Inflow/Infiltration Estimate

A. 1976 (32 inches annual precipitation)

1. Contribution of Users: Assume consumptive use = private water supply

Industry ---------- 6 mgd

Domestic -- $\frac{300,000}{800,000}$ (42) ---------- 16 mgd

Government, Commercial, School/Church
------0.19(20) ---------- 4 mgd

TOTAL ---------- 26 mgd

2. Infiltration
1976 Low Flow-Users = 41-26 ---------- 15 mgd

3. Inflow
1976 Estimated Annual Average - (Infiltration+Users)
= 55±5 - (15+26) ---------- 14±5 mgd

B. 1976 with 37 inches of Annual Precipitation

Flow Increase = (60±5) - (55±5) ---------- 5±10 mgd

1. Infiltration: Assume 20 percent of the flow increase = (1±2 mgd) + 15 -------- 16±2 mgd

2. Inflow: Assume 80 percent of the flow increase = (4±8 mgd) + (14±5 mgd) ----- 18±13 mgd

3. Total amount of Infiltration/Inflow
= (16±2 mgd) + (18±13 mgd) ---------- 34±15 mgd

USE ------ 35±15 mgd

believed that the 1976 influent quality characteristics are essentially correct as stated in Table A-4. The steady rise in BOD_5 and suspended solids is largely attributable to the release from Anheuser-Busch.

(3) Estimated 1976 Potential Influent Characteristics

Based upon the preceding paragraphs, it is possible to develop reasonable estimates of the true Southerly influent load. These estimates are believed to have a validity of ±10 percent.

	1976 Conditions	
Precipitation, inches/year	32	37
Influent Flow, mgd	55±5	60±5
BOD_5 @ 180,000 lbs/day, mg/l	380	360
SS @ 110,000 lbs/day, mg/l	230	220
Infiltration/Inflow, mgd	30±5	35±15

A.3 WASTEWATER TREATMENT FACILITIES

A.3.1 Jackson Pike

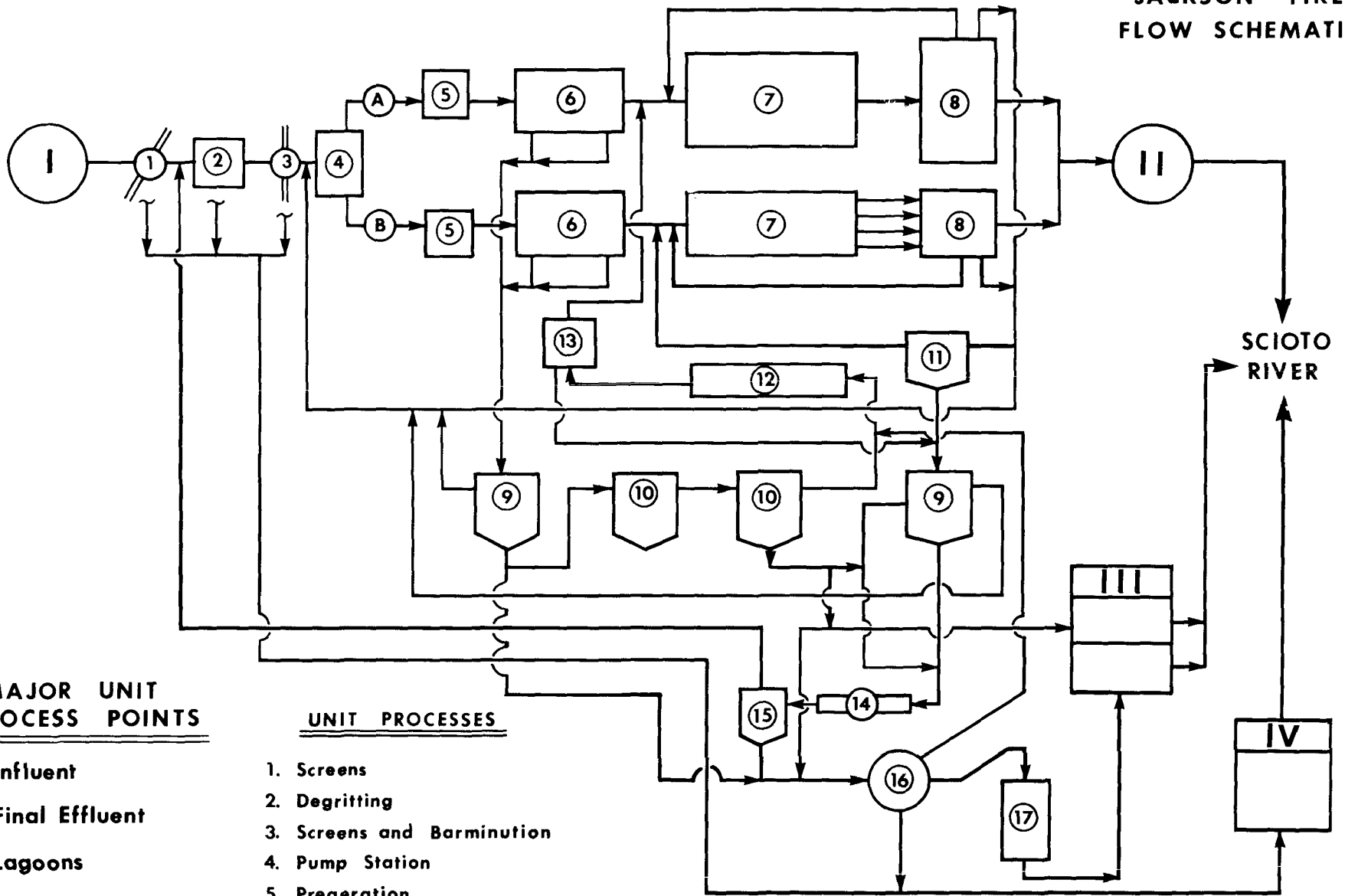
The Jackson Pike Wastewater Treatment Plant began operation in 1937. The plant was modernized and doubled in capacity in the mid-fifties. The older (Plant A) and newer (Plant B) facilities have a collective average day hydraulic capacity of about 100 mgd. The flow split, 50 to 60 percent in Plant A and 50 to 40 percent to Plant B, is achieved at the influent pump station. The two plants operate relatively independently of each other during liquid processing, but share sludge handling facilities.

Figure A-1 provides a schematic flow diagram of the Jackson Pike Plant. Table A-6 describes the unit capacities of the major treatment works. Where applicable, comments are provided in this Table to depict the present condition of the facilities. On an overall basis, after several decades of use, most of the plant's mechanical equipment is either worn out, outdated, or in need of frequent repair. Such would be expected. However, the plant's major structures appear physically sound, with only the external surfaces of the older concrete tanks showing noticeable wear.

FIGURE A-1

JACKSON PIKE

FLOW SCHEMATIC



MAJOR UNIT PROCESS POINTS

- I Influent
- II Final Effluent
- III Lagoons
- IV On-Site Landfill
- A A-Plant
- B B-Plant

UNIT PROCESSES

1. Screens
2. Degritting
3. Screens and Barminution
4. Pump Station
5. Preaeration
6. Primary Sedimentation
7. Activated Sludge Aeration
8. Final Sedimentation
9. Storage Tanks
10. Anaerobic Digestion
11. Thickening
12. Supernatant Aeration
13. Sedimentation
14. Thermal Conditioning
15. Decant Tank
16. Dewatering Complex
17. Incineration

Table A-6
Jackson Pike: Unit Capacities

PRETREATMENT AND PUMPING: Unit process 1 and 2 are at remote sewer yard, all concentrates applied to landfill.

1. Screens - Two, mechanically cleaned, with 1-inch openings (replaced in early 70's).

2. Degritting - Four tanks, each at 43.8'x20.8'x14.5', with 0.37 mg total volume - two 300 cfm blowers (collecting crane inoperable).

3. Screens/Barminutor - Mechanically cleaned bar screen with 1-inch openings, Barminutor inoperable (both replaced in early 70's).

4. Pump Station - 165 mgd firm capacity: two variable speed at 55 mgd (32 feet TDH), two constant speed at 27.5 mgd (27.5 TDH), and one constant speed at 60 mgd (30 feet TDH). Complex also contains two 21,000 cfm and four 15,000 cfm blowers which supplement plant A's preaeration and aeration requirements. Four engines provide 4,000 KWH of standby power generation capability contained in complex. (All equipment very old, power engines to be abandoned in future.) *

5. Preaeration/Grit Removal Capability

   Plant A - Two tanks, each at 180'x26'x15' SWD, with 1.05 mg total volume.

   Plant B - Two tanks, each at 113'x26'x15' SWD, with 0.66 mg total volume and two 3,000 cfm blowers.

PRIMARY SEDIMENTATION: Grease and sludge normally combined and sent to storage tanks.

6. Plant A - Four tanks, each at 150'x80'x10' SWD, with 3.6 mg total volume and 48,000 sf total area. Four 200 gpm sludge pumps.

6. Plant B - Four tanks, each at 150'x80'x10' SWD, with 3.6 mg total volume and 48,000 sf total area. Two 350 gpm sludge pumps. (All flights and chains reported in poor condition).

SECONDARY TREATMENT:

7. Aeration System - Fine bubble sock diffusers, operated as plug flow system with designed capability for step feed at quarter points.

Table A-6 Continued
Jackson Pike: Unit Capacities

SECONDARY TREATMENT CONTINUED:

7. Aeration System Continued - 450'x26'x15' SWD. Plant A is baffled at 80 feet, Plant B is baffled at 112'.

   Plant A - Six tanks with a total volume of 15.8 mg and two 20,000 cfm blowers.

   Plant B - Four tanks with a total volume of 10.5 mg and three 12,500 cfm blowers. (All blowers are constant speed, sock diffusers are maintenance intensive)

8. Final Sedimentation - 12 tanks, each at 60'x153'x12' SWD, nonskimmed, combination of clari-vac and chain and flight collection systems (chain and flight needs replacement).

   Plant A - Eight tanks with a total volume of 6.6 mg and a total area of 73,000 sf, fed from a common channel. Three constant speed return sludge pumps at 10, 8, and 5 mgd.

   Plant B - Four tanks with a total volume of 3.3 mg and a total area of 37,000 sf, operated in parallel with aerators. Three constant speed return sludge pumps at 8.5, 5.6, and 5 mgd.

WASTE SOLIDS HANDLING:

9. Storage Tanks - Two, each of 1.0 mg capacity, one receives only primary sludge and skimmings.

10. Anaerobic Digesters - Receive only primary sludge, gas storage in covers, (poor mixing and heating reported, gas production largely satisfies digester heating needs). Present operation sends some digested sludge to lagoons. Eight primary digesters, each at 0.79 mg capacity, with a total volume of 6.3 mg, and six secondary digesters, each at 1.0 mg capacity, with a total volume of 6.0 mg.

11. Thickening - Waste Activated Sludge largely applied to three tanks, each at 14.2x78.8x8' SWD, with a total volume of 0.2 mg and a total area of 3,400 sf. (Originally designed to provide flotation thickening, facilities are operated as gravity units).

Table A-6 Continued
Jackson Pike: Unit Capacities

WASTE SOLIDS HANDLING - CONTINUED

12. Supernatant (and filtrate) Aeration - Uses 2 aeration tanks from and in addition to the Plant A call-out giving a total volume of 5.2 mg. Shares Plant A's air supply.

13. Sedimentation Tank - Used to settle the aerated digester supernatant (and filtrate), one tank at 120'x60'x15' SWD, giving a total volume of 0.67 mg with a total area of 6,000 sf. (Three other tanks with the same size are in a state of disrepair and have been abandoned.)

14. Thermal Conditioning - One existing 200 gpm unit with one additional facility under construction. Basic facility contains grinders, high pressure pumps, heat exchangers, reactor with steam injection, pressure reduction facility. Reactor conditions 20 minutes detention time, 375 psi, 380°F. Present operation largely processes waste activated sludge. Chemical conditioning with polymer of digested and raw primary sludge planned to be phased out in future.

15. Decant Tank - One existing with one additional facility under construction. Tank size is 35 feet diameter with 13' SWD, giving a volume of 0.09 mg and an area of 960 sf. Fumes from pressure reduction and decant tanks are presently exhausted to the atmosphere, future improvements will vent fumes to carbon adsorber or incinerator.

16. Sludge Dewatering - Historic facility containing 4 cloth (10 foot diameter by 12 foot long) and 4 coil (11.5 foot diameter by 10 foot long) vacuum filters with one of each inoperable. Will be replaced by six 55 to 110 gpm scroll centrifuges. Existing coil filter operation shows a solids capture of 60 to 80 percent. Presently all thermally conditioned and filtered sludge is dumped into the field adjacent to the plant.

17. Incineration - Two seven hearth furnaces, each at 22.25' diameter and rated for 125 wet tons/day with 85 percent wet cake. One unit out

Table A-6 Continued
Jackson Pike: Unit Capacities

WASTE SOLIDS HANDLING - CONTINUED

17. Incineration - Continued - of operation. One new unit scheduled for construction. Present operation burns as much as possible and landfills the rest. Ash is applied to a separate ash lagoon. All lagoon overflows go to the river. Incineration of the thermally conditioned sludge has led to high hearth burning and hot spots; modifications are under way to adjust the unit's operational characteristics. *

A review of annual reports from 1971 to date show a nearly continuous program to modernize and repair the treatment facilities. Presently, several construction contracts are underway to rehabilitate and expand the plant's baseline treatment capability. These contracts are outlined below:

- rehabilitation of incinerators,
- construction of temporary disinfection facilities,
- addition of one 200 gpm thermal conditioning unit,
- provision of air pollution control equipment for incineration,
- expansion of plant water system,
- replacement of vacuum filters with six 55 to 110 gpm scroll centrifuges,
- replacement of pneumatic ash handling system with pump slurry to lagoon,
- addition of metering and sampling equipment,
- replacement of Plant A's high water pumps, and
- replacement of numerous valves and metering equipment in Plant A.

A.3.2 Southerly

The Southerly Wastewater Treatment Plant began operation in 1967 with a rated capacity of 40 mgd. In the early seventies, the wet stream hydraulic capacity of the plant was expanded to 100 mgd along with provision of a metal salt phosphorus removal capability. This expansion was followed by the addition of two flotation thickeners for waste activated sludge and three 200 gpm thermal sludge conditioning systems. The latter facility, placed in operation in June of 1976, was intended to improve the dewaterability of the sludge.

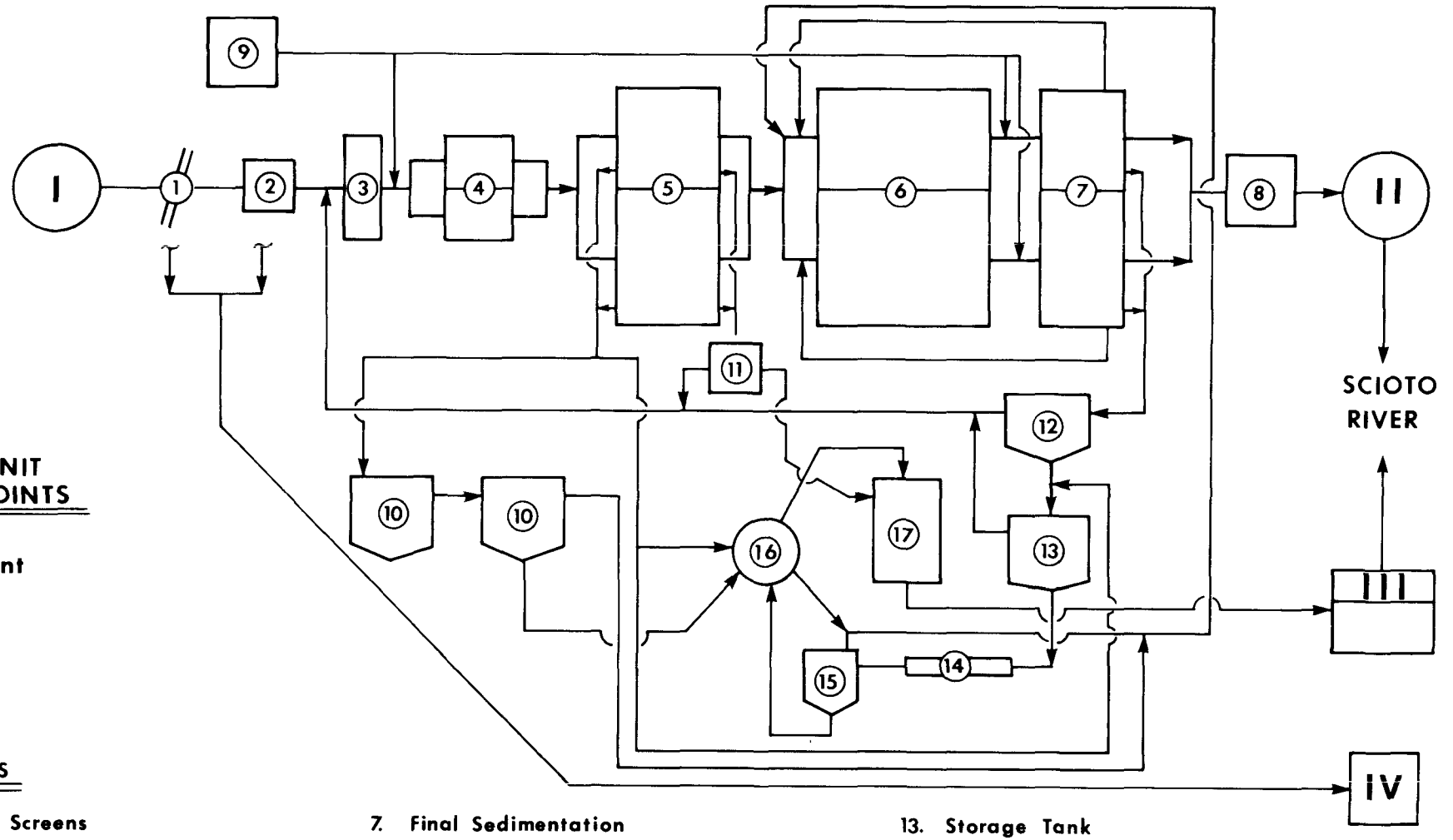
The 1967 main stream treatment capability is termed the Center Section. The newer 1973 system is called the West Section. Typically, the West Section receives 70 percent of the influent flow.

Figure A-2 provides a schematic flow diagram of the Southerly Plant. Table A-7 describes the unit capacities of the major treatment works. Where applicable, comments are provided in this table to note the present condition of the treatment facilities.

Historically, it would appear that Southerly has long been plagued with either hydraulic or solids handling problems compounded by a high turnover in the operating staff and improperly performing equipment. On an overall basis, it would appear that this plant has never fully achieved sustained, stable performance. The cause of this failure seems to be more one of unit process limitations with the 'as received' wastewater load than directly attributable to inattention and neglect upon the part of the plant's staff.

FIGURE A-2

SOUTHERLY FLOW SCHEMATIC



MAJOR UNIT PROCESS POINTS

- I Influent
- II Final Effluent
- III Lagoons
- IV Landfill

UNIT PROCESSES

1. Bar Racks and Screens
2. Degritting
3. Pump Station
4. Preaeration
5. Primary Sedimentation
6. Activated Sludge Aeration
7. Final Sedimentation
8. Chlorine Disinfection Basin
9. Chemical Feed Building
10. Anaerobic Digestion
11. Skimmings Concentration
12. Thickening
13. Storage Tank
14. Thermal Conditioning
15. Decant Tanks
16. Dewatering Complex
17. Incineration

Table A-7
Southerly: Unit Capacities

PRETREATMENT AND PUMPING - Auxiliary power source is not dependable, plant has capability to drop influent gates during power outage.

1. Bar Racks and Screens - Four bar racks with 5-1/2 inch openings and four mechanically cleaned bar screens with 1 inch openings.

2. Grit Removal - Four tanks, two at 44.5' x 20' x 13.5' SWD, and two at 51.2' x 20' x 13.5' SWD, for a total volume of 0.32 mg. Two variable speed blowers, each at 960 cfm. (Overhead crane inoperable, grit removal best at lowest blower setting; grit removal system should be changed.)

3. Pump Station - Three variable speed 250 HP 30 mgd (38 feet TDH) pumps, one constant speed 250 HP 30 mgd (38 feet TDH) pump, and two variable speed 600 HP 65 mgd (42 feet TDH) pumps.

4. Preaeration Tanks - Three constant speed blowers, each at 3400 cfm. Eight tanks, each at 112.7' x 26' x 15.5' SWD, with a total volume of 2.6 mgd. Point of chemical addition capability. (Grit removal capability being dismantled).

PRIMARY SEDIMENTATION - Only 5 tanks in service due to low flows.

5. Center Section - Four tanks, each at 80' x 163.2' x 10' SWD, giving a total volume of 3.9 mg and a total area of 52,000 sf, two 250 gpm sludge pumps.

5. West Section - Four tanks, each at 100' x 170' x 10' SWD, giving a total volume of 5.1 mg and a total area of 68,000 sf, two 250 gpm sludge pumps.

SECONDARY TREATMENT

6. Aeration System - Fine bubble sock diffusers, operated as plug flow system with designed capability for step feed at 1/4, 3/8, 1/2, 5/8 and 3/4 points. Each aerator contains two posses with each pass at 450' x 15' SWD. *

Table A-7 Continued
Southerly: Unit Capacities

SECONDARY TREATMENT - CONTINUED

6. Aeration System Continued - 112 feet. West section blowers (five at 20,000 cfm) are cross connected to feed center section, which contains three blowers at 12,500 cfm. All blowers are constant speed. (Back pressure buildup from dirty diffusers can prevent operating with full blower capacity. Sock diffusers are maintenance intensive.)

Center Section - Four tanks with a total volume of 10.5 mg.

West Section - Six tanks with a total volume of 15.8 mg.

7. Final Sedimentation - No skimming, chain and flight system.

Center Section - Four tanks, each at 89' x 170' x 12.5' SWD, with a total volume of 5.6 mg and a total area of 60,000 sf. Six constant speed return sludge pumps: four each at 17.2 mgd (100 HP), and two each at 11.7 mgd (50 HP). Four constant speed waste activated sludge pumps, each at 0.79 mgd (20 HP).

West Section - Four tanks, each at 104' x 180' x 10.5' SWD, with a total volume of 5.9 mg and a total area of 75,000 sf. Six constant speed return sludge pumps: Four each at 10 mgd (60 HP), and two each at 5 mgd (40 HP). Four constant speed waste activated sludge pumps, each at 0.79 mgd (20 HP).

POST TREATMENT - Six 35 mgd (150 HP) high water pumps.

8. Chlorine Contact Basin - 260' x 260' x 7' SWD with a total volume $\leq$ 3.5 mg, two 6,000 lb/day chlorinators (short circuiting and solids deposition likely in basin).

Table A-7 Continued
Southerly: Unit Capacities

CHEMICAL FEED BUILDING

9. Contains 10 23,600 gallon fiber glass storage tanks with 4 rotodip chemical feeders, each with a maximum rate of 1,200 gph and a 20:1 feed range (two tanks being modified for NaOCL, others will remain for metal salt addition).

WASTE SOLIDS HANDLING

10. Anaerobic Digestion System - Four primary digesters, with a total volume of 4.3 mg, and one secondary digester with a volume of 1.1 mg. (Approximately 25% of the waste primary sludge is fed to the digesters.)

11. Skimmings Concentration Tank

12. Thickening - Four tanks, each at 20' x 94' x 12.5' SWD, giving a total volume of 0.70 mg and a total area of 7500 sf. (Originally designed for dissolved air flotation, now operated as gravity units.) Facility receives all the waste activated sludge.

13. Storage Tank - One tank at 1.1 mg capacity, formerly a second stage digester.

14. Thermal Conditioning - Three 200 gpm heat treatment systems. Complex contains four grinders, four sludge pumps, six high pressure pumps, air compressors, heat exchangers, and three 12,000 gal reactors. (System has reportedly been unable to achieve seven consecutive days of operation since startup.)

15. Decant Tanks - Four tanks, each at 35 feet diameter and 13.5' SWD, yielding a total volume of 0.39 mg and a total area of 3800 sf. Six 100 gpm sludge pumps and three 400 gpm decant pumps. One tank is presently left empty for standby storage. Exhaust

Table A-7 Continued
Southerly: Unit Capacities

WASTE SOLIDS HANDLING - CONTINUED

15. Decant Tanks - Continued - gases will be burned either in the main incinerators or in a special fume incinerator.

16. Dewatering Complex - Four cloth vacuum filters, each with a diameter of 11.5 feet and a length of 12 feet, giving a total area of 1,700 SF. (Fabrics change as a function of waste solids - two equipped for thermal conditioned one for raw primary and one for digested primary; nonthermally conditioned sludge is conditioned with polyelectrolytes).

17. Incineration - Two eight hearth furnaces, each at 22.25 feet diameter with a rated capacity of 150 wet tons per day with an 85 percent moisture content. Plant personnel report that operating problems have increased with thermally conditioned sludge due to high temperatures on the top hearths. Physical modifications are being made; operator reports that it is rare to have both incinerators available for operation at one time). Ash and scrubber water are applied to ash lagoon. Digested sludge has been lagooned at plant site.

A.4 PERFORMANCE CHARACTERIZATION

A.4.1 Jackson Pike

The BOD_5 and suspended solids quality characteristics Jackson Pike's final effluent are reported in Table A-8. Data are presented to describe the last seven years of record and the variability of performance in 1976. The bottom of the Table describes the current definition of secondary treatment equivalency (STE) for the pollutants of concern. Annual performance in 1971, 1972, and 1975 violated the STE definition for effluent suspended solids. The average effluent quality in 1976 was clearly superior to that achieved in the previous years but, as noted previously, may be accompanied by more upstream bypassing of the influent pollutant load.

The performance variability data show little correlation with flow and dates. The failure of high BOD_5 data to correlate with elevated suspended solids concentrations can be attributed to the BOD_5 test itself, which does not keep solids in suspension and has a notorious analytical tolerance. In 1976, only the month of March exceeded the STE 30 day maximum for effluent suspended solids. A lack of flow correlation with elevated effluent suspended solids supports the hypothesis that high effluent suspended solids are more a function of the solids inventory in the activated sludge system. During the worst week of operation in March, the mixed liquor suspended solids concentration averaged 5,560 and 2,510 mg/l in the 'A' and 'B' plants, respectively. The average solids load on Plant A's final sedimentation tanks was 40 lbs/SF.day in this time period; clearly in excess of the 30 lbs/SF·day that is conventionally used in today's design practice for maximum loading conditions with an activated sludge exhibiting a sludge volume index (SVI) of 100 ml/gm. The SVI at the Jackson Pike Plant is normally in the range of 50 to 100 ml/gm. Low SVI's should be expected at Jackson Pike due to the preferential BOD_5:SS ratio in the influent and the digested solids recirculation.

Influent phosphorus levels are not reported at Jackson Pike, but removals should be somewhat higher than conventionally expected due to background iron concentrations in the raw sewage. Final effluent phosphorus concentrations averaged 4.5 mg/l in 1976.

Total nitrogen forms are not conventionally reported for the Jackson Pike influent or effluent. Effluent nitrate nitrogen values show a seasonal (temperature) dependency, ranging from less than 1.0 mg/l in January through February to a maximum of almost 9 mg/l as N in July. Higher nitrification could probably be achieved if desired; operation of

Table A-8
Jackson Pike Wastewater Treatment Plant:
Performance Characterization

Year (mgd)	Final Effluent - mg/l	
	BOD_5	SS
1970 (78 mgd)	17	22
1971 (87 mgd)	21	38
1972 (96 mgd)	21	39
1973 (92 mgd)	16	26
1974 (83 mgd)	16	30
1975 (75 mgd)	18	35
1976 (72 mgd)	15	14
1976 - Max. Mo.		
May (64 mgd)	22	
March (70 mgd)		38
1976 - Min. Mo.		
July (74 mgd)	9	
Sept. (75 mgd)		8
1976 - Max. Week		
May (61 mgd)	34	
March (77 mgd)		95
1976 - Min. Week		
July (77 mgd)	5	
Aug. (69 mgd)		4
1976 - Max. Day		
Aug. (71 mgd)	46	
March (76 mgd)		142
1976 - Min. Day		
July (76 mgd)	3	
Aug. (67 mgd)		1
Sec. Treat Equiv.		
Max. Month	30	30
Max. Week	45	45

the activated sludge system in a plug flow mode attenuates the nitrification capability of the plant due to the dissolved oxygen depression to trace levels for about 50 percent of each aerator's pass.

The 1976 cost of operation at Jackson Pike averaged about $140 per million gallons treated. The cost breakdown was as follows:

Category	Dollars	$/mg	Percent
payroll	$1,934,072	75	54
power	865,635	33	24
chemicals	46,234	2	1
miscellaneous	776,048	30	21
Total	$3,611,989	140	100

The power expenditure was associated with a nominal 1,490 KWH demand per million gallons of flow.

A.4.2 Southerly

Table A-9 summarizes the final effluent quality reported for the Southerly Wastewater Treatment Plant. The STE definition for effluent suspended solids was violated on an annual basis in 1971 through 1974; similar violations for the effluent BOD_5 occurred in 1973 and 1974.

The 1976 performance variability data shows little correlation with flow and dates. Again, as observed at Jackson Pike, suspect BOD_5 and SS ratios are evidenced due to the crudeness of the BOD_5 test and excessive operating solids in the activated sludge system. In 1976, average monthly BOD_5 values violated the STE criterion from July through October. Similar violations of the suspended solids STE criterion occurred during the same months with the exception of September. The average sludge volume indices during the same time period ranged from 160 to 320 ml/gm; while in the other months the SVI ranged from 130 to 190 ml/gm. The apparent causative agent for the bulking activated sludge has been identified by the plant staff and scientists from Ohio State University as a blue-green algae (*Schizothrix calciocola* or *Phormodium sp.*). It is obvious that the high temperatures and low dissolved oxygen stresses found during the summer period serve as a catalyst for the onset of severe bulking conditions. Equally clear is that the basic cause of this problem is the highly soluble carbohydrate brewery waste discharged from Anheuser-Busch. This

Table A-9
Southerly Wastewater Treatment Plant:
Performance Characterization

Year (mgd)	Final Effluent - mg/l	
	BOD_5	SS
1970 (40 mgd)	16	19
1971 (36 mgd)	19	33
1972 (50 mgd)	28	46
1973 (53 mgd)	59	90
1974 (52 mgd)	62	96
1975 (49 mgd)	18	24
1976 (46 mgd)	28	24
1976 - Max. Mo.		
Aug. (48 mgd)	52	
Aug. (48 mgd)		56
1976 - Min. Mo.		
March (47 mgd)	13	
Feb. (45 mgd)		8
1976 - Max. Week		
Aug. (53 mgd)	72	
July (42 mgd)		124
1976 - Min. Week		
March (46 mgd)	11	
Feb. (38 mgd)		6
1976 - Max. Day		
Oct. (43 mgd)	210	
July (40 mgd)		257
1976 - Min. Day		
March (44 mgd)	4	
May (44 mgd)		0
Sec. Treat Equiv.		
Max. Month	30	30
Max. Week	45	45

waste, which makes up 40 to 60 percent of the nominal BOD load at the plant, can cause daily influent BOD_5 peaks in excess of 1,000 mg/l.

The worst month of operation in 1976 was August. At that time, the average SVI was 310 ml/gm. A maximum solids load on the final settlers of about 10 lbs/SF·day would be recommended for this condition. The plant's average solids load was about 8 lbs/SF·day with a maximum day value of about 13 lbs/SF·day in the West Section. The average mixed liquor suspended solids (MLSS) during this month was about 1,850 mg/l. The estimated required return sludge percentage for this solids concentration given the August SVI is about 85 to 125 percent. Due to return sludge pumping limitations, the plant returned an average of 42 percent, or about half of the calculated requirement. Thus, it is seen that the August failure was more associated with an accumulation of solids in the final sedimentation tank than an overload of the system's allowable solids loading rate. Once the stored solids build up to an intolerable volume the system has little choice but to relieve itself through an excessive release of effluent suspended solids.

Influent phosphorus levels are not reported at Southerly, but removals should be somewhat higher than conventionally expected due to the high amount of sludge synthesis that accompanies a high influent organic concentration. The plant reported an average annual phosphorus release of 5.8 mg/l in 1976.

Nitrification at Southerly in 1976 was essentially nonexistent. The absence of nitrification can be attributed to the high carbonaceous load applied to the activated sludge system and the inability to achieve a dissolved oxygen concentration above trace levels for the majority of each aeration pass. The plant cannot use its full blower capacity due to back pressure problems with its sock diffusers, further complicating DO problems at high loading periods.

The 1976 cost of operation at Southerly averaged about $240 per million gallons treated. The cost breakdown was as follows:

Category	Dollars	$/mg	Percent
payroll	$1,630,833	99	41
power	948,905	58	24
chemicals	481,395	29	12
miscellaneous	871,225	54	23
Total	$3,932,408	240	100

The power expenditure was associated with a nominal 2,540 KWH demand per million gallons of treated flow.

In comparison to Jackson Pike, Southerly is a much more expensive operation. Reasons for this include the following:

- Payroll - Southerly is staffed to treat a higher flow than it presently accepts,
- Power - Southerly has high influent pumping head, uses more air to satisfy high oxygen demanding load, and contains two more thermal conditioning systems with attendent high pressure pumps and compressors,
- Chemicals - Southerly practices chlorination and chemical sludge conditioning routinely and added alum for a brief period in the summer, and
- Miscellaneous - Reason unknown, superficially a newer plant would be expected to have a lower cost.

APPENDIX B

MATHEMATICAL CHARACTERIZATION OF THE SCIOTO RIVER BELOW COLUMBUS

(This Appendix has been substantially revised in the final EIS. See Appendix DD in Volume II.)

APPENDIX B

MATHEMATICAL CHARACTERIZATION OF THE SCIOTO RIVER BELOW COLUMBUS

B.1 INTRODUCTION

The computer is a valuable tool in the systems analysis approach to comprehensive studies involving stream modeling and alternative evaluation in the development, use, and management of water resources. This study has used a basic dissolved oxygen water quality model to define the impact of point wastewater releases from the Jackson Pike and Southerly wastewater treatment facilities upon the oxygen resources of the Scioto River under a variety of low flow regimes. Effluent loadings were adjusted so as to establish a final load allocation for any modeled pollutant such that a violation of the applicable water quality standard is avoided. Ideally, this provides an optimum situation because the receiving stream can now be used as a final treatment device to the extent that its capability is not taxed to the detriment of the natural environment and indigenous aquatic species.

Obviously, any attempt at future prediction is fraught with difficulty and plagued with controversy. Indeed, the capability for mathematical sophistication via the computer far exceeds the fundamental knowledge needed to establish reasonably correct input parameters. The reader should remember that a mathematical model gives only correct relative results with constant input parameters. Specific, finite results are a desired goal but are rarely achievable.

B.2 DISSOLVED OXYGEN MODEL

Detailed mathematical analysis of the Scioto River revolves around a simplified dissolved oxygen profile. The basic program was produced by the Texas Water Development Board and titled "DOSAG"(1). This water quality model was then modified by the Georgia Environmental Protection Division to allow the incorporation of a different method of calculating reaeration and to drop flow augmentation considerations.

(1) Simulation of Water Quality in Streams and Canals DOSAG-1, Texas Water Development Board (1970).

The mathematical model was further refined to incorporate instream sheet oxygen demands and assets and reaction rate attenuation as a function of dissolved oxygen concentration or attainment of a set background ultimate carbonaceous oxygen demand. The final form of the dissolved oxygen model is given below.

$$D = \frac{K_1 L_o}{K_2 - K_1} (e^{-K_1 t} - e^{-K_2 t}) + D_o e^{-K_2 t}$$

$$+ \frac{K_3 N_o}{K_2 - K_3} (e^{-K_3 t} - e^{-K_2 t}) + \frac{BD}{28.3 d K_2} (1 - e^{-K_2 t})$$

where D_o = Initial dissolved oxygen deficit (mg/l)
L_o = Initial ultimate carbonaceous oxygen demand (mg/l)
N_o = Initial ultimate nitrogenous oxygen demand (mg/l)
D = Dissolved oxygen deficit (DO saturation - DO stream) at any time t (mg/l)
K_1 = Carbonaceous decay coefficient ($days^{-1}$)
K_2 = Reaeration coefficient ($days^{-1}$)
K_3 = Nitrogenous decay coefficient ($days^{-1}$)
t = travel time, days
BD = Sum of in-stream sheet demands and assets (mg/day/SF)
d = stream depth (ft.)
28.3 = Liters/cubic feet

The following sections describe the development and background thinking that went into the establishment of the input parameters for the model and the waste load allocation activities.

B.3 TEMPERATURE CONSIDERATIONS

The temperature adjustments for K_1, K_2, K_3 and BD are given below:

K_1, K_3 and BD at any T, ^oC = K_1, K_3 and BD at 20^oC $(1.05)^{T-20}$

K_2 at any T, ^oC = K_2 at 20^oC $(1.02)^{T-20}$

These adjustments are well documented in the literature and represent no deviation from the current state of the art.

Temperatures under low flow conditions in the Scioto will likely be relatively high due to the three cooling water releases in and below the City of Columbus. Two of these, Ohio State (not presently operating) and the Columbus Division of Electricity plant, are above Jackson Pike, while the third, Columbus and Southern Ohio Electric Company, is below Southerly. This bracketing of the facilities being modeled pointed toward use of the maximum permissible stream temperature stated in the Ohio Water Quality Standards, 32°C. Model sensitivity to temperature was investigated with additional computer runs at 28°C.

The use of an input temperature of 32°C will probably remain valid even after the closing of the present City Division of Electricity plant. Plans currently call for the replacement of this facility with another coal-and refuse-fired production unit just below Jackson Pike (pending voter approval), a move which will likely continue to produce elevated stream temperatures.

Winter model runs were also conducted for the same segment of the Scioto River. The stream temperature utilized in this effort was 12°C, a value which again reflects conditions resulting from releases of cooling water.

B.4 INSTREAM OXYGEN DEMANDS AND ASSETS

The BD term in the dissolved oxygen model represents the cumulative effect of algal photosynthesis, algal decay, and the oxygen demand associated with any benthic deposits. The first would represent a stream asset, and the other two would be demands.

Algal photosynthesis is, first of all, nutrient dependent. After that, a favorable habitat for algal replication is needed. Algal replication and, in turn, photosynthetic oxygenation, are dependent upon sunlight as an energy source. Where algal photosynthesis occurs algal decay is an inevitable corollary. A field sampling program will usually measure a stream condition exhibiting the maximum net influence of algal photosynthesis since it is most often conducted in the daylight hours. Only those samples taken near dawn will measure the maximum net impact of algal decay on the oxygen resources of the stream. Quantitatively, it is not known if the net 24 hour impact of photosynthesis and decay is positive or negative. Therefore, it was assumed in this study to be self-canceling.

The benthic oxygen demand is highly variable, since it reflects the accumulation of both natural organic debris (such as leaves in the Fall), organic settleable solids discharged from point wastewater sources, and the naturally developed sediment load from nonpoint sources. The cumulative impact of these considerations is further reduced to the intangible by storm frequency and intensity as well as stream velocity.

For the purposes of the modeling effort, it was assumed that both of the dischargers were achieving a minimum of secondary treatment equivalency with no settleable solids in their effluent. It was further assumed that the seven consecutive day, ten year low flow regime would precede the fall season and its attendant leaf litter in the streams. These assumptions allowed the use of a zero or insignificant benthic demand in all modeling runs.

B.5 REACTION COEFFICIENTS

B.5.1 Reaeration Coefficient (K_2)

The escape coefficient concept established by Tsivoglou and his co-workers is gaining wide acceptance in stream modeling work for a definition of the reaeration coefficient. The reported relationship is of the form:

$$K_2 = C \frac{\Delta h}{t} \text{ (base e, days}^{-1}\text{)}$$

where: C = escape coefficient, ft.$^{-1}$
Δh = change in stream bed height, ft.
t = time of travel, days.

Historic convention had been to use a constant C of 0.05 throughout the entire flow range with an upward adjustment for clean streams (up to 0.07) and a downward adjustment for grossly polluted streams (down to 0.02). However, a later publication by Tsivoglou and Neal[1] has further refined this relationship to reflect changing values of C with stream flow. This study recommends using an escape coefficient (at 20°C) of 0.05 when stream flows are in excess of 25 cfs. This value was used in all simulation runs.

(1) Tsivoglou, E.C., and Neal, L.A., Tracer Measurement of Stream Reaeration - III. Predicting the Reaeration Capacity of Inland Streams, 48th Annual WPCF Conference, Miami Beach, Florida (1975).

In this modeling effort, the Δh value was established using 7.5 minute USGS quadrangles and establishing a representative stream slope through a measured distance and reported contour lines. The change in elevation was then calculated from the slope over the stream reach. Slope on the Scioto from Columbus to Circleville is fairly uniform, with values ranging from 2.1 to 2.3 feet per mile.

B.5.2 Carbonaceous and Nitrogenous Decay Coefficients (K_1 and K_3)

The establishment of correct K_1 and K_3 inputs for mathematical characterization of a receiving stream is one of the most controversial aspects of river modeling and waste load allocation. Most historic modeling efforts have incorporated K_1 and K_3 rates corresponding to those observed in a standard laboratory BOD determination. Studies by Havens and Emerson[1][2] incorporating field derived K rates have indicated that laboratory values may significantly underquantify actual instream deoxygenation characteristics due to the static nature of the BOD test itself. The rates characterized as "high" in the following analyses represent a composite of those measured by Havens and Emerson in streams carrying elevated concentrations of oxygen demanding materials. These rates, as shown below, are adjusted as a function of velocity in a very rough approximation of the in-situ measurements. (It is probable that they truly vary as a function of both stream depth and velocity, i.e., a total mixing function.)

Velocity (fps)	K_1 ($days^{-1}$, base e, 20°C)	K_3 20°C
<0.6	0.6	0.3
>1.0	6.0	3.0
> 0.6 to 1.0	straight line transition	

(1) Water Quality Assessment and Basin Modeling - Rocky River and Tinkers Creek, prepared for the Three Rivers Watershed District by Havens and Emerson, Ltd. (1974).

(2) Water Quality Assessment and Low Flow Analysis - Muskingum Watershed, prepared for the Ohio EPA by Havens and Emerson, Ltd. (1976).

The critical velocities are those where instream settling ($\leq$0.6 fps) and instream scour ($\geq$1.0) are believed to dominate.

Laboratory rates are, generally speaking, approximately an order of magnitude less than the corresponding field rates found in the above referenced studies. As a general rule, it can be safely stated that a laboratory rate will be the lower limit of field rates experienced under any stream condition[1]. Accordingly, modeling runs were conducted at rates one tenth and one-half the above tabulated values in order to "envelope" probable stream conditions and to demonstrate model rate sensitivity. Rate coefficients of one half of the above tabulated values are considered to be the most probable for the river under the design conditions.

B.6 REACTION RATE ATTENUATION

B.6.1 Dissolved Oxygen

The dissolved oxygen model is only intended to characterize the stream's reaction under aerobic conditions. In recognition of this situation and the fact that aerobic organism activity will become attenuated under low dissolved oxygen conditions, it was necessary to reduce the deoxygenation coefficients associated with carbonaceous and nitrogenous stabilization. A review of several readily available references[1][2][3] indicated that carbonaceous stabilization rates begin to slow at dissolved oxygen levels on the order of 0.5 mg/l. Similarly, nitrogenous or nitrification rates begin to slow at a dissolved oxygen concentration of about 1.5 mg/l.

(1) "DO Workshop," Federal EPA sponsored Symposium: Rate Constants for Surface Water Modeling, San Fransico, California, April, 1977.

(2) Eckenfelder, W.W., and O'Connor, D.J., Biological Waste Treatment, Pergamon Press, New York, N.Y. (1961).

(3) Process Design Manual for Nitrogen Control, U.S. EPA Technology Transfer (1975).

(4) Hopwood, A.P., and Downing, A.L., Factors Affecting the Rate of Production and Properties of Activated Sludge in Plants Treating Dometic Sewage, Institute OF Sewage Purification, 5, 3 (1961).

Figure B-1 shows the rate attenuation employed in the water quality model. The model utilizes the calculated dissolved oxygen at the end of each subreach (each reach is divided into ten equal subreaches) to set the appropriate attenuation factor, if applicable, for K_1 and K_3 in the subsequent subreach.

This adjustment alone would make the dissolved oxygen model limited to aerobic waste stabilization. The predicted rate shutdown upon calculation of zero dissolved oxygen means that the oxygen demanding load will now start to accumulate as new downstream loads are introduced into the stream. Since this load accumulation will act to further suppress modeled stream recovery, any predicted recovery can be totally eliminated when the input is large. In recognition of this fact, a further refinement of the model incorporated a velocity dependent anaerobic decay function of the carbonaceous load when extremely low (< 0.1 mg/l) levels of dissolved oxygen are anticipated. Figure B-2 provides a comparison of this anaerobic adjustment with the usual aerobic equation.

B.6.2 Background Carbonaceous Load

A background carbonaceous load attenuation consideration is based upon the observation that some fraction of the ultimate carbonaceous load (L_o) is not readily biodegradable, and thus is stabilized at a much lower rate. The computer handles this by using a reaction rate one-hundredth of the normal value when a preset background ultimate carbonaceous load is calculated at the end of each subreach. A background L_o of 3 mg/l was utilized in all modeling runs.

B.7 VELOCITY CHARACTERIZATION

Many models of streams start with Manning's equation for velocity of liquids in open channels:

$$V = \frac{1.5}{N} R^{2/3} S^{1/2}$$

where N = Mannings n
R = hydraulic radius, ft.
S = slope, ft./ft.

Figure B-1
Attenuation Factors
for K_1 and K_3

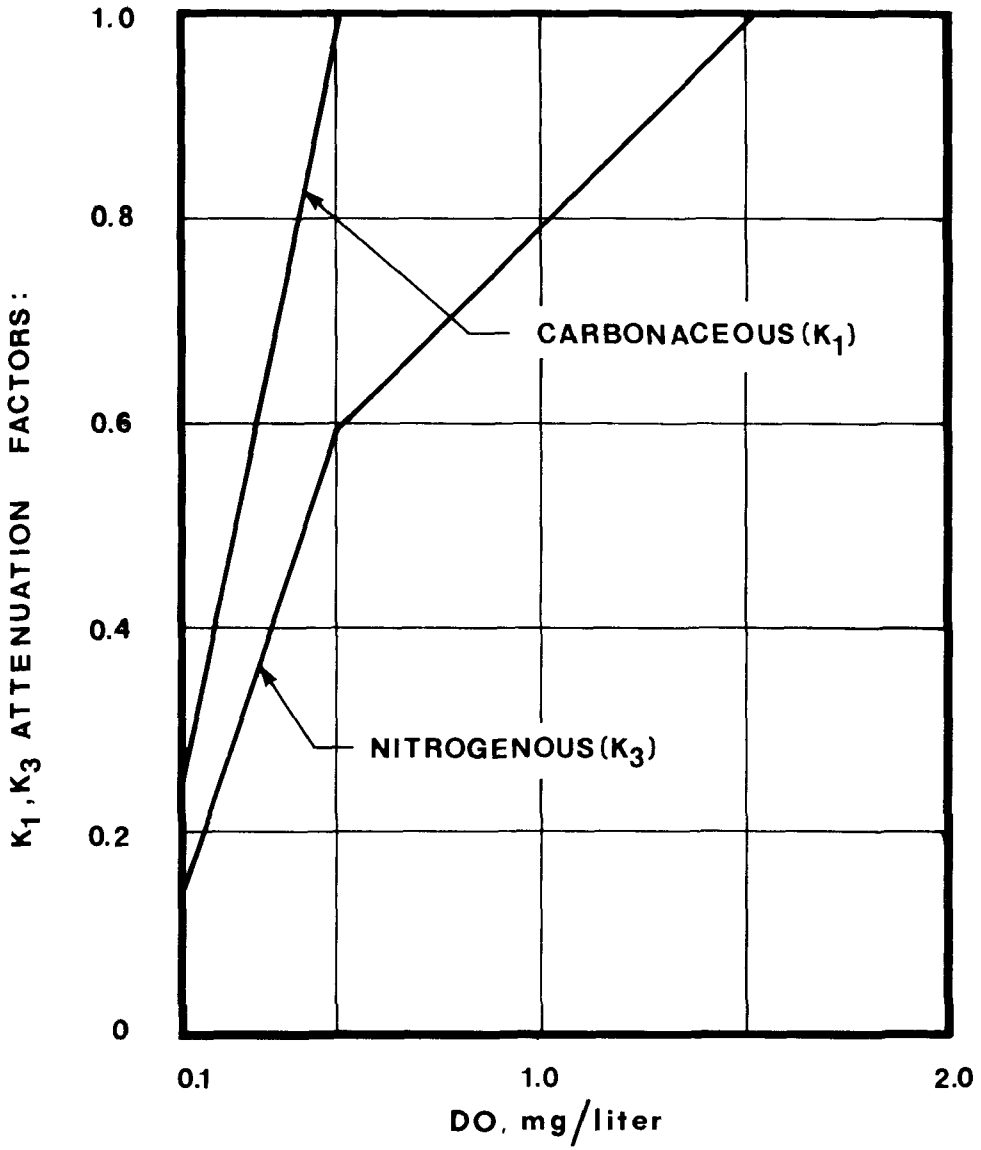


Figure B-2
Anaerobic K_1 Velocity Adjustments

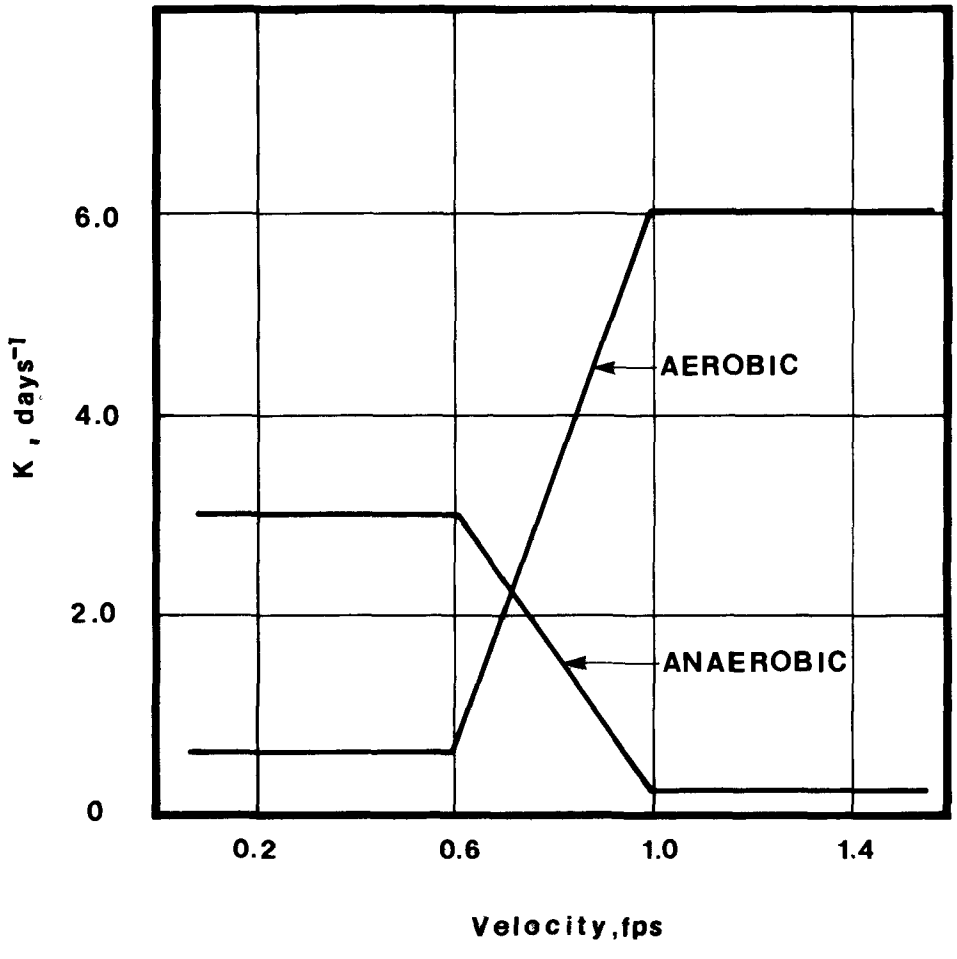
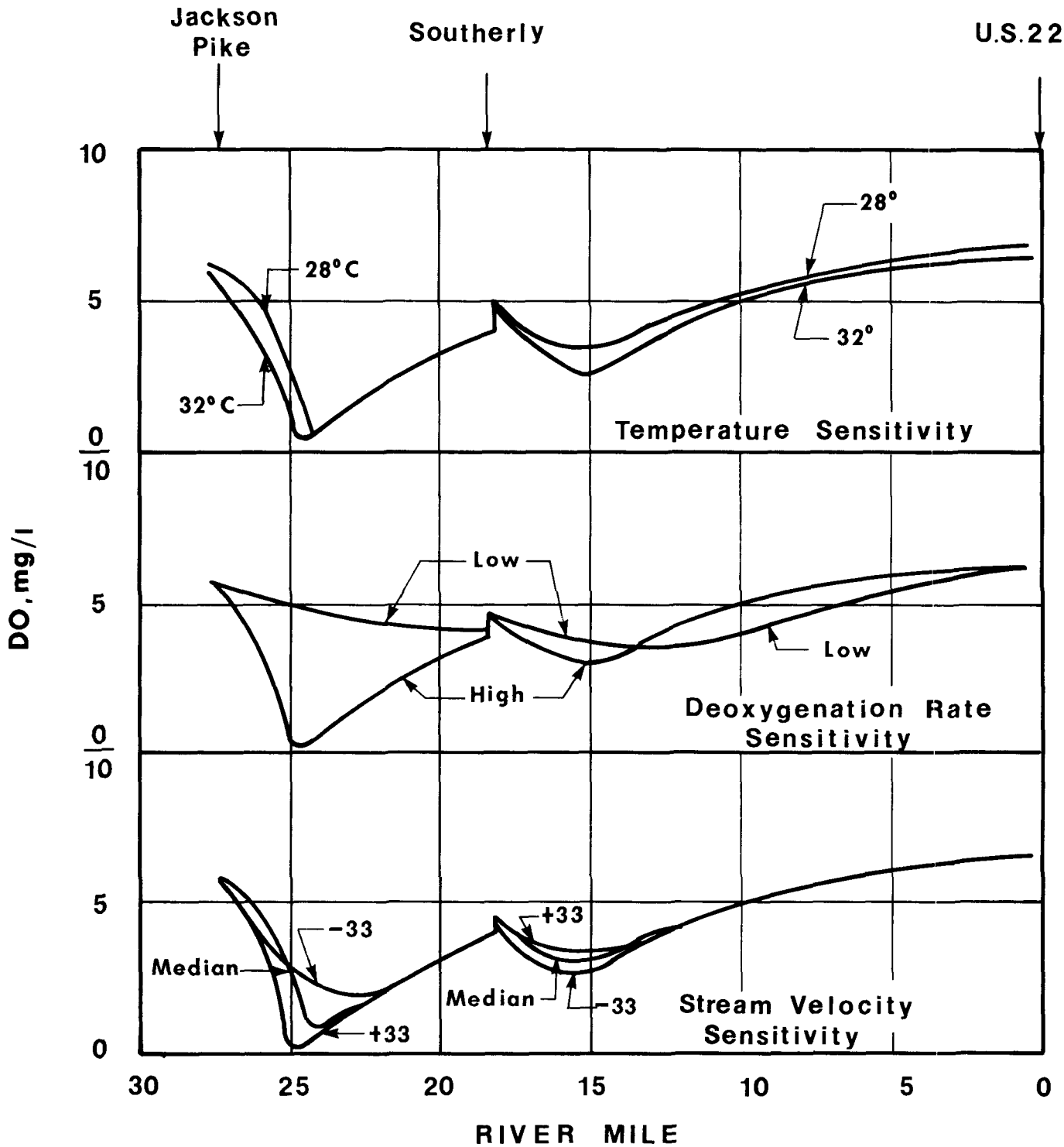


Figure B-3
Model Sensitivity at Summer NPDES Release Levels: DO = 6 mg/l ; L_o = 12 mg/l ; N_o = 10 mg/l



This equation can be solved by trial and error in the computer for a satisfying depth and velocity with a known flow. The major difficulty of using this technique is that it is dependent upon correct Manning's n and stream width assumptions for the flow regime under consideration. Since the detailed measurements and observations necessary to properly define these parameters were not possible in this study, it was thought to be preferable to attempt to define only the stream velocity of the Scioto River in the modeled segments. Characterization of the velocity bypasses intermediate estimates of physical parameters associated with a stream, since velocity is the result of a given physical stream reach experiencing a given flow at a calculated slope. Several methods were employed to estimate reasonable instream velocities for this study.

The first technique employed for velocity estimation was a statistical correlation of stage discharge relationships provided by the United States Geological Survey for gaging stations within the study area. Equations of the form $y = aQ^b$ can be developed from this data, with y equal to velocity, width, or depth such that the expression for hydraulic continuity ($Q = VA$) is satisfied. Data obtained in this manner in the study area is, to a large extent, site specific, since many stations experience upstream flow regulation; a phenomena which precludes the application of coefficients and exponents derived to other stream points which are similar physically but nonregulated.

Only three stations on the Scioto were within the modeled portion of the River: the USGS gage at Columbus (RM 27.0), a point between Shadeville and Southerly (RM 16.5), and at U.S. Route 22 in Circleville (RM 0.0). Coefficients relating stream flow to velocity at these points are 0.381, 0.009, and 0.055, respectively. Exponents on flow were found to be 0.232, 0.646, and 0.379, respectively.

Estimates of stream velocities in the Scioto River have also been made by the Ohio Environmental Protection Agency as a part of their 303e waste load allocation responsibilities. Values were obtained through a mathematical technique which adjusted a measured set of cross sectional data to predicted low flow cross sections and their attendant stream velocities.

Cross sectional measurements were also taken by consultants to the State of Ohio in 1962 as a part of a flood plain study for the Columbus area. Using the mean daily flow at the USGS Scioto River at Columbus gage on the dates of each measurement, a rough approximation to the stream velocity can be made. Table B-1 lists both the Ohio EPA and the 1962 velocity estimates as a function of Scioto River mile along with the predicted velocity at stream points where the coefficient and exponent method is applicable. The flow input for the treatment plants under the OEPA and gaged approximations cause overall flow in the stream to be near that noted in 1962, which was at somewhat higher background values with a lower plant input.

Table B-1 reveals a consistent velocity trend - a relatively slow stretch below Jackson Pike after which the River speeds up and gradually tapers off to a fairly steady velocity. A visual survey of USGS maps and the Scioto itself indicated likely points for these general velocity regimes to exert themselves due to either natural or artificial considerations acting upon channel geometry and side conditions. Again, in an effort to envelope actual future conditions, model sensitivity runs were conducted at velocities ±33 percent of the predicted values.

B.8 FLOW INPUTS

Effluent flows from the two Columbus wastewater treatment facilities were assigned the (1995) dry weather values attributed to them in the Environmental Assessment of the Columbus Metropolitan Area Facilities Plan. Jackson Pike was modeled at 100 million gallons per day (mgd), while Southerly was modeled at 85 mgd. Other present wastewater releases in the planning area were not modeled, since they will most likely be contributory to one of the larger plants by the design year. The proposed Delaware County plant on the Olentangy River is the exception to this, and is assumed to contribute its design flow to the stream above the study area. Cooling releases to the Scioto River are assumed to be an intake and once through arrangement, with no net stream flow addition or subtraction.

Background stream flows are unusually hard to define for the study area due to the regulated nature of many of the streams. The Scioto River is especially affected by regulation and withdrawals for water supply.

Table B-1
Predicted Velocity Comparison

River Mile	Velocity, fps		
	OEPA	X-SECT	GAGE
26.8	0.24	0.47	0.74
25.4	0.24	1.36	
24.0	0.80	0.49	
23.7	1.14		
23.2	1.14	0.33	
22.9	0.52		
21.6	0.52	0.59	
19.9	0.52	0.50	
18.5	0.34	0.34	
17.4	0.34	0.39	
17.1	0.36	-	
16.5	0.36	-	0.38
15.1	0.23	0.22	

River Mile	Velocity, fps		
	OEPA	X-SECT	GAGE
13.7	0.26	0.19	
12.5	0.26	0.50	
11.2	0.26	0.34	
9.4	0.26	0.12	
8.4	0.26	0.35	
7.3	0.19	0.23	
6.3	0.22	0.19	
4.5	0.22	0.47	
3.1	0.22	0.31	
2.3	0.22	0.10	
1.5	0.21	-	
1.0	0.23	-	
0.0	0.24	-	0.50

At least three low flow regimes on the Scioto below Columbus are possible and can be supported by some form of documentation. One flow assumption would be that the Scioto River above the Olentangy actually goes dry due to the withdrawals experienced, and that the Olentangy flows are those dictated by the low flow release schedule from the Corps of Engineers dam at Delaware Lake, as follows:

Period	Discharge, cfs
July 1-10	10
July 11-20	25
July 21-31	35
August 1-20	40
August 21-31	35
Sept. 1-Oct. 31	20
Minimum Release	5

Communications with the USGS have indicated that a flow regime which incorporates the minimum release from Delaware Lake in conjunction with a zero flow in the Scioto above the Olentangy is in fact far more severe statistically than the usually modeled low flow that persists for 7 days with a ten year recurrence (7-10)[1].

Another possible low flow regime is that which was used by the OEPA in arriving at their waste load allocations for the Columbus treatment facilities. This value, 18.2 cfs, attempted to strike a balance between the minimum permissible reservoir release and the normal low flow discharge schedule.

The USGS also maintains a computerized file for each of their stream gaging stations which will permit the calculation of a 7-10 (or any other statistically significant) flow. Since upstream regulation was instituted, the 7-10 flow reported to exist just above the Jackson Pike facility is 122 cfs. This value seems to be the best documented of the three possibilities, and was used in all allocation activities.

Flows from streams tributary to the Scioto were input on the basis of a USGS - specified 7-10 low flow or on a cfs/square mile transfer of those flows to similar streams on a direct drainage area ratio basis.

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(1) Personal Communication, Richard Swisshelm, Ohio District, USGS.

Wintertime flows were arrived at by analyzing seven consecutive day cold weather low flows which have actually been recorded at the Scioto River at Columbus USGS gage over the past ten years. A value of 222 cfs, which was observed in January, 1971, was selected as representative of a low wintertime flow regime. This is not to be confused with a cold weather statistically correct 7-10 low flow - it is merely intended to provide an approximation to such a value.

Table B-2 provides a summary of significant inputs to the stream model in terms of river mile. The velocities tabulated are those at the median field conditions.

B.9 WASTE LOAD ALLOCATION

National Pollutant Discharge Elimination System (NPDES) permits have been issued to both of the Columbus wastewater treatment plants. Limitations significant to a simplified stream modeling effort are those on dissolved oxygen (6.0 mg/l average), BOD_5 (8 mg/l monthly average), and NH_3-N (1.0 mg/l summer and 2.5 mg/l winter monthly averages). These values correspond to the Ohio EPA definition of BACTEA (Best Available Control Technology Economically Achievable). Since DOSAG operates on the basis of ultimate BOD (L_O) and ultimate nitrogenous demand (N_O), an adjustment to the NPDES permit values was required. In accordance with past Ohio EPA practice, L_O was defined as 1.5 x BOD_5 and N_O as 4.0 x NH_3-N. These release levels, along with an effluent DO of 6.0 mg/l, were used as a starting point for all model runs.

Table B-3 provides a summary of stream response to effluent loadings from Jackson Pike and Southerly at NPDES permit release levels. Model sensitivity to stream velocity, deoxygenation coefficients, and stream temperature is tabulated; as is the seasonal variation in the stream response to the applied load.

Figure B-3 provides a visual representation of the DO profile in the Scioto River for the various sensitivity runs under summer conditions. Two striking results are indicated by the Figure. The first of these regards the "tightness", or lack of significant variation, exhibited by the DO profiles under the temperature and velocity sensitivity runs. Such a phenomena indicates that many of the uncertainties associated with the prediction of these parameters are relatively insignificant. Even the parameter which showed

Table B-2
Model Input Summary

Input	River Mile	Q(1) cfs	ΔH Ft.	Velocity fps
Scioto River	26.8	122/221		
Jackson Pike WWTP	26.8	155		
			1.29	0.3
Kian Run	26.2	0.1/0.2		
			4.30	1.0
Scioto Big Run	24.2	0.3/0.5		
			2.80	1.0
Republican Run	22.9	0.4/0.7		
			3.01	0.5
Grant Run	21.5	0.4/0.7		
			6.45	0.5
Plum Run	18.5	0.2/0.4		
			0.46	0.5
Southerly WWTP	18.3	132		
			2.76	0.3
Big Walnut Creek	17.1	16/29		
			1.84	0.3
C & SO Electric	16.3	-		
			6.90	0.3
Peters Run	13.3	0.3/0.5		
			3.70	0.3

Table B-2 Continued
Model Input Summary

Input	River Mile	Q(1) cfs	ΔH Ft.	Velocity fps
Grove Run	11.7	0.2/0.4	0.69	0.3
Tributary	11.4	0.1/0.2	4.37	0.3
Tributary	9.5	0.1/0.2	2.30	0.3
Tributary	8.5	0.1/0.2	2.53	0.3
Van Meter Run	7.4	0.1/0.2	2.76	0.3
Walnut Creek	6.2	2.7/4.9	1.38	0.3
Tributary	5.6	0.1/0.2	1.84	0.3
Tributary	4.8	0.1/0.2	3.68	0.3
Dry Run	3.2	0.2/0.4	5.06	0.3
Big Darby Creek	1.0	5.3/9.6	1.61	0.3

Table B-2 Continued
Model Input Summary

Input	River Mile	Q(1) cfs	ΔH Ft.	Velocity fps
Hargus Creek	0.3	0.2/0.4	0.69	0.3

(1) Summer/Winter

Table B-3

Stream Summary at
NPDES Release Levels (1)

Season	Temp °C	K_1, K_3 Rates	Velocity % of Median	Minimum DO below: Jackson Pike mg/l	Jackson Pike Miles (3)	Southerly mg/l	Southerly Miles (3)	DO at US 22 mg/l
Summer	32	High	100	0.3	2.2	3.2	3.2	6.5
			133	0.7	2.7	3.5	4.1	6.5
			67	1.8	3.9	2.5	2.3	6.5
		Low	100	4.3	8.3	3.6	5.3	6.2
			133	4.6	9.7	4.0	6.9	6.1
			67	3.7	8.3	2.8	4.4	6.4
	28	High	100	0.6	2.6	3.5	4.3	6.8
			133	1.1	3.1	3.9	4.1	6.8
			67	2.4	4.5	2.8	2.6	6.8
		Low	100	4.8	8.0	4.1	5.8	6.4
			133	5.1	8.3	4.5	7.0	6.1
			67	4.3	8.3	3.3	5.0	6.6

Table B-3 Continued

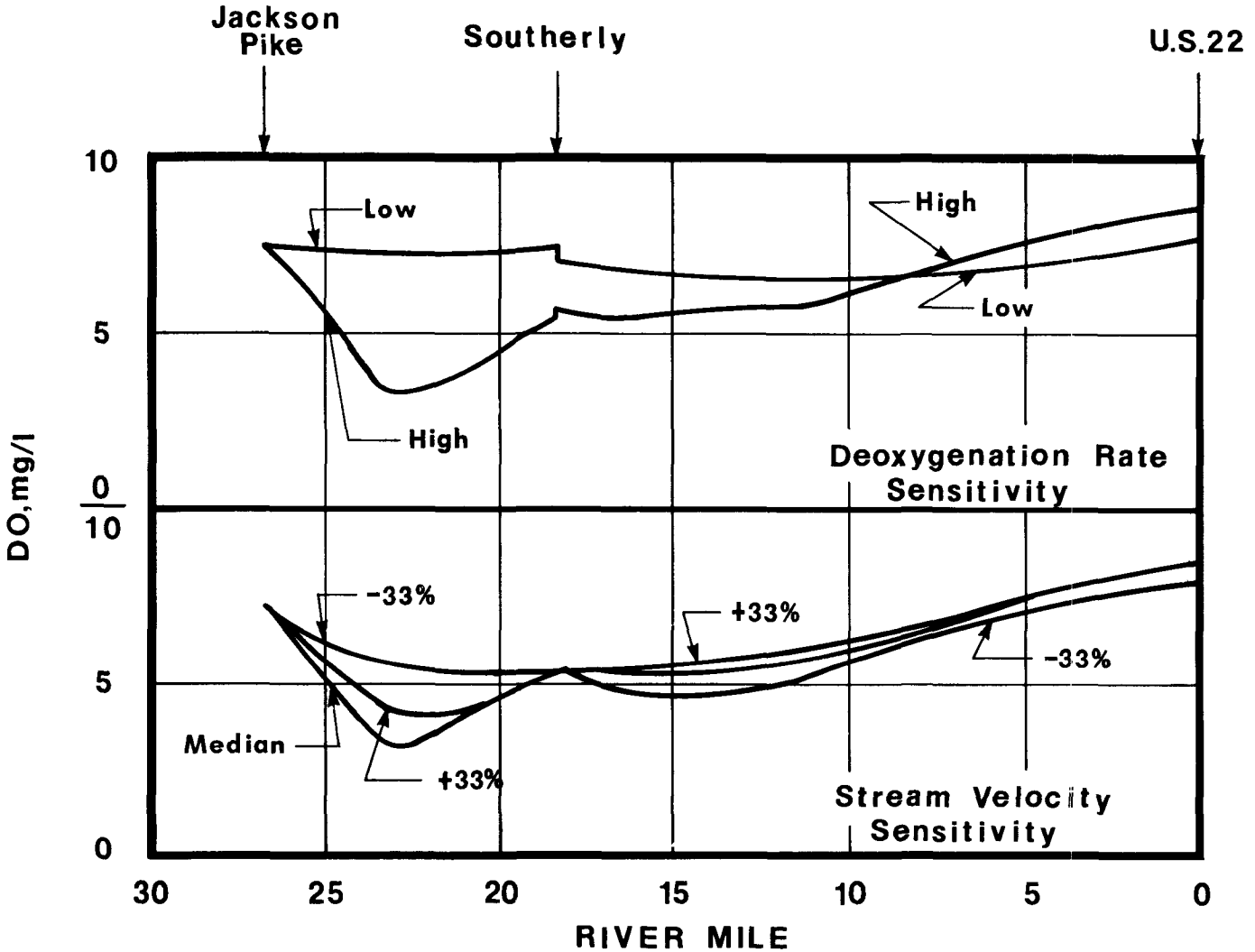
Stream Summary at
NPDES Release Levels (1)

Season	Temp °C	K_1, K_3 Rates	Velocity % of Median	Minimum DO below: Jackson Pike mg/l	Jackson Pike Miles (3)	Southerly mg/l	Southerly Miles (3)	DO at US 22 mg/l
Winter	12	High	100	3.4	4.0	5.4	1.2	8.4
			133	4.2	3.9	5.4	Mix	8.4
			67	5.6	6.5	4.7	5.2	8.1
		Low	100	7.4	0.6	6.7	6.6	7.3
			133	7.5	0.6	7.2	5.0	7.7
			67	7.1	8.5	6.7	6.6	7.3

(1) DO=6 mg/l; L_O=12 mg/l; N_O=4 mg/l summer, 10 mg/l winter Q=100 mgd at Jackson Pike
Q=85 mgd at Southerly

(2) Miles below Jackson Pike (Mile 26.8)
Miles below Southerly (Mile 18.3)

Figure B-4
Model Sensitivity at Winter
NPDES Release Levels: DO = 6 mg/l ;
L_o = 12 mg/l ; N_o = 10 mg/l



the greatest sensitivity, deoxygenation rates, produces a summer minimum DO below both treatment facilities which is still less than the 5.0 mg/l water quality standard at both modeled levels.

The second consistent output from all modeled runs at summer NPDES release levels is the small variation of stream DO at the end of each run at US 22 in Circleville (6.1 mg/l - 6.6 mg/l). Since Circleville is the next significant discharger of wastewater in the Scioto River basin, such a reduced upstream DO and instream pollutant load (in relation to current conditions) will allow allocation requirements at this facility to be established without regard to stream sag problems caused by the Columbus releases.

Overall, the output obtained for summer conditions would indicate that the decision is proper to require the Columbus facilities to upgrade to their final NPDES levels rather than to levels which are predicted to maintain present water quality standards. Despite probable continued dissolved oxygen violations below each release, conditions in the Scioto will improve immensely. Evidence has indicated a slowing of deoxygenation rates in streams that undergo substantial load reductions - a fact which points to the need for detailed observation and sampling of improved stream conditions before passing judgment on any water quality maintenance release levels.

Winter stream response upon receipt of NPDES allowable loads were modeled to determine the impact of the higher nitrogen releases allowed under nitrogenous stabilization rate limiting conditions resulting from colder temperatures. Again, as shown in Figure B-4, violations or near violations of instream DO levels were shown on four of the five sensitivity runs. Only the "low" deoxygenation rate condition allowed the stream to carry the release loads without noticeable impact. Instream oxygen levels at Circleville are again uniformly high under all modeled winter conditions (7.3-8.4 mg/l).

Although the decision to require the present NPDES release levels from the Columbus plants appears to be sound, some indication of probable allocations to achieve water quality standards is also in order. Table B-4 presents the allocated values for the various sensitivity runs in both summer and winter for the Jackson Pike facility. Table B-5 provides the same information for Southerly.

Table B-4
Jackson Pike WWTP
Waste Load Allocation Summary
(Effluent Flow = 100 mgd)

Season	Temp °C	K1, K3 Rates	Velocity	Effluent					Instream		
				DO	L_O		N_O		N_O Max	Minimum DO	
			% of Median	mg/l	mg/l	lb/day	mg/l	lb/day	mg/l	mg/l	Miles (1)
Summer	32	High	100	6	4	3,340	0	0	0	4.9	1.0
			133	6	4	3,340	0	0	0	5.0	1.2
			67	6	4	3,340	0	0	0	4.8	1.6
		Low	100	6	4	3,340	4	3,340	2.2	5.1	11.1
			133	6	6	5,000	4	3,340	2.2	5.0	12.9
			67	6	4	3,340	4	3,340	2.2	5.1	5.2
	28	High	100	6	4	3,340	0	0	0	4.9	1.2
			133	6	4	3,340	0	0	0	5.0	4.6
			67	6	4	3,340	0	0	0	5.1	1.8
		Low	100	6	6	5,000	4	3,340	2.2	5.1	14.6
			133	6	6	5,000	4	3,340	2.2	5.0	15.5
			67	6	4	3,340	4	3,340	2.2	5.2	10.5
Winter	12	High	100	8.8	9	7,510	10	8,340	4.1	4.9	3.6
			133	8.8	12	10,010	10	8,340	4.1	5.0	3.9
			67	8.8	9	7,510	10	8,340	4.1	5.1	13.2
		Low	100	8.8	12	1,010	24	2,020	9.9	5.2	18.7
			133	8.8	18	15,010	28	23,350	11.5	5.1	19.4
			67	8.8	12	1,010	14	11,680	5.8	5.6	18.7

(1) From release point at River Mile 26.8

Summertime modeling runs for Jackson Pike indicate the high degree of treatment required at this facility under all conditions. Releases of nitrogenous oxygen demand are reduced to zero under all but the least stringent (10%) rate condition. Such an effluent limitiation would require substantial additional processes at the facility, such as a breakpoint chlorination and dechlorination capability. Equally significant costs would be involved in reducing the carbonaceous load to the levels tabulated, which approach background stream concentrations.

Winter conditions at Jackson Pike indicate that it is possible to release levels of nitrogenous demand equal to or greater than that specified by the cold weather permit requirement in all runs. Carbonaceous levels are more variable, with two runs indicating the need for more stringent control than the NPDES limits, and one allowing release up to a secondary treatment equivalency. Differences in allowalbe DO release levels tabulated are intended to take advantage of higher oxygen solubility at lower temperatures, with effluent DO values of 6.0 mg/l indicating no need for post-aeration at the plant.

Summertime allocations for the Southerly treatment facility (Table B-5) are less stringent than those for Jackson Pike under all modeled conditions. Nitrogenous releases are never required to be less than permit values, while carbonaceous levels vary form 6 to 12 mg/l for eight of the ten conditions investigated.

Winter conditions allow nitrogenous releases to increase substantially from Southerly, with two of the five modeled runs limited by instream ammonia toxicity rather than oxygen demand and sag. Instream nitrogen levels were assumed to be toxic in accordance with the 1972 EPA Water Quality Criteria which sets an upper limit for un-ionized ammonia of 0.02 mg/l. The total ammonia exhibiting this un-ionized fraction will vary depending upon temperature and pH coditions. If one assumes a wintertime pH of 7.5 and a stream temperature of 12^{o}C, toxic conditions will exist when the total nitrogen demand exceeds 14 mg/l. Carbonaceous winter allocations are always equal to or less stringent than NPDES requirements, with reduced deoxygenation rates again allowing higher release levels.

Table B-5
Southerly WWTP
Waste Load Allocation Summary
(Effluent Flow = 85 mgd)

Season	Temp °C	K_1, K_3 Rates	Velocity	Effluent					Instream		
				DO	L_o		N_o		No Max	Minimum DO	
			% of Median	mg/l	mg/l	lb/day	mg/l	lb/day	mg/l	mg/l	Miles(1)
Summer	32	High	100	6	9	6,380	4	2,840	1.3	4.9	2.3
			133	6	9	6,380	4	2,840	1.3	5.1	2.9
			67	6	6	4,250	4	2,840	1.7	5.3	2.0
		Low	100	6	6	4,250	4	2,840	2.1	5.1	2.6
			133	6	6	4,250	4	2,840	2.2	5.0	4.4
			67	6	6	4,250	4	2,840	2.0	4.9	1.8
	28	High	100	6	9	6,380	4	2,840	1.3	5.1	2.9
			133	6	12	8,510	4	2,840	1.3	4.9	5.4
			67	6	6	4,250	4	2,840	1.3	4.9	1.8
		Low	100	6	6	4,250	4	2,840	2.2	5.1	4.1
			133	6	12	8,510	4	2,840	2.3	5.0	7.0
			67	6	6	4,250	4	2,840	2.1	5.2	2.0
Winter	12	High	100	6	12	8,510	36	25,520	10.9	5.1	6.6
			133	6	12	8,510	48	34,030	14.0(2)	5.0	7.5
			67	8.8	12	8,510	24	17,010	8.2	5.1	4.7
		Low	100	6	12	8,510	24	17,010	12.0	5.2	9.8
			133	6	18	12,760	28	19,850	14.3(2)	5.1	10.9
			67	8.8	12	8,510	14	9,920	6.0	5.6	9.8

(1) From release point at River Mile 18.3
(2) Toxicity Limited.

A few modeling runs, which are not tabulated, were also done to see whether or not it would be advantageous to treat a portion (50%) of the Jackson Pike flow at Southerly. Results consistently indicated little, if any change, in release requirements at Jackson Pike, while forcing Southerly to obtain more stringent effluent levels due to the combination of higher process flow and lower upstream dilution. It was concluded that such a treatment and release scheme would offer no overall benefits in terms of either environmental quality or cost savings.

The results of the modeling indicate that the following release levels are appropriate for maintenance of stream quality below the Columbus wastewater releases:

Table B-6
Required Release Levels (mg/l)

	DO	L_o	N_o
Summer:			
Jackson Pike	6.0	4	0
Southerly	6.0	9	4
Winter:			
Jackson Pike	8.8	12	14
Southerly	6.0	30	40

Facilities design activities summarized elsewhere in this Impact Statement were predicated on these effluent levels. *

B.10 HIGHER FLOW STUDIES

Although the design of the wastewater treatment facilities is such that the Table B-6 release levels will be maintained, it was considered desirable to determine what performance would be allowable while still maintaining stream standards under flow regimes higher than critical low flow. Accordingly, modeling runs were conducted at stream flows observed over the last ten years which represent low summer and winter month average flows.

The average of September and October Scioto River at Columbus USGS gage readings during this period was 379 cfs, while January and February flows averaged 2,640 cfs. Winter and summer temperatures were input at 28°C and 10°C, respectively. Stream velocities were adjusted by using the coefficient and exponent method at points of USGS gaging, as described earlier.

As shown in Table B-7, little change in carbonaceous load allocations at Jackson Pike is possible for summer conditions. An increase in flow up to the maximum monthly average observed in the last ten years is required to even allow the Jackson Pike facility to release at levels equal to or less stringent than those in the NPDES permit. Release levels at Southerly show little dependency on the summertime upstream flow. The ultimate nitrogen release permissible is the same at both modeled flows (28 mg/l), with toxicity considerations dominating at the average monthly upstream condition and oxygen sag the determining factor at maximum average monthly flow.

Winter conditions, also summarized in Table B-7, demonstrate the considerable factor of safety that would be involved in maintaining water quality below each plant. Results indicate that even temporary upset of the advanced treatment processes with effluent degradation to secondary equivalency levels will not cause a predicted downstream contravention of either dissolved oxygen or toxicity standards.

Table B-7
Discharger Load Allocation at Flows Above Critical

Facility	Season	Gage Flow cfs	DO mg/l	L_O (1) mg/l	N_O (1) mg/l
Jackson Pike	Summer	379 (2)	6.0	4-12	4-12
(River Mile 28.6)	Summer	1,313 (3)	6.0	12-18	4-12
	Winter	2,640 (4)	6.0	45	80
Southerly	Summer	379 (2)	6.0	12-24	$\leq$28 (5)
(River Mile 18.3)	Summer	1,313 (3)	6.0	$\leq$24	$\leq$28
	Winter	2,640 (4)	6.0	45	80

(1) Ranges indicates results with both "high" and "low" deoxygenation rates.
(2) Average September and October Stream Flow at Jackson Pike.
(3) Maximum Average September and October Stream Flow above Jackson Pike.
(4) Average January and February Stream Flow above Jackson Pike.
(5) Toxicity Limited.

APPENDIX C

WATER QUALITY DATA

Table C-1
Water Quality Standards[1]
(Maximum contaminant levels except where noted)

Parameter	Stream		
	General Stream Standard		Within 500 Yards of any public water supply
	Warm Water	Cold Water	
BACTERIOLOGICAL			
Fecal Coliform - No./100 ml			
Geometric Mean	200		
Maximum 90% less than	400		
MISCELLANEOUS			
pH - Units (1)			
Maximum	9		
Minimum	≥6	≥6.5	
Threshold Odor No.	24 at 40°C		
Radioactivity - picocuries / l			
Combined radium - 226 and radium - 228	-		
Alpha Emitters	3		
Gross Beta Activity	100		
Strontium 90	10		
Tritium	-		
96 Hour Median Tolerance Limit	0.1 for any indigenous aquatic species		
Turbidity - JTU			

(1) Deviations are allowed if associated with natural causes.

1 These standards have been superceded by new water quality standards adopted by the State (Ohio Administrative Code Regulations 3745-1 through 3745-1-14, formerly EP-1-01 through EP-1-09, recodified January 31, 1977; Amended December 30, 1977; Effective February 14, 1978).

Table C-1
Water Quality Standards - Continued
(Maximum contaminant levels except where noted)

Parameter	Stream		
	General Stream Standard		Within 500 Yards of any public water supply
	Warm Water	Cold Water	
MISCELLANEOUS - CONTINUED			
Temperature Maximum change above background conditions	5°F (2.8°C) Not to exceed the following: Jan,Feb-50°F(10.0°C) Mar -60°F(15.6°C) Apr,Nov-70°F(21.1°C) May -80°F(26.7°C) Jun,Jul-90°F(32.2°C) Aug,Sept Oct -78°F(25.6°C) Dec -57°F(13.9°C)		
Other	Freedom from substances associated with human activities which result in sludge deposits, floating materials, color, turbidity or any other nuisance conditions		
OTHER CONSTITUENTS - mg/l			
Ammonia (N)	1.5		
Arsenic	0.05		
Barium	0.8		
Cadmium	0.005		
Chloride	250		
Chromium	0.3		
Chromium (Hex)	0.05		0.01
Copper	See Zinc		
Cyanide	0.2		0.005
Free Cyanide	0.005		
Dissolved Oxygen			
Average	≥5	≥7(1)	
Minimum	≥4	≥6	

(1) In spawning areas.

Table C-1
Water Quality Standards - Continued
(Maximum contaminant levels except where noted)

Parameter	Stream		
	General Stream Standard		Within 500 yards of any public water supply
	Warm Water	Cold Water	
OTHER CONSTITUENTS - mg/l - CONTINUED			
Dissolved Solids May exceed one but not both	1500 and 150 due to human activities		500 monthly avg. 750 max. observation and 150 due to human activities (1)
Fluoride	1.3		
Foaming Agents (MBAS)	0.5		
Iron (dissolved)	1.0		0.3
Lead	0.04		
Manganese	1.0		0.05
Mercury	0.0005		
Nickel (Ni) (2)	See Zinc		
Nitrate (N)	8		8
Oil and Grease (Hexane soluble)	5		
Phenols	0.01		0.001
Selenium	0.005		
Silver	0.001		
Copper and Zinc (hardness as $CaCO_3$)	Hardness	Cu	Ni and Zn
	0-80	0.005	0.075
	80-160	0.01	0.1
	160-240	0.02	0.2
	240-320	0.05	0.4
	>320	0.075	0.5

(1) Also applies to any water supply intake.
(2) No standard presently in regulations, value listed suggested by Havens and Emerson, Limited.

Table C-1
Water Quality Standards - Continued
(Maximum contaminant levels except where noted)

Parameter	Warm Water Fishery	Cold Water Fishery
STREAM MIXING ZONES - SIZE LIMITATION		
Effective Width	0.5w	0.33w
Effective Vertical Cross-Sectional Area	0.33Av	0.20Av
Effective Downstream Extension	5w	5w
Effective Horizontal Area	12 acres	3 acres
Other	Shall Not Include: a) a drinking water supply, or b) spawning or nursery areas of any indigenous aquatic species, or Interdict: a) the migratory routes of any indigenous aquatic species	
STREAM MIXING ZONES - WATER QUALITY STANDARDS		
96-Hour TLM for any indigenous aquatic species	1	1
Allowable Temperature Change: May thru Oct. Nov. thru Apr.	$15^{o}F$ ($8.3^{o}C$) $23^{o}F$ ($12.8^{o}C$)	($5^{o}F$) ($2.8^{o}C$) ($23^{o}F$) ($12.8^{o}C$)

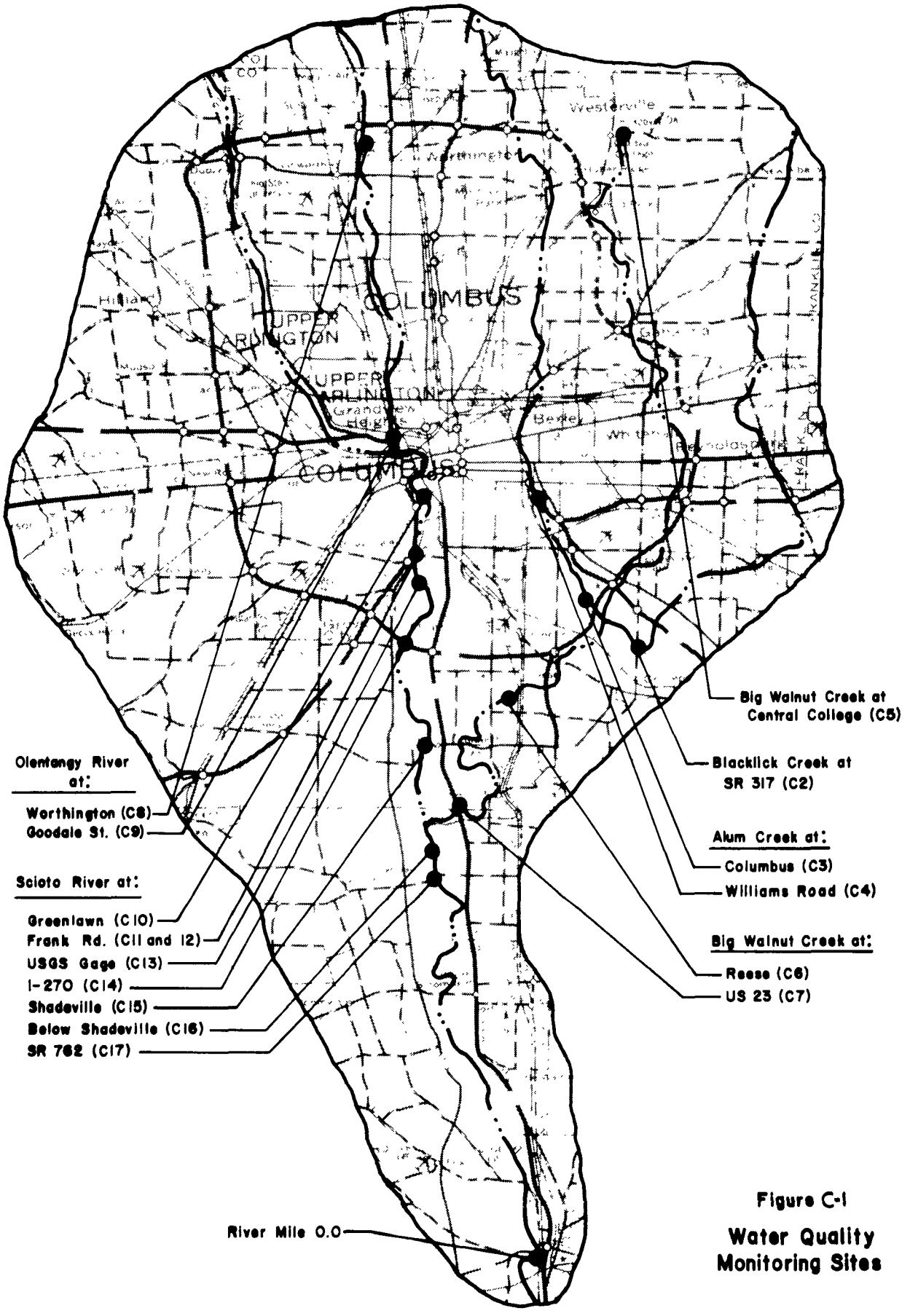


Figure C-1

Water Quality Monitoring Sites

Table C-2

Surface Water Quality
Blacklick Creek at SR 317 (RM 32.5)
(1974-1975)

Flow* cfs	Date	pH Units	Temp °C	DO mg/l	BOD_5 mg/l	SS mg/l	TDS mg/l	TKN mg/l	NH_3-N mg/l	P_{tot} mg/l	$P_{diss.}$ mg/l	Cl^- mg/l	F.Coli. No/100 ml
33	8/28/75	7.7	22.5	1.8	4.0	32	516	3.5	2.97	1.7			
46	7/24/75	7.8	25.0	2.4	2.6	16		3.6	2.97	1.92			220
49	7/23/74	7.6	21.0	4.8	8.4				2.92	1.5			
69	9/18/74	7.7	18.0	4.2	4.8	38			1.27	1.3	0.38	13	
86	6/ 8/75	7.8	12.5	3.3		24		1.8	1.8	1.23			
108	5/14/75	7.7	15.0	3.4	5.8	10		1.4	0.99	1.05			4900
154	6/20/74	7.6	19.5	3.6	5.6	23			1.03	1.2			
155	10/22/75	7.4	12.5	7.5	3.9	21	345	0.8	0.74	0.5			
175	5/29/74	7.8	17.0	4.1	8.6	198			1.26	1.2			
365	8/29/74	7.8	20.5	3.6	3.4	19			1.97	1.3			
582	4/29/75	7.9	11.5	9.8	4.6	25		0.4	0.34	0.31			
1465	3/29/75	7.5	6.0	10.5	3.8	86		0.4	0.24	0.1			
Median													
131		7.7	17.5	3.9	5.6	25		1.4	1.27	1.27	0.38	13	
High													
1465		7.9	25.0	10.5	8.4	198	516	3.6	2.97	1.92			4900
Low													
33		7.4	6.0	1.8	2.6	10	345	0.4	0.24	0.1			220

*Big Walnut Creek at Reese (RM 27.3)
Average Q = 508 cfs

Table C-3
Surface Water Quality
Alum Creek at Columbus (1) (RM 37.3)
(1970-1976)

Observations	Overall Summary			Quality vs. Flow								
	≤34			≤16			≤6			≤12		
Flow Range, cfs				0-40			40-100			100 +		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs	58	1,500	11	21	40	11	64	94	55	318	1,500	106
pH, Units	7.5	8.4	7.0	7.5	8.0	7.1	8.4	-	-	7.7	8.1	7.0
Temp., °C	18.0	25.0	0.0	18.5	25.0	1.0	-	19.0	0.0	7.5	22.5	2.0
DO, mg/l	7.0	12.1	5.5	6.6	9.1	5.5	-	-	-	12.1	-	-
BOD_5, mg/l	2.4	6.5	2.2	2.4	6.5	2.2	-	-	-	-	-	-
NH_3-N, mg/l	0.24	0.77	0.01	0.14	0.46	0.01	-	-	-	0.77	-	-
NO_2^--N, mg/l	0.01	0.04	0.0	0.02	0.04	0.0	-	-	-	0.03	0.01	0.0
NO_3^--N, mg/l	1.8	14.0	1.7	1.0	14.0	0.49	-	-	-	2.2	3.2	1.7
Ptot, mg/l	0.2	0.34	0.12	0.19	0.34	0.12	-	-	-	0.21	-	-
$SO_4^=$, mg/l	92	180	45	97	140	45	180	-	-	81	130	53
Cl-, mg/l	45	116	20	52	70	23	72	116	40	34	74	20

(1) Average Q = 168 cfs

Table C-4
Surface Water Quality
Alum Creek at Williams Road (RM 32.3)
(1970-1976)

Observations Flow Range, cfs	Overall Summary ≤25			Quality vs. Flow ≤11 0-40			≤6 40-100			≤8 100 +		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs*		2,000	9	20	40	9		82	49		2,000	108
pH, Units	7.7	8.6	6.9	7.6	8.6	6.9	7.8	8.2	7.7	7.7	7.8	7.6
Temp, °C	18.0	27.0	7.0	20.2	27.0	11.0	15.5	26.0	7.0	13.0	22.0	7.0
DO, mg/l	6.9	13.9	3.4	6.4	13.9	3.4	8.2	11.3	5.8	9.6	10.6	5.2
BOD_5, mg/l	2.3	7.8	1.0	3.7	7.8	1.3	1.5	7.6	1.0	1.8	2.1	1.5
COD, mg/l	16	27	12	16	24	16	16	27	12	12	12	12
Phenol, µg/l	0	2	0	0	2	0	0	0	0	1	2	0
SS, mg/l	32	111	11	32	94	11	23	72	11	99	111	87
TDS, mg/l	413	532	322	461	532	385	347	375	322	326	326	326
TKN, mg/l	0.7	1.8	0.4	0.7	1.8	0.4						
NH_3-N, mg/l	0.29	1.1	0.07	0.26	0.54	0.07	0.18	1.1	0.16			
Ptot, mg/l	0.14	0.2	0.0	0.17	0.2	0.14				0.0	0.0	0.0
Fetot, mg/l	1.4	11.4	0.95	1.09	1.6	0.95	2.4	2.4	2.4	5.0	11.4	1.23
Fec. Coli. No/100 ml	1,700	44,000	240	318	640	14	1,700	10,000	240	29,000	44,000	900

* Alum Creek at Columbus (RM 37.3)
Average Q = 168 cfs

Table C-5
Surface Water Quality
Big Walnut Creek at Central College (1) (RM 42.1)
(1970-1976)

Flow cfs	Date	pH Units	Temp °C	DO mg/l	BOD_5 mg/l	NH_3-N mg/l	NO_2-N mg/l	NO_3-N mg/l	P_{tot} mg/l	$SO_4^=$ mg/l	Cl^- mg/l
92	5/ 8/70	8.1	3.0							68	22
94	1/10/72	8.0	16.5						0.021	59	21
102	10/20/71	7.5	7.0							64	20
104	6/21/76	7.8	17.5	9.2	0.5	0.00	0.01	1.7	0.05	59	20
105	8/ 7/74	8.2	23.0	9.4				1.3	0.01	51	18
112	10/ 4/72	8.2	18.0						0.03	69	18
115	7/12/71	8.0	24.0							58	20
116	6/27/72	7.6	19.0							52	17
116	2/19/74	7.6	4.0				0.00	1.9		52	24
117	7/20/73	8.2	24.0							45	16
119	9/ 7/73	8.0	24.5				0.00	0.18	0.00	41	12
120	4/16/74	7.7	9.5				0.00	2.0		54	21
120	9/ 4/75	7.4	21.5	7.9	1.7	0.02	0.02	1.3	0.03	46	17
125	4/15/76	9.0	12.5	13.8	1.2	0.04	0.04	2.4	0.07	52	21
129	12/ 9/70	7.8	7.0							61	18
142	10/30/73	8.4	14.0				0.00	1.1		46	14
171	1/24/73	7.6	2.0							54	23
182	2/ 5/71	7.8	0.0							63	21
248	3/23/73	8.1	8.0							54	18
329	4/10/72	7.4	8.5							70	26
2740	2/26/75	7.8	3.0	10.8		0.73	0.04	2.4	0.10	55	18
Median											
119		7.8	12.5	9.4	1.2	0.02	0.01	1.7	0.03	54	20
High											
2740		9.0	24.5	13.8	1.7	0.73	0.04	2.4	0.10	70	26
Low											
92		7.4	0.0	7.9	0.5	0.00	0.00	0.18	0.00	41	12

(1) Average Q = 184 cfs

Table C-6
Surface Water Quality
Big Walnut Creek at Reese [1] (R.M. 27.3)
(1970-1976)

Observations Flow Range, cfs	Overall Summary ≤47			Quality vs. Flow ≤18 10-100			≤17 100-1,000			≤12 1,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs	185	10,800	40	66	100	40	229	855	115	2,250	10,800	1,030
pH, Units	7.9	8.6	6.6	8.0	8.5	7.4	8.1	8.6	6.6	7.6	8.0	6.9
Temp., ^{o}C	13.5	25.5	0.0	19.5	25.5	0.0	8.5	24.5	1.0	10.0	24.0	1.5
Turb., JTU	14.5	24	4.3	18	24	3.2	9.3	20.1	4.3	18.4	-	-
DO, mg/l	8.6	12.8	4.3	7.7	10.5	4.3	10.1	12.8	7.2	-	12.6	11.9
BOD_5, mg/l	3.5	5.4	1.5	4.1	5.4	2.6	3.5	5.0	1.5	-	5.0	2.8
COD, mg/l	12	24	6	13	20	8	12	24	6	12	-	-
Phenol, µg/l	2	8	2	3	5	2	2	8	2	2	-	-
SS, mg/l	30	55	16	33	47	18	18	20	16	55	-	-
TDS, mg/l	376	466	333	384	466	345	374	421	333	376	-	-
TKN, mg/l	0.7	1.3	0.3	0.5	1.3	0.3	0.8	0.8	0.7	0.6	-	-
NH_3-N, mg/l	0.17	1.2	0.0	0.19	1.2	0.0	0.17	0.35	0.13	-	0.17	0.17
NO_2^--N, mg/l	0.06	0.1	0.0	0.04	0.1	0.0	0.02	0.07	0.0	0.03	0.07	0.0
NO_3^--N, mg/l	0.85	5.6	0.04	0.7	5.6	0.04	1.22	2.4	0.53	1.27	1.8	0.79
Ptot, mg/l	0.21	0.9	0.01	0.31	0.9	0.01	0.2	0.22	0.15	-	0.16	0.1
O-$PO_4^{\equiv}$, mg/l as P	0.17	0.22	0.03	0.17	0.22	0.03	0.17	0.17	0.06	0.03	-	-
$SO_4^{\equiv}$, mg/l	69	140	31	82	120	31	77	140	63	60	71	37
Cl^-, mg/l	38	72	12	45	65	35	42	72	31	24	35	12
Fe_{tot}, mg/l	1.39	2.54	0.91	1.39	-	-	0.91	-	-	2.54	-	-
Fecal Coli., No/100 ml	490	4,800	300	530	1,100	300	1,200	4,800	300	450	-	-

(1) Average Q = 508 cfs

Table C-7
Surface Water Quality
Big Walnut Creek at U.S. 23 (RM 18.6)
(1974-1975)

Flow* cfs	Date	pH Units	Temp °C	DO mg/l	BOD5 mg/l	SS mg/l	TDS mg/l	TKN mg/l	NH_3-N mg/l	P_{tot} mg/l	Fe_{tot} mg/l
34	8/29/75	7.8	23.5	5.4	2.0	12	341	0.3	0.27	0.2	
35	7/31/75	7.9	25.5	4.9	3.1	35	514	0.9	0.42	0.14	
51	7/25/74	7.9	21.5	6.1	2.5	60			0.08	0.0	1.7
77	5/22/75	7.8	22.0	6.7	2.8	19	480	1.2	0.05	0.12	0.46
134	9/ 6/74	7.7	16.0	8.2	1.4	71			0.1	0.0	2.0
154	6/20/74	7.6	19.7	6.7	2.1	70			0.04	0.0	1.8
155	10/23/75	7.6	12.0	8.0	1.9	32	352	0.7	0.14	0.2	1.07
257	6/25/75	7.6	25.5	7.1	4.5	47	368	0.6	0.15	0.18	0.9
422	4/30/75	7.7	13.0		2.6	30	286	0.4	0.37	0.12	1.0
718	3/21/75	7.6	7.0	10.2	1.6	71	266	0.8	0.44	0.1	3.3
Median											
144		7.7	20.6	6.7	2.3	41	341	0.7	0.15	0.12	1.39
High											
718		7.9	25.5	10.2	4.5	71	514	1.2	0.44	0.2	3.3
Low											
34		7.6	7.0	4.9	1.4	12	266	0.3	0.04	0.0	0.46

*Big Walnut Creek at Reese (RM 27.3).

Average Q = 108 cfs

Table C-8
Surface Water Quality
Olentangy River Near Worthington (1) (RM 40.5)
(1970-1977)

Observations	Overall Summary			Quality vs. Flow								
	≤42			≤19			≤15			≤8		
Flow Range, cfs				10-100			100-1,000			1,000 +		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs	165	4,460	20	43	100	20	272	817	140	2,585	4,460	1,170
pH, Units	7.9	8.5	6.7	8.0	8.4	7.4	7.7	8.5	6.7	7.8	8.4	7.1
Temp, ^{o}C	18.5	25	0.0	22.0	25.0	5.5	9.0	18.8	0.0	5.0	21.0	2.0
Turb, JTU	20	27	1.2	7.4	18	3.8	24	27	1.2	22	-	-
DO, mg/l	7.8	12.9	6.2	7.0	10.0	6.2	9.7	12.9	7.8	-	12.1	11.6
BOD_5, mg/l	1.7	4.0	0.0	2.9	4.0	0.0	2.2	4.0	1.2	1.3	-	-
COD, mg/l	17	24	8	19	24	12	14	19	8	16	-	-
Phenol, µg/l	2	2	2	2	2	2	2	2	2	2	-	-
SS, mg/l	22	83	15	22	57	15	17	34	16	83	-	-
TDS, mg/l	360	546	311	405	546	345	321	374	311	346	-	-
TKN, mg/l	0.4	1.1	0.3	0.5	1.0	0.3	-	1.1	0.4	0.3	-	-
NH_3-N, mg/l	0.21	1.3	0.09	0.13	0.35	0.09	0.43	0.77	0.14	0.77	1.3	0.23
NO_2^--N, mg/l	0.05	0.11	0.0	0.02	0.1	0.0	0.04	0.11	0.0	0.06	0.07	0.05
NO_3^--N, mg/l	2.58	5.58	0.62	1.46	5.58	0.62	2.6	3.19	0.94	3.51	4.02	3.0
Ptot, mg/l	0.3	2.9	0.01	0.38	2.9	0.01	0.25	0.61	0.2	0.32	0.44	0.2
O-$PO_4^{\equiv}$, mg/l as P	0.14	0.42	0.09	0.18	0..42	0.09	-	0.13	0.12	0.1	-	-
$SO_4^{=}$, mg/l	81	140	34	105	140	72	88	110	48	54	79	34
Cl-, mg/l	41	120	10	43	60	32	40	120	29	17	54	10
Fetot, mg/l	1.26	4.9	0.32	1.26	-	-	0.32	-	-	4.9	-	-
Fec. Coli No/100 ml	930	2,600	13	2,300	2,600	670	-	240	13	930	-	-

(1) Average Q = 447 cfs

Table C-9
Surface Water Quality
Olentangy River at Goodale Street (RM 32.7)
(1974-1975)

Flow* cfs	Date	pH Units	Temp °C	DO mg/l	BOD_5 mg/l	COD mg/l	SS mg/l	TKN mg/l	NH_3-N mg/l	P_{tot} mg/l	PO_4 mg/l	$SO_4^{=}$ mg/l	Cl^{-} mg/l
34	7/25/74	7.6	26.8	3.9	11.2	32.0			1.38		1.6		
43	7/24/75	7.6	26.5	1.0	6.0	28.0	10	5.5	1.49	0.36			
64	6/24/75	7.8	29.0	6.8		24.0	11	1.2	1.1	0.36		92	45
101	9/18/74	7.5	20.5	7.2	14.8	24.0	31		0.23	0.0			
110	5/29/74	8.0			5.7	28.0	38		0.47		0.6		
114	6/26/74	7.6	18.3	7.1	8.8	20.0	53		0.42		1.0		
294	9/ 6/74	7.9	19.0	8.6	3.0	20.0	37		0.27		0.5		
360	3/27/75	7.8	5.0	10.8	1.1	12.0	53	0.5	0.31	0.1			
399	4/29/75	8.2	11.5	11.0	2.0	20.0	18	0.3	0.2	0.1		82	35
Median													
110		7.8	19.8	7.2	7.4	24.0	34	0.9	0.42	0.1	0.8	-	-
High													
399		8.2	29.0	11.0	14.8	32.0	53	5.5	1.49	0.36	1.6	92	45
Low													
34		7.5	5.0	1.0	1.1	12.0	10	0.3	0.27	0.0	0.5	82	35

*Olentangy River near Worthington (RM 40.5).
Average Q = 447 cfs

Table C-10

Surface Water Quality
Scioto River at Greenlawn Dam (R.M. 29.2)
(1970-1976)

Observations Flow Range, cfs	Quality vs. Flow											
	≤76			≤50			≤66			≤14		
	100-500			500-1,000			1,000-5,000			5,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs*	246	486	155	724	990	510	2,160	4,960	1,010	6,600	13,100	5,350
pH, Units	8.1	8.6	7.6	8.1	8.5	7.1	7.8	8.3	6.6	7.7	8.0	6.9
Temp., °C	21.0	28.0	0.0	15.0	27.0	0.0	10.0	26.0	1.0	10.0	23.0	0.0
DO, mg/l	8.2	13.8	3.0	9.9	14.2	6.6	11.0	14.6	6.9	11.3	15.2	7.7
BOD_5, mg/l	5.0	16.0	2.0	3.4	12.0	1.0	3.6	15.0	1.0	3.9	10.0	1.0
COD, mg/l	45	45	45	-	-	-	-	-	-	-	-	-
NH_3-N, mg/l	0.43	34	0.0	0.33	3.2	0.0	0.47	2.5	0.05	0.45	1.1	0.05
NO_2^--N, mg/l	0.04	0.27	0.0	0.04	0.22	0.0	0.1	0.5	0.0	0.06	0.23	0.0
NO_3^--N, mg/l	0.5	9.81	0.06	3.93	12.87	0.0	3.41	11.09	0.54	3.0	4.84	0.6
P_{tot}, mg/l	0.38	1.0	0.0	0.55	1.7	0.0	0.47	1.44	0.0	0.37	0.91	0.2
P_{diss}, mg/l	0.2	0.72	0.08	0.24	0.68	0.06	0.21	0.5	0.1	0.78	0.63	0.14
Cl^-, mg/l	45	83	26	38	72	24	30	244	18	25	130	16
Fe_{tot}, mg/l	1.3	1.3	1.3	-	-	-	-	-	-	-	-	-

*Scioto River at Columbus (R.M. 27.0).
Average Q = 1383 cfs

Table C-11
Surface Water Quality
Scioto River at Frank Road (RM 27.5)
(1974-1975)

Flow* cfs	Date	pH Units	Temp °C	DO mg/l	BOD5 mg/l	COD mg/l	SS mg/l	TDS mg/l	TKN mg/l	NH_3-N mg/l	P_{tot} mg/l	Fe_{tot} mg/l	F.Coli. No/100 ml
170	9/15/75	7.7	27.0	7.0	4.5	13.0	13	512	2.4	0.05	0.1		290
179	7/25/74	7.7	26.0	12.0	10.8	32.0	24			0.09	0.0		100
241	6/20/74	7.7	21.0	4.6		20.0	26			0.43	0.3	0.9	
241	8/29/75	7.7	25.0	4.8	3.0		20		0.9	0.46	0.2		
311	5/22/75	7.6	23.0	7.2	4.0	32.0	19	396	1.1	0.15	0.1	0.67	130
465	6/25/75	7.7	29.0	6.7	5.5	24.0	34	404	1.4		0.12		
507	10/23/75	7.7	13.5	7.9	2.6		17	438	1.1	0.52	0.3	0.66	
524	5/29/74	8.1	19.7	7.1	5.9	24.0	40			0.29	0.0		610
524	9/ 6/74	7.8	17.5	6.8	2.6	24.0	26			0.47	0.3		
1990	4/30/75	8.2	13.0	10.2		20.0	25	424	0.3	0.17	0.17		770
3600	3/21/75	7.9	5.5	12.0	1.7	36.0	59	328	0.5	0.54	0.1		610
Median													
465		7.7	21.0	7.1	4.0	24.0	25	431	1.1	0.36	0.17	0.67	420
High													
3600		8.2	29.0	12.0	10.8	36.0	59	512	2.4	0.54	0.3	0.9	770
Low													
170		7.6	5.5	4.6	1.7	13.0	13	328	0.3	0.05	0.0	0.66	100

*Scioto River at Columbus (RM 27.0)
Average Q = 1,383 cfs

Table C-12
Surface Water Quality
Scioto River at Frank Road (R.M. 27.5)
(1975-1976)

Observations	Quality vs. Flow											
	≤ 50			≤ 20			≤ 14			≤3		
Flow Range,cfs	100-500			500-1,000			1,000-5,000			5,000 +		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow,cfs *	286	486	138	690	985	518	1,680	3,740	1,030	6,690	13,100	5,350
pH, Units	7.8	8.4	7.2	8.0	8.3	7.3	7.9	8.2	7.7	8.0	8.1	8.0
DO, mg/l	8.0	16.0	0.3	7.3	13.0	2.5	10.1	14.0	6.0	13.5	14.1	12.5
BOD_5, mg/l	6	24	2	4	12	1	3	14	< 1	2	11	2
SS, mg/l	21	82	4	30	73	9	49	211	20	114	373	47
Fecal Coli., No/100 ml	2,700	950,000	25	4,500	300,000	250	3,100	105,000	800	5,000	5,800	1,200

* Scioto River at Columbus (R.M. 27.0)

Average Q = 1,383 cfs

Table C-13
Surface Water Quality
Scioto River at Columbus [1] (R.M. 27.0)
(1970-1976)

Observations / Flow Range	Overall Summary ≤38			Quality vs. Flow ≤15 100-500			≤15 500-2,000			≤8 2,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Q, cfs	594	17,400	150	257	499	150	800	1,960	532	3,255	17,400	2,500
pH, Units	7.8	8.6	6.8	7.5	8.6	6.8	7.6	8.3	7.5	7.8	8.4	7.4
Temp., °C	14.0	26.5	1.0	23.5	26.5	10.0	10.0	24.0	2.5	7.8	22.0	1.0
DO, mg/l	8.0	11.4	6.8	8.0	-	-	7.9	9.5	6.8	11.4	-	-
NH_3-N, mg/l	0.28	0.64	0.15	0.15	-	-	0.28	0.36	0.25	0.64	-	-
NO_2^--N, mg/l	0.03	0.09	0.0	0.0	0.09	0.0	0.04	0.08	0.0	-	0.03	0.0
NO_3^--N, mg/l	2.7	9.4	0.68	6.0	9.4	2.5	1.87	40	0.68	-	5.4	2.7
P_{tot}, mg/l	0.27	3.9	0.2	1.3	3.9	0.16	0.22	0.27	0.2	0.78	-	-
$SO_4^=$, mg/l	92	210	29	160	210	75	92	120	75	73	110	29
Cl^-, mg/l	37	102	9	54	65	33	43	102	21	20	36	9

[1] Average Q = 1,383 cfs

Table C-14
Surface Water Quality
Scioto River at I-270 Bridge (R.M. 24.2)
(1975-1976)

Observations Flow Range	Quality vs. Flow											
	≤50 100-500			≤20 500-1,000			≤14 1,000-5,000			≤3 5,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs*	286	486	138	690	985	518	1,618	3,740	1,030	6,390	13,100	5,350
pH, Units	7.6	8.2	7.0	7.8	8.1	7.3	7.9	8.2	7.6	8.0	8.0	7.9
DO, mg/l	6.6	11.1	0.5	6.7	12.5	1.6	10	13.8	4.7	13.1	13.2	12.2
BOD_5, mg/l	10	30	3	8	17	3	6	20	<1	3	13	3
SS, mg/l	19	73	8	37	84	21	62	204	27	147	453	58
Fecal Coli., No/100 ml	21,000	700,000	1,800	14,500	500,000	3,500	8,200	240,000	200	2,000	12,000	700

*Scioto River at Columbus (R.M. 27.0).
Average Q = 1,383 cfs

Table C-15
Surface Water Quality
Scioto River at Shadeville (R.M. 19.8)
(1970-1976)

Observations Flow Range	Quality vs. Flow											
	≤91			≤54			≤75			≤14		
	100-500			500-1,000			1,000-5,000			5,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs*	250	489	152	609	990	510	2,170	4,960	1,010	6,600	73,100	5,350
pH, Units	7.6	8.1	7.2	7.7	8.2	7.1	7.7	8.2	6.5	7.7	8.0	7.1
Turb., JTU	5.6	8.6	2.7	12.0	12.0	12.0	36	44	27	-	-	-
Temp., °C	21.0	26.0	4.0	15.0	26.8	1.5	10.0	25.5	2.2	10.0	22.5	0.0
DO, mg/l	3.8	10.0	1.5	6.0	12.9	1.3	9.8	14.2	2.1	10.5	14.6	5.7
BOD_5, mg/l	8.1	25.0	2.0	8.8	21.0	3.0	6.7	28.0	2.0	5.2	10.8	2.2
COD, mg/l	51.5	51.5	51.5	27	54	12	18.0	20.0	17.4	-	-	-
Phenol, µg/l	-	-	-	4	5	2	2	2	2	-	-	-
SS, mg/l	21	38	8	37	68	6	69	368	4	164	321	103
TDS, mg/l	530	554	509	497	569	425	-	473	430	-	-	-
TKN, mg/l	5.1	6.5	3.8	4.4	-	-	0.3	-	-	-	-	-
NH_3-N, mg/l	5.6	15.0	0.01	3.38	12.88	0.74	1.72	4.42	0.2	0.21	0.94	0.32
NO_2^--N, mg/l	0.28	1.02	0.0	0.17	0.71	0.0	0.12	0.5	0.0	0.27	1.2	0.05
NO_3^--N, mg/l	1.02	11.51	0.0	2.4	5.54	0.01	2.88	7.8	0.0	1.9	5.13	0.0
P_{tot}, mg/l	2.38	11.1	0.1	1.3	5.6	0.27	0.95	3.6	0.05	1.09	4.2	0.4
P_{diss}, mg/l	2.3	8.2	0.85	1.4	3.5	0.7	0.47	2.3	0.14	0.2	0.66	0.06
O-PO_4-P, mg/l	1.94	2.11	1.76	0.83	-	-	0.35		-	0.11	0.19	0.02
Cl^-, mg/l	58	204	40	47	90	32	35	70	21	24	36	18
Fe_{tot}, mg/l	0.62	-	-	-	-	-	1.92	-	-	-	-	-
Fecal Coli., No/100 ml	13,000	256,000	1,300	9,000	600,000	1,000	5,900	200,000	200	-	-	-

*Scioto River at Columbus (R.M. 27.0).
Average Q = 1,383 cfs

Table C-16
Surface Water Quality
Scioto River Below Shadeville (R.M. 16.2)
(1970-1976)

Observations Flow Range	Quality vs. Flow											
	≤31			≤21			≤42			≤23		
	100-500			500-1,000			1,000-5,000			5,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs *	291	471	212	741	985	512	1,852	4,500	1,025	8,310	30,020	5,240
pH, Units	8.0	8.5	6.7	7.4	8.3	6.8	8.0	8.5	6.9	7.8	8.5	6.9
Temp., °C	18.5	25.0	0.0	12.0	27.5	3.0	13.0	24.0	2.0	11.0	23.0	1.0
DO, mg/l	3.0	4.2	2.9	2.4	7.6	0.7	-	10.5	9.7	-	-	-
BOD_5, mg/l	5.9	-	-	5.0	-	-	5.6	-	-	-	-	-
NH_3-N, mg/l	-	-	-	5.4	6.0	4.8	-	1.8	0.67	-	-	-
NO_2^--N, mg/l	0.0	0.59	0.0	0.01	0.71	0.0	0.01	0.13	0.0	0.0	0.01	0.0
NO_3^-, mg/l	6.4	11.0	3.0	4.0	4.9	0.09	3.6	3.9	1.4	2.1	2.7	1.2
P_{tot}, mg/l	-	3.5	3.4	1.3	2.7	0.63	0.73	-	-	-	-	-
$SO_4^=$, mg/l	150	190	73	115	140	70	87	160	40	61	130	33
Cl^-, mg/l	57	123	26	46	66	23	32	210	12	22	48	13

* Scioto River at Columbus (RM 27.0)
Average Q = 1,383 cfs

Table C-17
Surface Water Quality
Scioto River at S.R. 762 (R.M. 15.2)
(1975-1976)

Observations / Flow Range	Quality vs. Flow											
	≤53			≤20			≤14			≤3		
	100-500			500-1,000			1,000-5,000			5,000+		
	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	Low
Flow, cfs[1]	285	486	138	690	985	518	1,680	3,740	1,030	6,690	13,100	5,350
pH, Units	7.6	8.1	7.2	7.8	8.0	7.2	7.8	8.1	7.5	7.8	8.0	7.8
DO, mg/l	4.6	12.1	0.5	5.7	13	1.5	8.2	13	1.8	12.5	13.1	11.5
BOD_5, mg/l	9	23	3	11	19	4	8	29	2	7	12	5
SS, mg/l	19	100	1	29	107	9	69	426	23	207	358	70
Fecal Coli., No/100 ml	5,700	TNTC[2]	190	8,100	400,000	400	17,000	170,000	200	3,100	6,000	3,000

(1) Scioto River at Columbus (R.M. 27.0).
(2) Too numerous to count.
Average Q = 1,383 cfs

APPENDIX D

HISTORIC SITES

TABLE D-1
Historic Structures and
Sites of Franklin County

Structure/Site	Location
Anson Davis House	4900 Hayden Run Road
Bergstresser Covered Bridge	West of OH 674 over Walnut Creek
Squire's Glen Farm	6770 Sunbury Road
American Insurance Union Citadel	50 West Broad Street
Coe Mound	West of High Street
Columbus Country Club Mound	4831 East Broad Street
Samuel Davis House	4264 Dublin Road
East Town Street Historic District	Roughly bounded by Grant, Franklin Avenues, Lester Dr., and East Rich Street
Franklin Park Conservatory	1547 East Broad Street
German Village	Roughly bounded by Livingston Avenue, Pear Alley, Nursey Lane, Blackberry Alley,and Lathrop Street
Ohio Asylum for the Blind	240 Parson Avenue
Ohio Stadium	404 West 17th Avenue
Ohio State Arsenal	139 West Main Street
Capt. Edward V. Rickenbacker House	1334 East Livingston Avenue
Sessions Village	Both sides of Sessions Drive
Trinity Episcopal Church	125 East Broad Street
Union Station Entrance	348 North High Street

TABLE D-1:
Historic Structures and
Sites of Franklin County
(Continued)

Structure/Site	Location
Hartley Mound	North of Columbus
Hartman Stock Farm Historic District	South of Columbuson U.S. 23
Jackson Fort	Columbus Vicinity
Jonathan Noble House	5030 Westerville Road
Holder-Wright Works	Dublin Vicinity
Benjamin Sells House	South of Dublin at 4586 Hayden Run Road
John Galbreath Mound	West of Galloway
Tom Cannon Mound	Georgesville Vicinity
Groveport Log Houses	Wirt Road, Groveport
Mark Russell House,	5805 North High Street, Riverlea
Gideon Hart House	7328 Hempstead Road, Westerville
Westerville High School Vince Street School	44 North Vine Street, Westerville
John W. Everal Farm Buildings	7610 Cleveland Avenue, Westerville vicinity
John Snow House	41 West New England Avenue, Worthington
H.P. Jeffers Mound	Worthington Vicinity

TABLE D-1

Historic Structures and Sites of Franklin County

Structure/Site	Location	Description
Campbell Mound	Columbus McKinley Ave.	A large conical Indian burial mound constructed during the period 500 B.C.-400 A.D.
Fort Hayes	Cleveland Ave. and Int. 71	Established by the U.S. War Dept. in 1863 for the manufacture and storage of war materials.
Hays Hall	Ohio State University	1893 - The first Ohio college building to be designed and used exclusively for manual, technical and domestic instruction.
Orton Hall	Ohio State University	1893 - Built for laboratory work and as a museum.
Camp Chase Site	2900 Sullivant Avenue	1861-1865 - Used during the Civil War as a training camp for new recruits. Later became a military prison till 1865. Prisoners' graveyard remains.
Franklinton Post Office (David Dearduff House)	72 South Gift Street	1807 - The first post office of Franklinton
General William Henry Harrison Headquarters (Jacob Oberdier House)	570 West Broad Street	1807 - Used as headquarters by Gen. William Henry Harrison during the winter of 1813-1814.
Ohio State House	S.E. corner of High and Broad Streets	1839-1861 - Noted for its Greek Doric style.
Ohio Theatre	39 East State Street	1928 - Noted for its extremely ornate interior.
Old Governor's Mansion (Ohio (Archives Building)	1234 East Broad Street	1904 - Noted for its Neo-Georgian style.
Old, Old Post Office	121 East State Street	1884-1887 - Noted for its Romanesque and Gothic style.

TABLE D-1 (continued)

Structure/Site	Location	Description
	Columbus cont'd	
Peruna Drug Manufacturing Building	115 East Rich Street	1902-1906 - One of the most ornate commercial structures in Columbus.
Benjamin Smith House	181 East Broad Street	1860 - Also the home of two Ohio governors.
Lucas Sullivant Building	714 West Gay Street	1822 - House and office of one of the first settlers in the area.
Toledo and Ohio Central Railroad Station	379 West Broad Street	1895 - Noted for its oriental style tower and front entrance and also its ornate interior.
Wyandotte Building	21 West Broad Street	1897-1898 - An 11-story building, it is the first skyscraper of Columbus.
	Westerville	
Benjamin Hanby House	160 West Main Street	1850 - The home of song composer Benjamin Hanby.
Towers Hall, Otterbein College	West Main and Grove Streets	1872 - Since 1872 has served as the main classroom building of Otterbein College.
	Worthington	
Orange Johnson House	956 High Street	1816 - Home of Orange Johnson, comb manufacturer.
New England Lodge	634 North High Street	1820 - The oldest Masonic Temple west of Allegheny Mountains.
Worthington Manufacturing Company Boarding House	25 Fox Lane	1812 - The company manufactured military gear and saddlery.

Source: The National Register of Historic Places, 1972; and Supplement, 1974.

APPENDIX E

AIR QUALITY DATA

TABLE E-1
Particulates, Annual Average (in ug/m^3)

Site	No. Obs.	Geo Mean	Arith Mean	Max	2nd Max
181 S. Washington Blvd.	253	85.05	92.52	240	238
Multipurpose Bldg. - Fairgrounds	57	92.48	101.98	238	204
1313 Cheaspeake Avenue	221	69.61	76.23	199	168
1780 Windsor Avenue	57	91.28	102.09	250	226
4300 Kimberly Pky	46	58.92	64.59	133	124
2626 Cleveland Avenue	58	64.31	70.62	143	138
5750 Maple Canyon Drive	58	65.28	71.47	151	135
215 Norton Avenue	57	54.74	47.50	132	131
1016 Grandview Avenue	64	65.28	69.42	225	141
584 Dennis Lane	59	53.36	59.29	146	133

Standard-Federal (secondary): 60 ug/m^3 (25°C) Geometric mean
State (secondary): 60 ug/m^3 (25°C) Geometric Mean, max.

TABLE E-2
Sulfur Dioxide, Annual Average (in ug/m^3)

Site	No. Obs.	Geo Mean	Arith Mean	Max	2nd Max
181 S. Washington Blvd.	61	19.85	24.21	83	81
1313 Cheaspeake Avenue	57	15.54	17.81	69	52
	6563*	.018*	.028*	--	--
1780 Windsor Avenue	61	13.68	14.57	45	42
State Fairgrounds	61	22.82		131	128
	6273*	.009*	0.17*	--	--
395 E. Capitol Street	61	21.02	26.27	96	84
2626 Cleveland Avenue	50	14.97	16.90	58	53
5750 Maple Canyon Drive	57	14.35	15.66	51	50
1016 Grandview Avenue	50	13.70	14.39	37	33

Standard - Federal (Primary): 365 ug/m^3 (25°C) .14 ppm 24 hr. max, 1 per yr.
State (Secondary): 260 ug/m^3 (25°C) .10 ppm 24 hr. max, 1 per yr.

* Sampling Interval, 1 hour; units, ppm.

Table E-3
Nitrogen Dioxide, Annual Average (in ug/m^3)

Site	No. Obs.	Geo Mean	Arith Mean	Max	2nd Max
181 S. Washington Blvd.	60	46.43	53.00	114	96
1313 Cheaspeake Avenue	57	34.91	41.21	86	77
	2712*	.031*	.055*	--	--
1780 Windsor Avenue	60	28.51	32.23	62	56
State Fairgrounds	61	46.53	51.59	94	88
395 E. Capitol Street	61	38.67	44.00	94	85
2626 Cleveland Avenue	49	29.32	37.82	117	91
5750 Maple Cayon Avenue	56	35.93	44.18	94	92
1016 Grandview Avenue	49	29.12	35.67	71	69

Standard - Federal (Secondary): 100 ug/m^3 (25°C) .05 ppm Arith. mean
State (Secondary): 100 ug/m^3 (25°C) .05 ppm Arith. max.

* Sampling Interval, 1 hour; units, ppm.

TABLE E-4
Ozone, Annual Average (in ppm)

Site	No. Obs.	Geo Mean	Arith Mean
1313 Cheaspeake Ave.	8470*	.014	.026
395 E. Capitol Street	3326*	.009	.017
5750 Maple Canyon Drive	5343*	.007	.011

Standard - State (Secondary): 119 ug/m^3 (25°C),
.06 ppm 1 hr. Arith. mean max

* Sampling interval, 1 hour

TABLE E-5
Nonmethane Hydrocarbons, Annual Average (in ppm)

Site	No. Obs.	Geo Mean	Arith Mean
1313 Cheaspeake Avenue	6995*	1.25	2.13

Standard - Federal (Secondary): 160 ug/m^3 (25°C) .24 ppm
3 hr. max. 1 per yr.
State (Secondary): 126 ug/m^3 (25°C) .19 ppm
3 hr. Arith mean max, 6-9 A.M.

* Sampling interval, 1 hour

APPENDIX F

INTERCEPTOR ALTERNATIVE DESIGN TABLES

Table F-1
West Scioto Alternative Design

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Low Level							
#1 to #2	0.07	16,800	1.68	3.20	5.38	10.55	36"
#2 to #3	0.06	25,200	2.52	2.95	7.43	14.58	42"
#3 to #4	0.06	30,200	3.02	2.85	8.61	16.88	48"
#4 to #5	0.04	33,600	3.36	2.75	9.24	18.12	48"
#5 to #6	0.06	42,600	4.26	2.60	11.08	21.72	48"
High Level							
#1 to #2	0.15	16,800	1.68	3.20	5.38	10.55	36"
#2 to #3	0.15	25,200	2.52	2.95	7.43	14.58	36"
#3 to #4	0.15	30,200	3.02	2.85	8.61	16.88	36"
#4 to #5	0.83	33,600	3.36	2.75	9.24	18.12	36"
#5 to #6	0.10	42,600	4.26	2.60	11.08	21.72	48"
Modification to High (add 15,000 people from Delaware County)							
#1 to #2	0.15	31,800	3.18	2.80	8.90	17.46	42"
#2 to #3	0.15	40,200	4.02	2.65	10.65	20.89	42"
#3 to #4	0.15	45,200	4.52	2.60	11.75	23.04	42"
#4 to #5	0.83	48,600	4.86	2.55	12.39	24.30	42"
#5 to #6	0.10	57,600	5.76	2.45	14.11	27.67	48"

Table F-2
Big Run Alternative Design

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
#1 to #2	0.05	1,700	0.17	4.60	0.78	1.58	18"
#2 to #3	0.30	2,500	0.25	4.20	1.05	2.06	18"
#3 to #4	0.12	4,400	0.44	3.80	1.67	3.28	21"
#4 to #5	0.12	10,400	1.04	3.40	3.54	6.93	27"
#5 to #6	0.12	10,400	1.04	3.40	3.54	6.93	27"

Table F-3
Minerva Park Alternative Design

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
#1 to #2	0.80	1,200	0.12	5.00	0.60	1.18	12"
#2 to #3	0.80	3,100	0.31	4.05	1.26	2.46	15"
#3 to #4	1.00	3,500	0.35	3.95	1.38	2.71	15"
#1 to #2	0.80	1,900	0.19	4.45	0.85	1.66	12"

Table F-4
Alternative A Design for Big Walnut,
Rocky Fork, and Blacklick Creek

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Big Walnut							
#1 to #2	0.10	14,000	1.40	3.25	4.55	8.92	36
#2 to #3	0.10	21,300	2.13	3.00	6.39	12.53	36
Rocky Fork							
#1 to #2	0.20	9,000	0.90	3.50	3.15	6.18	24
#2 to #3	0.20	11,300	1.13	3.40	3.84	7.53	27
#3 to #4	0.10	17,800	1.78	3.15	5.61	10.99	36
#4 to #5	0.50	17,800	1.78	3.15	5.61	10.99	36(*)
Blacklick							
#1 to #2	0.40	7,300	0.73	3.60	2.63	5.15	21
#2 to #3	0.30	16,300	1.63	3.20	5.22	10.23	27
#3 to #4	0.30	37,400	3.74	2.70	10.10	19.80	36
#4 to #5	0.30	41,900	4.19	2.60	10.89	21.36	36

(*)Size was not decreased in order to maintain same hydraulic characteristics downstream.

Table F-5
Alternative B Design for Big Walnut,
Rocky Fork, and Blacklick Creek

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Big Walnut							
#1 to #2	0.20	3,000	0.30	4.05	1.22	2.38	18
#2 to #3	0.20	14,000	1.40	3.25	4.55	8.92	27
#3 to #4	0.10	21,300	2.13	3.00	6.39	12.53	36
Rocky Fork							
#1 to #2	0.20	9,000	0.90	3.50	3.15	6.18	24
#2 to #3	0.20	11,300	1.13	3.40	3.84	7.53	27
#3 to #4	0.10	17,800	1.78	3.15	5.61	10.99	36
#4 to BL#2	0.15	17,800	1.78	3.15	5.61	10.99	36
PS to #2	FM(b)	(6,200)	0.62	3.00(a)	1.87	-	
#2 to #3	0.20	-	-	-	1.87	-	Existing 15
Blacklick							
#1 to #2	0.40	5,900	0.59	3.65	2.15	4.22	18
#2 to #3	0.40	25,100	2.51	2.95	7.40	14.52	30
#3 to #4	0.30	34,100	3.41	2.75	9.38	18.39	36
#4 to #5	0.30	59,700	5.97	2.40	14.33	28.09	42

(a) For pump station a peaking factor of 3 was used to be conservative on its design.

(b) When population of force main reaches 6,200, either the existing 15" must be replaced as well as enlarging the pump station or a gravity sewer to serve this area must be constructed.

Table F-6
Alternative C Design for Big Walnut,
Rocky Fork, and Blacklick Creek

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Big Walnut							
#1 to #2	0.10	11,300	1.13	3.40	3.84	7.53	30
#2 to #3	0.10	18,600	1.86	3.10	5.77	11.31	36
Rocky Fork							
#1 to #2	0.20	4,000	0.40	3.85	1.54	3.02	18
#2 to #3	0.20	11,700	1.17	3.35	3.92	7.69	27
#3 to #4	0.20	14,000	1.40	3.25	4.55	8.92	27
#4 to #5	0.10	20,500	2.05	3.05	6.25	12.26	36
#5 to BL#2	0.15	20,500	2.05	3.05	6.25	12.26	36
Blacklick							
#1 to #2	0.40	5,900	0.59	3.65	2.15	4.22	18
#2 to #3	0.40	27,900	2.79	2.90	8.09	15.86	30
#3 to #4	0.30	36,800	3.68	2.70	9.94	19.48	36
#4 to #5	0.30	58,000	5.80	2.45	14.21	27.86	42
#5 to #6	0.30	62,400	6.24	2.40	14.98	29.36	42

Table F-7
Alternative D Design for Big Walnut,
Rocky Fork, and Blacklick Creek

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Big Walnut							
#1 to #2	0.10	14,000	1.40	3.25	4.55	8.92	36
#2 to #3	0.10	21,300	2.13	3.00	6.39	12.53	36
Rocky Fork							
FM to Gr.	-	5,000	0.50	3.00 (a)	1.50	2.94	2-8" FM
Gr. to Existing	0.28	5,000	0.50	3.75	1.88	3.68	18
Blacklick							
FM to Gr.	-	22,000	2.20	3.00 (a)	6.60	12.94	2-16" FM
Gr. to Existing	1.1	22,000	2.20	3.00	6.60	12.94	24

(a) A peaking factor of 3 was used to be conservative in the force main and pump station design.

Table F-8
Groveport Alternative Design

Section	Slope (%)	Year 2000 Population	Dry Weather Flow (mgd)	Peaking Factor	Peaked Flow (mgd)	Design Flow (mgd)	Pipe Size (inches)
Alternative A							
East Branch	0.12	5,200	0.52	3.70	1.92	3.77	24"
Main Branch	0.15	10,400	1.04	3.40	3.54	6.93	27"
Main Branch	0.16	2,100	0.21	4.35	0.91	1.79	18"
Main Branch	0.16	2,100	0.21	4.35	0.91	1.79	18"
Northeast	0.16	1,200	0.21	5.00	0.60	1.18	15"
Alternative B							
East Branch	0.19	1,500	0.15	4.75	0.71	1.40	15"
Canal Interceptor	0.09	4,900	0.49	3.75	1.84	3.60	24"
Main Branch	0.09	10,400	1.04	3.40	3.54	6.93	30"
Main Branch	0.10	8,700	0.87	3.50	3.05	5.97	27"
Main Branch	0.09	2,000	0.20	4.4	0.88	1.73	18"
Main Branch	0.09	2,000	0.20	4.4	0.88	1.73	18"
Main Branch	0.10	6,900	0.69	3.6	2.48	4.87	27"
Northeast	0.16	1,200	0.12	5.00	0.60	1.18	15"

APPENDIX G

PRM No. 77-8

FUNDING OF SEWAGE COLLECTION SYSTEM PROJECTS

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

OCT 18 1977

NOTICE

REGION V IMPLEMENTATION OF PROGRAM REQUIREMENTS MEMORANDUM (PRM) 77-8, FUNDING OF SEWAGE COLLECTION SYSTEM PROJECTS

The purpose of this notice is to inform applicants/grantees with active Step 1 (facilities planning) projects about the subject PRM 77-8. Where the Step 1 facilities plans involving collection sewers have not yet been approved, the full requirements of the PRM 77-8 are in effect.

Basically, the PRM provides clarification of the EPA policy and does not levy any fundamentally new requirements. Rather it refines the previous Agency policy by providing for a more rigorous review of grant application requirements to insure compliance with the following statutory and regulatory criteria:

1) The area under consideration for collection sewers must have substantial human habitation in existence on October 18, 1972.

2) The proposed collection system must ab.te a public health hazard, groundwater contamination problem, or a surface water quality violation.

3) The proposed collection system, including treatment cost, must be cost-effective when compared to other alternatives such as non-sewered solutions, e.g., septic tanks.

4) The proposed system must be designed so that the bulk (generally two-thirds) of the flow design capacity through the collection sewers will be for wastes originating from the community (habitation) in existence on October 18, 1972.

5) The project costs including those items identified under III. C. in PRM 77-8 must have been publicly displayed or disclosed to the anticipated users.

Region V is committed to ensure that grants for collection sewers are necessary, cost-effective and meet applicable statutory and regulatory requirements including the policy set forth in PRM 77-8. We urge your cooperation in submitting facilities plans which meet the stated requirements.

Copies of the PRM and additional EPA guidance to implement the PRM are attached.

Sincerely yours,

Charles H. Sutfin
Director, Water Division

Attachments

Attachment #1

REGION V, EPA GUIDANCE FOR THE EVALUATION OF LESS COSTLY TREATMENT SYSTEMS

Institutional Arrangements and Physical Alternatives

Institutional solutions utilizing existing individual systems can be quite varied. Four possible arrangements are as follows:

1. Improvement and operation of existing systems by individual users; present users retain ownership; inspection program by municipality.

2. Same as #1 with a municipally supported maintenance program available to owners (honey wagon, construction aid, etc.).

3. Improvement of existing systems by municipality; operation, maintenance and ownership by municipality.

4. Improvement of existing systems with Federal Section 201 funds as per Draft Guidance forwarded to you on October 20, 1976; operation, maintenance, and ownership by municipality.

The selection of the institutional solution will be decided on a case-by-case basis depending on the problem, legal constraints, availability of funds and other considerations.

Municipal ownership of individual systems, as used above, must include free access for inspection, maintenance and construction purposes, and can be accomplished by any legally binding method such as an easement.

A portion of the cost of developing an implementation program, such as municipal ownership and maintenance for the above institutional solutions, may be eligible for Section 201 funds.

Attachment #2

REGION V, EPA GUIDANCE FOR EVALUATION OF LESS COSTLY TREATMENT SYSTEMS

Method for Evaluating Existing System Alternatives

To comply with the requirements of PRM 77-8, and to minimize the potentially high Facilities Plan costs of analyzing the alternative of retaining existing individual waste treatment systems, the evaluation of this alternative should be completed in accordance with the following procedures:

Stage 1

1. Determine the effect on surface and groundwater quality of treatment received from individual wastewater treatment systems. A distinction must be made between relatively isolated local water quality problems and more widespread problems causing a public health hazard or significant water quality degradation. The applicant shall provide evidence in the form of stream sampling and discharge data to support allegations of a pollution problem. If no degradation can be documented, conclude the analysis and transmit the results of the water quality monitoring to the State pollution control agency for evaluation. If water quality standards have been violated by discharges from individual wastewater treatment systems, the analysis should be continued.

2. Check existing soil maps.

3. Check county health department for existing information.

4. Determine the type of water system used in the planning area. If water is obtained from wells, their location relative to existing and potential soil absorption fields should be identified.

5. Determine the present condition of septic systems. A community survey must be conducted to determine the number of disposal systems in the community, and the number, nature and location of malfunctioning systems.

6. Where failure exists, the reason for failure should be identified (i.e., age, capacity, frequency of cleaning, lot size, as well as clear water and garbage grinder connections). A determination of the final discharge point of the system (storm drain, soil, etc.) also needs to be included. This information should be compiled to project the number and distribution of individual systems that could work in the area.

It should be emphasized that past performance is far more indicative of future performance than theoretical predictions. Thus, if some systems in a community are operating properly, an analysis is necessary to provide direction for rehabilitation of malfunctioning systems.

Further, minimum site, soil and lot size requirements for optimal operation of absorption fields found in the literature should not be applied to existing systems where past performance indicates successful operation.

At the conclusion of Stage 1, we request that the applicant consult the State agency and U.S. EPA prior to proceeding to Stage 2. In this way, we can jointly evaluate whether a cost-effective analysis, in accordance with PRM 77-8, should be completed at that time or delayed until completion of Stage 2.

Stage 2

This stage includes appropriate field analysis including percolation, dye and smoke testing to determine the discharge points of those systems not determined by the community survey and to predict the future viability of existing, rehabilitated and new absorption fields. If percolation rates are an issue, separate representative percolation tests should be performed for each different soil type in the community. Percolation tests should be performed in conformance with appropriate local and State codes.

Preparation of the Cost-Effective Analysis

On the basis of the results obtained in the community survey and, if necessary, the field analysis, alternatives to conventional sewage collection and treatment shall be provided which specifically list the capital, operation and maintenance costs and methodology involved in:

1. Upgrading malfunctioning systems.

2. Maintaining currently functioning systems that can be expected to malfunction during the planning period because of age or inadequate design.

3. Providing alternative collection and treatment measures for those users whose systems cannot reasonably be expected to function. These measures should include investigating the use of the mound septic system, sand filter systems, and septic systems serving small clusters of users; community septic systems; small diameter, pressure and vacuum sewers; and holding tanks for small portions of the community.

4. Utilizing combinations of the above solutions.

To provide the public with the necessary information for an adequate evaluation of the options available, the analysis of the alternative(s) to conventional collection and treatment and the data upon which it is based, especially the community survey, need to be discussed in some detail at the public hearing. This discussion should include the nature and extent of the community's problem, an outline of the costs

of the alternatives considered, and the distribution of these costs. This is especially important where on-site disposal is less costly and likely to not solve isolated nuisance discharges. It is the citizens themselves who must choose the appropriate solution in these cases.

In summary, EPA is looking toward the engineering profession to be innovative in dealing with the problems of small communities. Further, EPA is committed to provide whatever financial and technical assistance available to obtain solutions for small communities equivalent to their problems.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D C. 20460

21 JUN 1977

CONSTRUCTION GRANTS
Program Requirements Memorandum
No. 77-8

THE ADMINISTRATOR

MEMORANDUM FOR Regional Administrators

SUBJECT: Funding of Sewage Collection System Projects

I. PURPOSE

This memorandum summarizes Agency policy on the award of grants for sewage collection system projects under P.L. 92-500. It sets forth guidance for rigorous review of grant applications to ensure that proposed projects meet the established requirements of the law and regulations.

II. DISCUSSION

Sewage collection system projects may be grant eligible projects under P.L. 92-500 (the Act). Eligibility is limited, however, by Section 211 of the Act which provides for funding of collection systems only 1) for the replacement or major rehabilitation of an existing collection system or 2) for new collection systems in existing communities.

Sewage collection systems are defined in 40 CFR § 35.905-19 as:

> For the purpose of § 35.925-13, each, and all, of the common lateral sewers, within a publicly-owned treatment system, which are primarily installed to receive wastewaters directly from facilities which convey wastewater from individual structures or from private property, and which include service connection "Y" fittings designed for connection with those facilities. The facilities which convey wastewater from individual structures or from private property to the public lateral sewer, or its equivalent, are specifically excluded from the definition, with the exception of pumping units, and pressurized lines, for individual structures or groups of structures when such units are cost effective and are owned and maintained by the grantee.

The eligibility of sewage collection system projects is further defined in 40 CFR § 35.925-13 which reads:

> That, if the project is for, or includes sewage collection system work, such work (a) is for replacement or major rehabilitation of an existing sewer system pursuant to § 35.927-3(a) and is necessary to the total integrity and performance of the waste treatment works servicing such community, or (b) is for a new sewer system in a community in existence on October 18, 1972, with sufficient existing or planned capacity to adequately treat such collected sewage. Replacement or major rehabilitation of an existing sewer system may be approved only if cost effective and must result in a sewer system design capacity equivalent only to that of the existing system plus a reasonable amount for future growth. A community, for purposes of this section, would include any area with substantial human habitation on October 18, 1972. No award may be made for a new sewer system in a community in existence on October 18, 1972 unless it is further determined by the Regional Administrator that the bulk (generally two-thirds) of the flow design capacity through the sewer system will be for waste waters originating from the community (habitation) in existence on October 18, 1972.

This section of the EPA regulations implements Section 211 of P.L. 92-500.

All treatment works funded under the construction grants program must represent the most cost effective alternative to comply with the requirements of the Act. Treatment works are defined in Section 212 to include sewage collection systems. EPA cost-effectiveness requirements are found in 40 CFR § 35.925-7 and in Appendix A to 40 CFR Part 35.

A large number of new collection system projects have appeared on FY 1977 State project priority lists. The lists contain both individual collection system projects and collection systems associated with treatment plant and interceptor sewer projects. Many of these projects may not meet the eligibility and cost-effectiveness requirements set forth above.

Funding must be denied for all collection system projects which are not grant eligible or not cost-effective. This is important for two reasons. First, the requirements of the regulations must be satisfied. Secondly, the funding of collection system projects not meeting the

eligibility and cost-effectiveness requirements will commit limited Federal dollars to projects which provide fewer pollution control benefits than more needed treatment plants and interceptors.

Public disclosure of costs is a fundamental prerequisite for all grants projects, including collection systems. Program Requirements Memorandum 76-3, "Presentation of Local Government Costs of Wastewater Treatment Works in Facility Plans," August 16, 1976, requires that cost information be presented at all public hearings held on facility plans after January 2, 1977. However, public hearings were held on many collection system projects prior to this date. Special measures are necessary to ensure the public is aware of the cost implications of collection systems prior to their approval.

The following policy is to be followed in reviewing future grant applications for collection system projects. This policy supplements all existing Agency regulations and policy statements. It does not levy any fundamentally new requirements, but provides guidance for more rigorous review of grant applications to ensure that proposed projects meet the established requirements of the law and regulations. Compliance with this policy will help to assure that only grant eligible and cost-effective collection system projects are funded by EPA.

III. POLICY

EPA policy on the funding of sewage collection systems is as follows:

A. Substantial human habitation

New collector sewer projects are eligible for funding only in a community in existence on October 18, 1972, with sufficient existing or planned capacity to treat adequately such collected sewage. The Title II regulation states in Section 35.925-13 that a community would include any area with substantial human habitation on October 18, 1972. The bulk (generally two-thirds) of the flow design capacity through the sewer system is to be for wastewaters originating from the habitation.

The Agency policy is that closely populated areas with average densities of 1.7 persons per acre (one household for every two acres) or more on October 18, 1972, shall be considered to meet the requirement for "substantial human habitation". Population density should be evaluated block by block or, where typical city blocks do not exist, by areas of 5 acres or less. The "two-thirds" rule would apply within each area evaluated when making a decision on collector sewer eligibility.

Densities of less than one household for every two acres rarely result in serious localized pollution or public health problems from the use of properly operated on-site systems. These areas should not be considered to have had, on October 18, 1972, substantial habitation warranting collection sewers from a pollution control standpoint.

B. Cost-Effectiveness

New collector sewers must be proven in the facility plan to be necessary and cost-effective in addition to being eligible under the definition of "substantial human habitation" and the two-thirds rule.

New collector sewers should be funded only when the systems in use (e.g. septic tanks or raw discharges from homes) for disposal of wastes from the existing population are creating a public health problem, contaminating groundwater, or violating the point source discharge requirements of the Act. Specific documentation of the nature and extent of health, groundwater and discharge problems must be provided in the facility plan. Where site characteristics are considered to restrict the use of on-site systems, such characteristics, (e.g. groundwater levels, soil permeability, topography, geology, etc.) must be documented by soil maps, historical data and other pertinent information.

The facility plan must also document the nature, number and location of existing disposal systems (e.g. septic tanks) which are malfunctioning. A community survey of individual disposal systems is recommended for this purpose, and is grant eligible.

In addition, the facility plan must demonstrate, where population density is less than 10 persons per acre, that alternatives are clearly less cost-effective than new gravity collector sewer construction and centralized treatment. Such alternatives are cited in the previous Administrator's memorandum of December 30, 1976, subject: "Encouraging Less Costly Wastewater Facilities for Small Communities" and Mr. Rhett's memorandum of August 18, 1976 on "Eligibility of Septic Tanks and other Small Treatment Systems". A draft guidance document accompanied the August 18 memorandum. The draft policy represents the policy of the Agency until issued in final form.

The alternatives to be evaluated include the following:

- measures to improve operation and maintenance of existing septic tanks including more frequent inspections, timely pumpouts, and prohibition of garbage grinders.

- new septic tanks

- holding tanks and "honey wagons"

- various means of upgrading septic tanks, including mounds, alternate leaching fields and pressure sewers

- other systems to serve individual households or a cluster of households. Such systems include, for example, wastewater separation, water conservation and recycle systems where feasible.

The facility plan, where applicable, must examine alternatives such as limited sewer service for a portion of a community. For example, septic systems work very well in many small towns except in one isolated area such as a business district where open space for adequate on-site disposal is not available.

C. Public Disclosure of Costs

All projects, including collection systems, on which public hearings were held after January 2, 1977, must comply fully with the requirements of Program Requirements Memorandum 76-3 prior to approval.

Agency policy is to ensure public disclosure of the costs of any collection system projects where a public hearing was held on or before January 2, 1977. Such disclosure shall take the form of a prominently published notice in a local newspaper, and the cost is grant eligible. The Agency shall pay the cost of the notice if necessary to expedite the project.

The notice shall include the estimated monthly charge for operation and maintenance, the estimated monthly debt service charge, the estimated connection charge and the total monthly charge to a typical residential customer for the new collection system being funded and any other associated wastewater facilities required. Such associated facilities would include new treatment capacity needed to handle the flows from the new collection system.

The charges may be only rough estimates, and may be presented as a range of possible costs when major unknowns exist such as whether or not substantial parts of the project are grant eligible.

IV. IMPLEMENTATION

The States are to be advised of the issuance of this policy at once. All pending and future grant applications for collection system projects or projects containing collection systems are to be reviewed for compliance with this policy.

The requirements of sections III-A and III-C are effective immediately.

The requirements of Section III-B are effective immediately for all projects which have received a step 1 facility planning grant but have not yet received approval of their facility plan.

For all other projects, the requirements of section III-B are effective immediately unless the Regional Administrator determines, from information in the facility plan and other sources, that a project is necessary and cost-effective even though the full documentation required by section III-B is not available. In any case, the full requirements of section III-B shall apply without exception to all projects being reviewed for funding after September 30, 1977.

V. REFERENCES

A. Sections 201, 211, 212, P.L. 92-500.

B. 40 CFR §§ 35.905-19, 925-7, 925-13, Appendix B.

C. PRM 76-3, "Presentation of Local Government Costs of Wastewater Treatment Works in Facility Plans", August 16, 1976.

D. Memorandum to Regional Administrators from Russell E. Train, "Encouraging Less Costly Wastewater Facilities For Small Communities", December 30, 1976.

E. Memorandum to Regional Administrators from John T. Rhett, "Less Costly Treatment Systems", August 18, 1976.

for Douglas M. Costle

APPENDIX H

COMBINED SEWER OVERFLOWS

APPENDIX H

COMBINED SEWER OVERFLOWS

H.1 BACKGROUND INFORMATION

H.1.1 Present Conditions

The City of Columbus has almost 12,000 acres of area served by combined sewers. This constitutes approximately 12 percent of the present service areas of the two Columbus wastewater treatment plants.

Flow from the 2,500 acres of the combined area tributary to the Southerly Treatment Plant may discharge through only one regulated point: the Alum Creek Storm Standby Tank. This tank receives flow from a 108-inch interceptor and passes it through a 48-inch square regulator gate which is presently set at an 8-inch opening. When large quantities of storm water are added to the sanitary flow the regulator gate acts as an orifice which passes a fraction of the total flow and impounds the remainder until it overflows into the storm standby tank. The standby tank is designed to treat influent flows by sedimentation and to collect floating material before discharging to Alum Creek.

The remaining 9,400 acres of combined area contributes flow to the Jackson Pike Plant. Flow is collected by numerous interceptors, each of which must pass through a regulator before entering the Olentangy Scioto Intercepting Sewer (O.S.I.S.). Each regulator is composed of a system of sluice gates for interception and weirs for overflow. Table H-1 describes the 17 regulators which discharge flow into the O.S.I.S.

Table H-1 also describes the six regulators in the Jackson Pike system which are not part of the O.S.I.S. network above the Whittier tanks. The Old Main and South Side interceptor sewers each have two regulators. Two regulators also exist on the west side of the Scioto River. The Sullivant Avenue regulator has its overflow blocked, preventing any discharge. Apparently, the bypass into which the Harmon Avenue regulator overflows has not been used by the Jackson Pike treatment facility for over two years, indicating total interception of the flows from the separate sewer area above this point.

Flows in the O.S.I.S. can be ultimately regulated by the Whittier Street Storm Standby Tanks. The Jackson Pike Plant has controls onsite to automatically shutdown and

Table H-1
Present Regulators

Location	Description: Pipe Regulated	Description: Size of Opening to Interceptor	Description: Interceptor Discharge to
Hudson Street	48" Sewer	24" x 24" Sluice Gate	O.S.I.S.
Doe Alley	33" Sewer	18" x 18" Sluice Gate	O.S.I.S.
Frambes Avenue	66" Sewer	48" x 36" Sluice Gate	O.S.I.S.
Indianola Avenue	8' Sewer	54" x 54" Sluice Gate	O.S.I.S.
King Avenue	24" Sewer 36" Sewer	24" x 36" Sluice Gate	O.S.I.S.
Third Avenue (1)	84" Sewer	48" x 48" Sluice Gate	O.S.I.S.
First Avenue	15" Sewer 24" Sewer	20" x 20" Sluice Gate	O.S.I.S.
Henry Street (1) (2)	96" Sewer	72" x 48" Sluice Gate	O.S.I.S.
West Street	60" Sewer	30" Diameter Sluice Gate	O.S.I.S.
Chestnut Street	117" Sewer 72" Sewer	66" x 66" Sluice Gate	O.S.I.S.
Spring Street	36" Sewer 84" Sewer	30" x 30" Sluice Gate	O.S.I.S.
Long Street	42" Sewer	30" x 36" Sluice Gate	O.S.I.S.
Broad Street	96" Sewer	30" x 48" Sluice Gate	O.S.I.S.
Town Street	72" Sewer	38" x 48" Sluice Gate	O.S.I.S.
Rich Street	49" x 60" Sewer	36" Diameter Sluice Gate	O.S.I.S.

Table H-1 - Continued
Present Regulators

Location	Description: Pipe Regulated	Description: Size of Opening to Interceptor	Description: Interceptor Discharge to
Peters Run	120" x 66" Sewer	54" x 54" Sluice Gate	O.S.I.S.
Whittier Street	36" Sewer	36" x 36" Sluice Gate	O.S.I.S.
Cozzins Avenue	96" Sewer	16" Flap Gate Float Actuated	Old Main Int.
Spring & West Street	24" Sewer	16" Flap Gate Float Actuated	Old Main Int.
Moler Street	60" Sewer	36" x 36" Sluice Gate	South Side Int.
Markison Avenue	72" Sewer	30" x 30" Sluice Gate	South Side Int.
Sullivant Avenue(3)	48" Sewer	12" x 12" Sluice Gate	O.S.I.S. (after Whittier Tank)
Harmon Avenue	78" Sewer	24" x 24" Sluice Gate	O.S.I.S. (after Whittier Tank)

(1) Sewers Cross Connect - able to share flows.
(2) Overflow intercepted by Cozzins Avenue Regulators.
(3) Overflow blocked.

bypass the flow from the O.S.I.S. through the storm standby tanks by activating a regulator gate. If the Jackson Pike Plant does not control the closure of the regulator at the Whittier tanks, the gate automatically holds the level of flow through the O.S.I.S. at or below U.S.G.S. Elevation 705.

H.1.2 Present Plans

A sewer system evaluation survey for the combined areas has been authorized by the City of Columbus. This study will be performed by consultants to the City, and is expected to be completed by mid-1978. The City of Columbus has separated several sections of the combined sewered areas over the past 10 to 12 years, with the most recent being an area near the Ohio State University. These improvements have all been completed using local funds.

A bond issue was recently passed which included $30.7 million for sewer separation. Three areas are presently being considered for separation. They are:

- Milo-Grogan Area - Approximately 1,100 acres of area located between the Ohio State Fairgrounds and the Penn Central Railroad. This area is presently undergoing detailed engineering design.

- East Central Area - Approximately 2,500 acres, or roughly the entire combined area in the Southerly service district. This area is presently undergoing engineering design, with the lower portion being done in detail.

- Lower West Side - Roughly 1,900 acres, including all combined sewers west of the Scioto River. This area is presently under detailed engineering design for both sewer separation and sanitary relief sewers, with 40-50% of the planned work presently under contract for construction.

Figure H-1 provides an overview of the total combined areas along with a delineation of those undergoing study for separation.

H.2 MATHEMATICAL CHARACTERIZATION OF OVERFLOWS

This Section describes and documents the data and results for input information into a mathematical model of the combined overflows along with the model output.

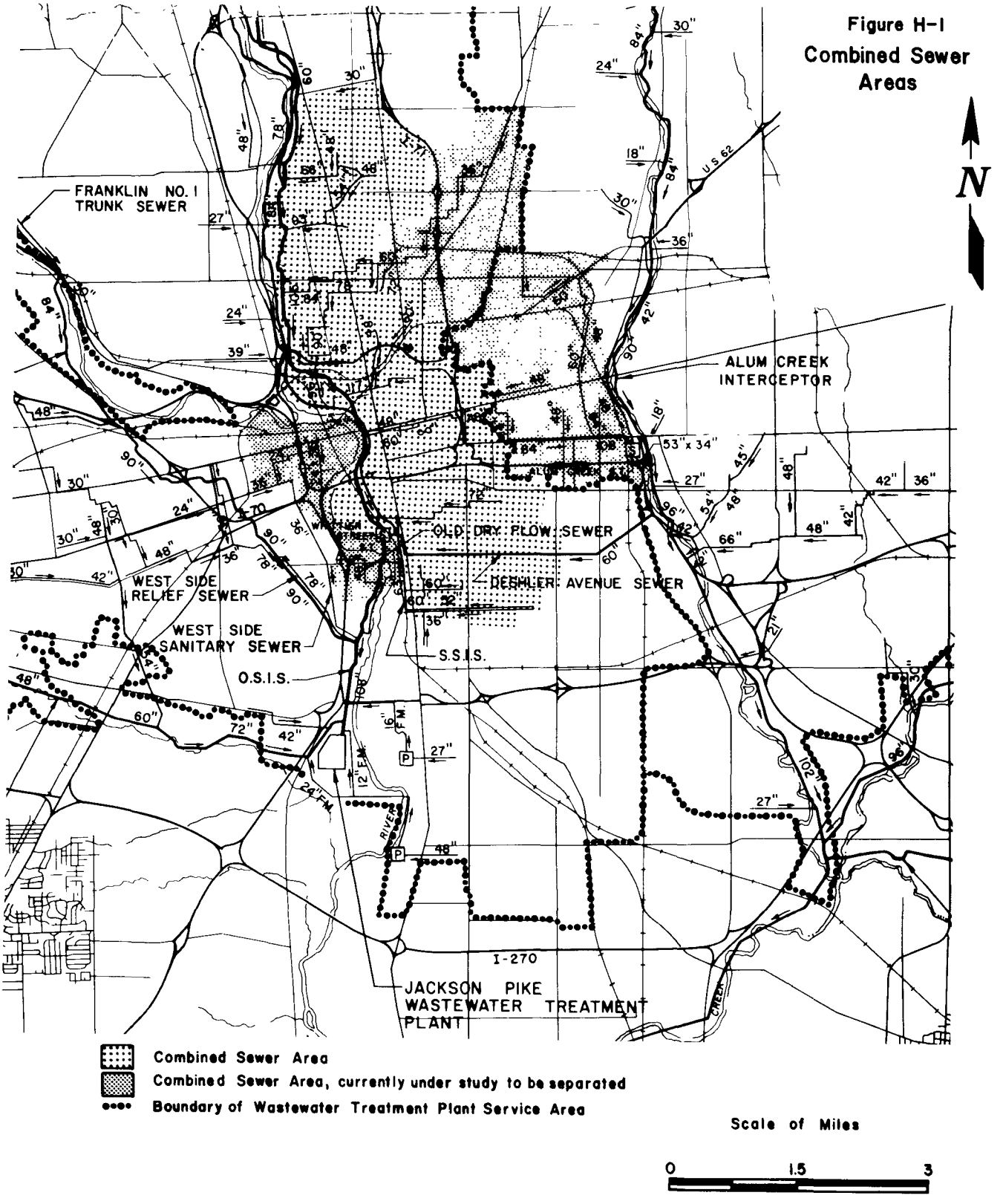


Figure H-1
Combined Sewer Areas
N
FRANKLIN NO. 1 TRUNK SEWER
ALUM CREEK INTERCEPTOR
OLD DRY FLOW SEWER
DEEMLER AVENUE SEWER
WEST SIDE RELIEF SEWER
WEST SIDE SANITARY SEWER
O.S.I.S.
S.S.I.S.
JACKSON PIKE WASTEWATER TREATMENT PLANT
I-270
U.S. 62
Combined Sewer Area
Combined Sewer Area, currently under study to be separated
Boundary of Wastewater Treatment Plant Service Area
Scale of Miles
0
1.5
3

H.2.1 Precipitation

Five years of precipitation records for the Columbus area (1971-1975) were evaluated in an attempt to establish probable precipitation effects. Three types of occurences were chosen to illustrate precipitation effects on combined overflows. Numbers of events, as well as total duration time for each, were grouped for rainfall events below 0.25 inches, 0.50 inches, and 1.4 inches (a one year/three-hour duration storm).

Table H-2 gives information as to duration, intensity, and percent exceedance of each range between these precipitation events. The one year storm event with three hour duration was chosen as critical, since several of the combined areas were calculated to have a time of concentration which approached three hours.

H.2.2 Overflow Quantities

Using the reported average intensities in conjunction with planimetered areas, the Rational Method ($Q = CiA$) was used to find peak runoff quantities from the areas served by combined sewers. The "C" values in the Rational equation were found by using the Hoad-McKee method, which considers percent imperviousness and duration time. For a duration of three hours the "C" values ranged from 0.60 to 0.85; while a duration of six hours resulted in a constant value of 0.95 for all combined sewered areas.

Since the duration of each storm event considered is about one-half an hour longer than the largest calculated time of concentration, a conservative estimate was used which assumed the peak runoffs from each contributory area were additive. The two treatment facilities were assumed to handle as much of this runoff quantity as their peak hydraulic capacity will allow. Table H-3 shows the computed runoff quantity for each storm event, the flow that treatment plants will be able to accept, and the quantity of runoff estimated to overflow to the respective water courses.

Table H-2
Five Year Period Precipitation Event Data

Amount of Precipitation Per Event	Average Duration (hours)	Average Intensity (in/hr)	Percent Exceedance
Less than 0.25 inches	3	0.08	18
Between 0.25 inches and 0.50 inches	6	0.08	18
Between 0.50 inches and 1 year/3 hour storm (a)	3 (b)	0.47	1

(a) According to Technical Bulletin 40, the one year storm with a three hour duration time for this area is 1.4 inches.

(b) The storm events between 0.50 inches and the one year storm average 10 hours duration; however, the one year storm gave a larger intensity and was therefore chosen for this range.

Table H-3

I. Overflow Quantities for Alum Creek

Storm Event		Peak Runoff (mgd)	Intercepted Flow To Southerly (mgd)	Overflow (mgd)
Average Intensity (in/hr)	Average Duration (hr)			
0.08	3	96	110	0
0.08	6	122	110	12
0.47	3	565	110	455

II. Overflow Quantities for the Scioto River

Storm Event		Peak Runoff (mgd)	Intercepted Flow(1) (mgd)	Overflow (mgd)
Average Intensity (in/hr)	Average Duration (hr)			
0.08	3	360	170	190
0.08	6	460	170	290
0.47	3	2,100	170	1,930

(1) Assumes ability to transfer flow through 150"-156" interconnecting sewer to Southerly at design conditions.

H.2.3 Overflow Qualities

The quality associated with combined sewer overflows must be estimated in order to examine the impact of pollutant loads for various rainfall events. Quality characterization should include, at a minimum, estimates of concentrations of BOD, ammonia nitrogen, and dissolved oxygen. Due to the extreme variability of combined sewer overflows and the site and event specific nature of the problem, very broad ranges for each parameter were incorporated into all analyses. It is not intended to pinpoint exact loads discharged at each regulator, as a detailed and lengthy field program would be required for such a task. (The current, ongoing sewer system evaluation survey is designed to fulfill these needs.) However, the approach of modeling the expected average high and low concentrations does lend itself as a tool for judging the relative impacts of various rainfalls and may make possible the drawing of generalized conclusions.

The range of concentrations used for each of the three parameters are given in Table H-4.

Table H-4
Overflow Qualities

Parameter	Poor Quality mg/l	Good Quality mg/l
SS	500	150
BOD_5	130	50
TKN	10	1
DO	2	4

These levels were determined by a search of available literature as indicative of conditions ranging from poor overflow quality heavily impacted by sanitary wastes to a relatively dilute flow which reflects a greater storm water makeup. These concentrations must be related to peak flow and are not intended to reflect a first flush phenomena. First flush conditions are not considered due to the operation of the existing regulators, which intercept the first flush (or a large portion thereof) and transport it to the treatment plants.

H.2.4 Mathematical Modeling

Computer modeling of combined sewer overflows is a complex undertaking, with the many variables and conditions discussed earlier usually investigated by use of a sophisticated,

nonsteady state computer model. The nature of the available data, particularly with regard to anticipated flow variations at the significant overflow points, precludes such a sophisticated analysis for the purposes of this report. Little can be gained by following and modeling the time-varying effects of overflow quantities and loads in a model when these basic inputs are poorly defined.

Given the assumptions that were made regarding flows and loads, it seemed appropriate to use the same steady state model employed in the low flow characterization of the Scioto River below the Jackson Pike and Southerly wastewater treatment plants (Appendix B). Such a model will predict an instantaneous condition in a receiving stream, with no indication of the duration of a stress condition at a given point. Inputs from modeled overflows were varied in terms of both flow and load to attempt to simulate different release conditions. Results should be interpreted in a very broad, relative sense, and not as indicative of specific occurrences which would be encountered following a particular storm event.

Release flows used for modeling runs were those developed for the three storms discussed earlier. Each was modeled initially at both of the pollutants levels (DO = 2 or 4 mg/l, BOD_5 = 50 or 130 mg/l, NH_4-N = 1.0 or 10 mg/l) indicated by literature review to be representative of ranges expected from combined overflows.

Background stream flows and quality above the release point of the modeled overflows are extremely difficult to quantify, but in a different sense than that associated with the definition of these same variables for the actual overflow. Estimates of significant statistical flow regimes are arrived at relatively easily due to the many USGS (United States Geological Survey) stream gaging stations in the area. Despite this quantification, there is no general agreement among investigators as to what particular flow regime is indicative of probable critical conditions prior to a major storm event. It is generally conceded, however, that the seven consecutive day, ten year low flow used in the modeling and allocation of loads from continuous point sources of wastewater (i.e. treatment plants) is too severe a background condition for modeling of combined sewer overflows. Accordingly, this study has used estimates of stream flow provided by the USGS which represent seven consecutive day two year low flow (7-2); 120 day, two year low flow (120-2); and average annual flow. It was originally intended to

investigate conditions under a 120 day, ten year (120-10) background low flow as well, but this regime proved to be closely approximated in streams in the Columbus area by the 7-2 flow. Table H-5 provides a summary of the three flow regimes used in the modeling activities.

Background stream quality characteristics are also difficult to define. In an effort to avoid overquantification and confusion as to the source of stream impact below the combined releases; a background stream BOD_5 of 4.0 mg/l was input, a value only slightly higher under all flow regimes than that used in the Appendix B modeling for critical (7-10) low flow. Dissolved oxygen concentrations were assumed to be at 90 percent of saturation, and background ammonia levels were considered to be negligible.

Stream temperatures were assumed to be 22°C for the 7-2 and 120-2 conditions and 18°C for the average annual flow. Flow velocities were calculated by the model using the coefficient-exponent technique described in Appendix B. Actual time of travel and velocity runs conducted by the USGS on Alum Creek demonstrate good correlation with velocities predicted using the coefficient-exponent method with input flows similar to those present at measured conditions.

Deoxygenation rates for both carbonaceous and nitrogenous demand stabilization were incorporated at the "high" levels presented in Appendix B. Rates were adjusted as stream velocity varied, with lowest values assumed at depositing (< 0.6 fps) velocities, and highest values used at scouring (> 1.0 fps) velocities.

A total of 30 modeling runs were conducted for untreated overflow conditions: 12 for Alum Creek and 18 for the Scioto River. Each overflow quantity at each of the two major points of release was modeled at both untreated quality levels previously defined in combination with the three background stream flow regimes.

Results for the six Alum Creek simulation runs at the one year storm overflow indicate severe degradation under even the lowest flowing load assumption of a good overflow quality release into an average annual stream flow. Dissolved oxygen levels are predicted to fall to a zero or trace concentration at all conditions investigated. Probable ammonia toxicity conditions are also predicted at all three background stream flows if a poor quality release is assumed.

Table H-5
Input Stream Flows and Loads

USGS Station Identification	7-2		120-2		Avg. Annual	
	cfs	cfs/ sq. mi.	cfs	cfs/ sq. mi.	cfs	cfs/ sq. mi.
Alum Creek at Columbus (1) (2)	3.0	0.016	17.0	0.090	167	0.880
Big Walnut Creek at Reese	33.0	0.061	103	0.189	507	0.932
Scioto River at Columbus (2)	157	0.096	314	0.193	1,380	0.847
Big Darby Creek at Darbyville	17.0	0.032	47	0.120	443	0.830

(1) Some change in the tabulated values will be effected by the Alum Creek Reservoir.

(2) Flow values per square mile used for tributary inputs in modeling runs.

Due to the severity of the degradation caused by the one year storm untreated overflows, load reduction measures were only investigated in conjunction with an annual average background flow. Assuming that no reduction in the ammonia levels contained in the "good" untreated quality will take place, cuts were made in the BOD_5 release concentrations. Even after reducing the BOD_5 level to 10 mg/l (at a DO of 5 mg/l) minimum stream DO only increased to slightly under 3.0 mg/l. Once this release quality level was attained, however, stream quality proved to be relatively insensitive to release flow quantities, with release flow cuts of 50 percent producing small (< 0.2 mg/l) increases in downstream minimum DO levels.

Trace DO levels were observed in five out of six model runs conducted for the untreated overflow resulting from a 0.5 inch, three hour storm. Only in the good release quality to an annual average stream flow run did the DO remain at a somewhat acceptable level (3.0 mg/l). Treatment of the overflow to a BOD_5 of 10 mg/l produced minimum downstream DO's of 3-4 mg/l at the 7-2 and 120-2 background flow regimes. Reduction of BOD_5 to 20 mg/l was all that was required to maintain a minimum DO of 5 mg/l at average annual stream flow. Due to the low overflow magnitude (12 mgd), such a treatment level may already be achieved by the existing tank.

The untreated release situation below the Whittier Storm Tanks demonstrates trace DO levels under all release and dilution consideration investigated. Unlike Alum Creek, there are severe degradation problems at all storm events quantified, for even the smallest of these three produces an overflow situation. Thus, conditions modeled in the Scioto River are far more likely to occur than those in Alum Creek, both in terms of rainfall event probability and likelihood of proper characterization in this analysis. The latter statement is true because even if flow and quality characteristics of the release have been significantly overstated, there is sufficient variation between the events modeled (190 vs. 1,930 mgd) to assure that at least the lower values will occur on a regular basis.

Reductions in the overflow BOD_5 to 10 mg/l produced significant improvement in the Scioto for only the lowest overflow quantity modeled. Even then, minimum stream DO remained near 1.0 mg/l at 7-2 and 120-2 background stream flow, and increased to only slightly over 3.0 mg/l at an average annual flow condition. The essential comparison,

then, between the Alum Creek and Scioto River overflow situations is that similar levels of treatment on the overflow due to the smallest storm event at points above and including the Whittier Tanks will produce a stream quality nearly equivalent to that which occurs below the Alum Creek Storm Tanks following the greatest storm event considered.

H.3 ALTERNATIVES FOR ABATEMENT OF COMBINED SEWER OVERFLOW IMPACT

This section uses the output of the computer model to define alternatives for abatement of overflow loads and flows.

H.3.1 Alum Creek

The model output indicated that the degradation of Alum Creek is more dependent on the quality of combined overflow than the quantity (within the ranges investigated). Therefore, this section will consider only those combined overflow management alternatives which will reduce pollutant loading to the receiving stream.

The following methodologies are discussed:

- source control
- collection system control
- storage
- physical treatment
- physical-chemical treatment
- biological treatment

(1) Source Control

The only source control alternative that would specifically exert a significant impact on the quality of storm runoff is street cleaning. Sweeping efficiency ranges from 79% for a particle size of 2,000 microns, to 15% for particle sizes of less than 43 microns. Unfortunately, the pollutant characteristics of combined storm and wastewater flows are dominated by the smaller particle distribution. Consequently, the largest

source of pollutants is least efficiently removed by street sweeping equipment. An estimate of pollution reduction due to a well coordinated street sweeping program approaches only 20% for both BOD and total solids.

(2) Collection System Control

Collection system control alternatives pertain to the transport of flow in combined sewers. These alternatives include sewer separation, infiltration/inflow control, line flushing, polymer injection, regulators, and remote monitoring and control.

Sewer separation is attained by the construction of either a sanitary or storm sewer adjoining the existing combined sewer. A separated sewer system can also be achieved by constructing a sewer within the existing combined sewer. The advantages of sewer separation include:

- all sanitary sewage is treated prior to discharge
- wastewater treatment plants operate more efficiently under more stable flow regimes.
- external power requirements are minimal
- no land acquisition is necessary
- little increase in operation and maintenance manpower is needed.

Disadvantages of separate sewers include:

- a comparatively expensive alternative
- extensive construction creating disruptions over extended periods of time
- only partial reduction of the pollution effects of overflow is achieved due to the pollutants contained in stormwater alone.

Infiltration and inflow represent two sources of unnecessary additional flow through the sewer system. However, unless this flow is unusually large, its dilution effect would not ease the quality dependent situation at Alum Creek.

Flushing of the sewer system represents a control alternative which decreases the first flush pollutant impact of combined sewer overflows. Since the storm standby tank can already accept and pass the first flush, this would not be an effective alternative. Polymer injection to increase the hydraulic capacity of the combined sewers is not viable, since the Southerly WWTP is considered to be operating at its peak hydraulic capacity at the overflow conditions investigated.

The remaining collection system control alternatives; regulators, and remote monitoring and control of combined sewer flows, have been partially implemented with the construction of the Alum Creek Storm Standby Tank. It is possible to automate this tank's operation in the future.

(3) Storage

Storage of combined sewer overflow can be either an "in-line" or "off-line" control technique. The storage facilities in both instances dampen the quantity of combined sewer overflow during storm events. "In-line" storage is accomplished by retaining flow in the sewer system and subsequently allowing it to continue on for treatment. "Off-line" storage involves the diversion of the combined overflow to a holding facility. Stored flow is either returned to the sewer system after overflows have ceased or is held for onsite treatment.

In addition to providing flow detention, storage can be easily adapted to provide primary treatmant for combined sewer overflows. Other advantages in using storage as a control technique include:

- simple in design
- unaffected by quality or quantity fluctuations
- relatively fail-safe
- adapts well to stage construction

The major drawbacks to storage facilities area:

- construction costs
- real estate requirements due to large size

- aesthetic impacts
- possible solids handling and disposal problems
- impact on value of adjoining land

"In-line" storage may be a viable solution, but "off-line" storage will not be considered further due primarily to the need for relatively large land areas in the highly developed areas served by the combined sewer system.

(4) Physical Treatment

Physical treatment alternatives include sedimentation, dissolved air flotation, screening, swirl concentration, or the use of a helical bend. Dissolved air flotation and screening are not considered feasible for the Alum Creek conditions due to their relatively low removal of BOD_5 in conjunction with large capital investments and O&M costs.

1. Sedimentation

Sedimentation facilities consist of concrete settling basins designed to provide quiescent conditions for the combined sewer flow. Proper design can achieve removal rates of approximately 30 and 60 percent for BOD_5 and suspended solids, respectively.

Using sedimentation as a control for combined sewer overflow has two main advantages:

- the process is well proven and refined
- the detention tank itself provides storage capacity for combined sewer flows.

The major disadvantage of using sedimentation is found in the size of the detention tank which results in large construction costs when compared to other physical treatment methods.

2. Swirl Concentration

The swirl concentration control technique consists of an off-line circular channel in which rotary motion creates a gentle swirl. Combined sewer overflow into the chamber is slowed and diffused with very little turbulence. The particles entering the basin settle rapidly and are concentrated at an underflow outlet back to the interceptor. Excess flow discharges over a center circular weir in the unit and is conveyed to storage, further treatment, or the receiving stream.

Experience at Syracuse, New York, indicates that swirl concentrators can achieve BOD_5 and suspended solids removals in excess of 50%. The swirl concentrator is considered to be particularly attractive for treatment of the first flush derived from combined overflows.

The main advantage in using a swirl concentrator is its cost-effectiveness for the amount of treatment provided. This technique can handle high flows and is relatively maintenance free, since it incorporates no moving parts. The main disadvantage of a swirl concentrator is the large head loss experienced between trunk and interceptor sewers. This situation often necessitates the installation of a pump to return the concentrated underflow to the interceptor. Construction and maintenance costs associated with such a pump decrease the relative cost-effectiveness of this alternative.

3. Helical Bend

A helical bend control alternative can operate efficiently as a flow-through, nonmechanical channel bend device in removing settleable solids and, thereby, reducing the pollutional impact of periodic overflow incidents. Field testing of this alternative has been limited. The only full scale helical bend in operation is in Nantwich, England, and is reported to be operating successfully. Grit removals in lab prototypes have been reported to approach 100%. Suspended solids and BOD_5 removal efficiencies can be expected to approach, and possibly exceed, those reported for a swirl concentrator, which elicits 90% grit removal.

The helical bend control alternative possesses the potential to provide good control of wet weather flow in combined sewers. The English study[1] suggests that the main advantages of utilizing the helical bend are:

- the structure can be designed to treat high flow rates;
- it is potentially maintenance free;
- requires minimal land usage;
- it requires less head loss than the swirl concentrator; and
- it is cost-competitive.

The main disadvantages are that:

- its design requires a transition section of 10 to 15 times the inlet sewer diameter; and
- it has had limited field applications.

(5) Physical-Chemical Treatment

Physical-chemical treatment systems are best utilized as a control alternative when effluent requirements are extremely stringent. Excluding simple coagulant addition, a process of this type is not cost-effective for the Columbus situation due to the large capital and operation and maintenance expenditures required for the relatively infrequent times the system is to be operated. The objectives here are better achieved with less sophisticated and less costly methods.

(6) Biological Treatment

Biological treatment is used to remove nonsettleable colloidal solids and to stabilize dissolved organic matter. This treatment process is not considered viable for combined sewer overflow treatment unless it is incorporated at a wastewater treatment plant site.

(1) "The Helical Bend Combined Sewer Overflow Regulator", Environmental Protection Technology Series, Report EPA-600/2-75-062, December 1975.

(7) Alternative Selection

There is no clear choice of any one technique or combinations of techniques to be implemented at the Alum Creek Storm Standby Tank. Five of the methods discussed above have been retained for cost comparison in this section. They are:

- sewer separation;
- in-line storage;
- sedimentation and storage;
- swirl concentrator; and
- helical bend

Another alternative which should be considered is allowing the present system to operate "as is" with no new capital outlays.

Sewer separation is a very costly procedure. The USEPA report entitled "Alternative Waste Management Techniques for Best Practicable Waste Treatment" lists 1964 costs of sewer separation for 16 cities as $468/person. If this cost is brought to 1977 by use of an ENR Construction Cost Index ratio of 2.6, the cost per person would be increased to almost $1,220. If the Alum Creek combined sewer area is assumed to presently contain approximately 30,000 people, the cost for separation, in 1977 dollars, would be estimated at over $36 million. As mentioned earlier, $30.7 million has been allocated through a City bond issue, a portion of which will be used to eliminate the Alum Creek overflow by selected sewer separation.

In-line storage for the Alum Creek combined area would require a thorough knowledge of the system in order to maximize the volume of flows stored. The reason for its inclusion in this analysis is that the actual cost of the sewer modifications and operations is usually low relative to most other control schemes.

At this time, there is little knowledge of how well the present Alum Creek Storm Standby Tank is operating. The original plans at this site provided for the future construction of one additional tank. If further study shows the need for this second tank, it could be installed for an estimated cost of $1.8 million. This tank would increase the total available volume to 1.7 million gallons, which will provide 30 minutes detention for an average flow rate of 82 mgd.

Costs for helical bends and swirl concentrators were derived from a USEPA report entitled "The Helical Bend Combined Sewer Overflow Regulator". Since removal efficiencies vary with amount of overflow treated, costs were developed for three capacities for both helical bends and swirl concentrators.

Table H-6 summarizes costs for all selected control methodologies in terms of 1977 dollars. All of these alternatives have costs associated with them due to operation and maintenance expenses. The largest possible expenditure of this type is associated with the swirl concentrator, which may require pumpage due to head loss through the system. Inclusion of operating and maintenance costs will not affect the overall cost comparison of the alternatives.

H.3.2 Scioto River

The computer model indicated that the overflows to the Scioto River are not easily assimilated for any of the conditions investigated. Degradation of the stream occurs due to the impact of both the quality and quantity of combined sewer overflow. The control methods previously described for the Alum Creek situation could also apply to the Scioto River. However, due to the need for abatement of both quality and quantity of combined sewer system overflows, and the many different locations to be considered (over 20), the most likely alternative is to first optimize the operation of the existing system.

Costs for total sewer separation in the combined areas located along the Scioto River seem to be prohibitive. If the same basis is used as in the Alum Creek area, assuming a population of 147,000 people, a total estimated cost of over $180 million is derived.

The planned separation and sanitary sewer relief for some 3,000 acres in the Jackson Pike service area would result in a 13 to 14 percent reduction in the peak runoff values given in Table H-3, with the overflow quantities reduced even more significantly. The three hour storm event at 0.08 inches per hour would have a 24 percent reduction in peak overflow. The six hour duration storm with the same intensity would have a 22 percent reduction, while the one year storm would have a reduction of 14 percent. These reductions will not affect the conclusion drawn from the data reported in Table H-3, since, as stated above, the degradation of the Scioto River below combined overflow points is due to both overflow quantity and quality.

Table H-6
Cost Comparisons of Selected Combined Overflow Management Alternatives for the Alum Creek Area

Method	Flow Capacity (mgd)	Estimated % BOD_5 Reduction	Capital Cost (1) $100,000
Sewer Separation	N.A.	N.A.	360
In-line Storage (2)	-	-	-
Sedimentation and Storage	41 (64 cfs) (3)	30	18.0
Swirl Concentrator	32.3 (50 cfs)	50	1.3
	64.6 (100 cfs)	50	2.1
	106.7 (165 cfs)	50	3.0
Helical Bend	32.3 (50 cfs)	50	3.2
	64.6 (100 cfs)	50	6.0
	106.7 (165 cfs)	50	8.5

(1) Land Costs not included.

(2) Feasibility studies required for even preliminary capacity and cost estimates.

(3) Total capacity = 82 mgd.

N.A. - Not Applicable

A special analysis and report on the Whittier Storm Standby Tanks was published in 1971 by the Federal EPA.[1] The recommendations from this report are presented below:

- The Jackson Pike Wastewater Treatment Plant is limited in the volume of flow which it can handle from the Olentangy-Scioto Intercepting Sewer upstream of the Whittier Street Storm Standby Tanks. All flow in excess of the limiting rate (often 10 mgd) will have to be passed through the tanks, except in rare instances when it will be necessary to open the emergency gates to avoid tank overflow. Since some reduction in concentrations of solids and BOD and improvement of dissolved oxygen is obtained, even at higher rates of flow, it is recommended that all flow up to the point where overflow of the tanks would occur be passed through the tanks.

- The construction of two additional tanks considered in the original design is not recommended because of the limited benefits which would be derived.

If the existing system is to stay in use, steps toward increasing the efficiency of its operation would include:

- Require the separation of sewage and storm waters in new or renewed construction areas.

- Maximize interception of the regulator chamber flows into the O.S.I.S. so as to pass as much flow as possible through the Whittier Tanks.

- Maximize the quantity of combined sewer flows to be treated at either the Jackson Pike or Southerly Treatment Plants through the use of the interconnecting sewer.

The above suggestions would have a minimal cost to the City of Columbus associated with them, and could be implemented along with any future decision regarding further control of the combined overflows.

(1) "Evaluation of Storm Standby Tanks, Columbus, Ohio", Water Pollution Control Research Series 11020FAL 03/71, EPA Water Quality Office, 1971.

APPENDIX I

REVIEW AND EVALUATION OF THE WASTEWATER TREATMENT PROCESSES RECOMMENDED BY THE COLUMBUS FACILITIES PLANS

APPENDIX I

REVIEW AND EVALUATION OF THE WASTEWATER TREATMENT PROCESSES RECOMMENDED BY THE COLUMBUS FACILITIES PLANS

This chapter presents the project plan for wastewater treatment and waste solids management at the Jackson Pike and Southerly Water Pollution Control Facilities proposed by Consultants to the City of Columbus. It is divided into four sections. The first provides the basic data used by the consultants to screen, evaluate, and design the recommended improvements. The second and third sections, respectively, address the main stream treatment and waste solids management Facilities Plans. These sections describe the unit processes or treatment concepts examined in the screening process, the viable alternatives subjected to a detailed comparison, and the final recommended project plan. The data presented in the first three sections was extracted and summarized directly from the Facilities Plans; costs and evaluations therein are solely the work of the consultants retained by the City of Columbus.

The final section provides an independent engineering analysis which evaluates the original basis of design as defined by the influent wastewater characteristics, the conclusions of the screening and detailed comparisons, and the final recommended project plan. A review of the costs used in the Facilities Plan indicated no serious areas of disagreement. Consequently, they have been retained in this analysis and in the cost comparisons drawn in the main text of this Impact Statement.

I.1 BASIC DATA

I.1.1 Design Populations and Loads

Population projections for the Jackson Pike and Southerly Wastewater Treatment Plants' service areas are presented in Table I-1.

Table I-1
Population Projections

	1985	1995
Southerly	442,633	573,177
Jackson Pike	561,589	610,348

These data were used to determine the flow, BOD_5, and suspended solids loadings for 1995 as summarized in Table I-2.

Table I-2
1995 Influent Flows and Loads

	Jackson Pike		Southerly		
	30 Day Maximum	Average Annual	30 Day Maximum	Average Annual	
Q, mgd	120	120	120	120	
BOD_5, mg/l	225	190	340	265	*
SS, mg/l	302	270	275	220	*
P, mg/l	12	10	13	9	
Primary sludge, lb/day	136,000	121,600	123,800	99,100	
Secondary sludge, lb/day	204,500	175,300	233,500	178,500	*

This table also cites the waste sludge quantities used for design. These values include the additional waste solids associated with phosphorus removal and final effluent polishing.

I.1.2 Design Effluent Standards

Performance goals for the two Columbus Wastewater Treatment Plants are defined by the current National Pollutant Discharge Elimination System (NPDES) permit limitations of each. These release criteria are summarized in Table I-3. Essentially, both plants must achieve the same performance levels.

I.2 MAIN STREAM TREATMENT

I.2.1 Preliminary Screening of Process Alternatives

This section provides a summary of the unit processes or treatment concepts initially examined for their applicability in serving the treatment needs at both the Jackson Pike and Southerly facilities.

Table I-3
Jackson Pike and Southerly
NPDES Effluent Limitations

Parameter	Average Permissible Values 30 Day	7 Day
BOD_5, mg/l	8	12
SS, mg/l	8	12
Fecal Coliform, No/100 ml(1)	200	400
NH_4-N, mg/l		
July-October	1.0	1.5 *
November-June	2.5	5.0
P, mg/l	1.0	1.5
DO, mg/l	6.0	
pH, units	6-9	

	Maximum Permissible Values(2)	
Cl_2 residual, mg/l	0.5	
DO, mg/l	4.0	(minimum)
Cr_{tot}, µg/l	300	
Cr_{+6}, µg/l	50	
Ni, µg/l	500	(3)
Pb, µg/l	40	(4)
Cu_{tot}, µg/l	50	(5)
Zn_{tot}, µg/l	400	(5)

(1) Geometric means
(2) Listed values are instantaneous maximums except for DO
(3) Southerly only
(4) Jackson Pike only
(5) Assuming total hardness is 240-320 mg/l as $CaCO_3$

(1) Preliminary Treatment

Screening, grit removal, influent pumping, and preaeration were recommended for inclusion in any final treatment scheme at both plants.

(2) Primary Sedimentation

Primary sedimentation was also recommended as an essential process in any alternative for Columbus' wastewater treatment.

(3) Phosphorus Removal

Phosphorus removal by either metal salt (iron or aluminum) or lime addition was examined during the screening step of process selection. Main stream lime coagulation and clarification was rejected on both a cost-competitive basis and by its incompatibility with existing unit processes.

In comparison to iron, aluminum is less likely to show significant soluble residuals in the final effluent at similar metal ion-to-phosphorus molar dosages. This advantage, coupled with the overall favorable cost comparison attributed to metal salt addition, makes the selection of the addition of aluminum as alum the most attractive process for phosphorus removal.

(4) Carbonaceous BOD Removal

Methods of carbonaceous BOD removal by biological and physical-chemical means were screened in the Facilities Plan. Physical-chemical techniques, such as activated carbon adsorption, ion exchange and reverse osmosis were eliminated as not cost-competitive with biological treatment concepts. This was due to both the readily biodegradable nature of the Columbus wastewater and the unproven applicability of these physical-chemical processes for other than advanced treatment applications.

Alternatives cited for biological stabilization of the wastewater's carbonaceous component included both suspended (air and oxygen activated sludge) and fixed film or attached growth reactors (rock and synthetic media trickling filters and rotating biological contactors). Rotating biological contactors were eliminated from further consideration due to area limitations at both plants. Synthetic media trickling filters were selected over those containing rock due to performance and cost considerations.

(5) Nitrogenous Oxygen Demand

The physical-chemical alternatives for removal of the nitrogenous oxygen demand (ammonia stripping, selective ion exchange, and breakpoint chlorination) were screened and rejected for one or more of the following reasons:

- economic unattractiveness,
- cold weather failure,
- unproven full-scale performance, and
- incompatibility with existing unit processes.

Biological nitrification, alone and with additives, was selected as the only viable concept for removal of the nitrogenous oxygen demand. In the screening process, single stage attached growth systems were eliminated for reasons of cost and unreliability. Single stage air activated sludge and attached growth-suspended growth treatment options without the benefit of intermediate sedimentation alternatives were also screened out for reasons of undocumented performance under similar operating conditions or needs. The net result of the screening evaluation was that six biological alternatives were retained for detailed evaluation. These six alternatives are described in the "Alternative Evaluation" section later in this chapter.

(6) Effluent Polishing

Microscreening and granular media filtration were considered as the only viable unit process of those screened for effluent polishing at the Columbus facilities. Lagooning, land application, and granular activated carbon adsorption were examined and rejected for reasons of implementability or expense. Ultimately, granular media filtration was selected as the only reliable unit process which could consistently achieve the required final effluent suspended solids residuals.

(7) Disinfection

Chlorination and ozonation were screened for applicability at the two wastewater treatment plants. Chlorination was finally selected due to the capital and operational intensive costs found with ozonation.

I.2.2 Alternative Evaluation

The preliminary screening of alternate unit process and treatment concepts resulted in the selection of six alternatives for possible application at Jackson Pike and Southerly. Each of these alternatives share common preliminary, primary, effluent filtration and disinfection treatment capabilities. The six alternatives can be grouped as a function of two-stage or single-stage treatment concepts as shown below:

- Two-stage treatment with intermediate sedimentation
  - synthetic media trickling filtration and pure oxygen activated sludge
  - synthetic media trickling filtration and air activated sludge
  - pure oxygen activated sludge
  - air activated sludge
- Single-stage treatment
  - pure oxygen activated sludge
  - air activated sludge with powdered activated carbon addition

Only the air activated sludge system with powdered activated carbon addition represents a significant departure from more or less proven nitrification technology. This system, patented by Zimpro, claims the benefit of improved stability and effluent clarity but relies upon successful regeneration and reuse of the powdered activated carbon for economic feasibility.

(1) Evaluation Methodology

Each of the previously listed alternatives was evaluated on the basis of five parameters: cost, reliability, implementation capability, energy and resource use, and public acceptability. The evaluation procedure incorporated a subjective ranking system of 1 through 10 with the lowest number being the most acceptable or desirable. Table I-4 provides the ranking matrix from the Facilities Plan. A short discussion of each parameter follows.

1. Cost

Detailed costs were developed in the Facilities Plan for all six alternatives. The single-stage pure oxygen system was most expensive in first cost at both treatment facilities. Conversely, on

Table I-4
Process System Alternatives
Ranking Matrix

Parameters	Two Stage Treatment				Single Stage Treatment	
	T.F./O_2	T.F./Air	O_2O_2	Air/Air	O_2	Air w/Carbon
Cost	4	3 (2)	4	2 (5)	5 (6)	8 (6)
Reliability	3	2	5	5	5	8
Implementation Capability	4	2	6	3	6	4
Energy and Resource Use	3	5	4	4	6	7
Public Acceptability	5	4	5	5	6	8
TOTAL	19	16 (15)	24	19 (22)	28 (29)	35 (33)

( ) Unique to Southerly, all other rankings common to both plants.

a first cost basis, the two-stage air activated sludge system was most attractive at Jackson Pike while the trickling filter-air activated sludge system was most preferable at Southerly. Operation and maintenance expenditures at both plants were highest for the single-stage air activated sludge system incorporating powdered activated carbon additions, and the lowest for the trickling filter-pure oxygen activated sludge two-stage treatment alternative. Collectively, these costs translated into a least cost selection of two-stage treatment at both plants: air activated sludge at Jackson Pike, and trickling filtration with air activated sludge at Southerly.

2. Reliability

The reliability parameter formulated in the Facilities Plans addressed two considerations: the ability of a process sequence to consistently meet the required air, land, and water standards; and the ability of the present management system and operators to utilize the proposed sequence efficiently. The trickling filter-air activated sludge system was deemed the most reliable of the alternatives evaluated.

3. Implementation Capability

The ability of the City to undertake, construct, and operate a proposed system alternative was of major import in the implementation capability category. The short-term effects derived with any change from the existing system were also considered under this evaluation parameter. Once again, the Facilities Plan rated the two-stage trickling filter-air activated sludge alternative as the most favorable.

4. Energy and Resource Use

The energy and resource use parameter considered the irretrievable commitment of power, fuel, and chemicals associated with each alternative. Here, the apparent advantages of the two-stage trickling filter-pure oxygen activated sludge system were highlighted, as the system was rated the least energy and resource use intensive.

5. Public Acceptability

The final parameter, public acceptability, collectively considers the previous four with recognition of the dominance of cost considerations. The two-stage trickling filter-air activated sludge system was rated as most acceptable to the public in the opinion of the City's consultants.

(2) Conclusions

Summation of the subjective weights assigned to each process alternative for each parameter showed the two-stage trickling filter-air activated sludge alternative to be the preferred treatment system for both Columbus facilities. This alternative scored consistently well throughout the parameters evaluated. Accordingly, it was selected for implementation at both the Jackson Pike and Southerly Wastewater Treatment Plants.

I.2.3 The Project Plan

(1) Facility Requirements

Table I-5 summarizes the capital improvement program proposed for the two Columbus plants and the resulting unit process sizing.

(2) Power Requirements

Table I-6 summarizes the estimated nameplate and operating horsepower for the two treatment plants at the proposed design conditions.

(3) Cost Estimates

Table I-7 summarizes the estimated construction and operating costs for the improved wastewater treatment plants. In total, the proposed main stream treatment improvement program was estimated to cost over $90 million with an operating budget of nearly $7.5 million annually.

Table I-5
Main Stream Treatment Improved Facilities
(Existing Facilities Identified in Appendix A)

Unit Process	Jackson Pike	Southerly
PRETREATMENT		
Headworks	Construct new headworks, convey all flows to new screen, grit and pumping facilities for 200 mgd capacity.	
Bar Screens and Racks	Construct for 200 mgd capacity three manually cleaned bar racks and three mechanically cleaned bar screens.	
Grit Facility	Construct four new grit tanks with a total volume of 0.42 mg and a firm blower capacity of approximately 1,000 cfm.	Existing four tanks, with a total volume of 0.32 mgd, and two blowers, at 960 cfm per, are adequate.
Influent Pumps	Construct a new pump building for five 50 mgd pumps.	Existing facilities of four 30 mgd pumps and two 65 mgd pumps are adequate.
PREAERATION	Expansion of existing four tanks from 1.7 mg to 2.1 mg. Blower capacity to increase from two 3,000 cfm units to a total firm capacity of 21,000 cfm.	Existing three tank total volume of 2.6 mgd is adequate. Blower capacity of three 3,400 cfm units to be increased to include an additional two 4,000 cfm units.
PRIMARY TANKS	Existing eight tanks to be improved to increase capacity from 96,000 SF to 125,000 SF.	Existing eight tanks, with a total area of 120,000 SF, are adequate.

Table I-5 - Continued
Main Stream Treatment Improved Facilities
(Existing Facilities Identified in Appendix A)

Unit Process	Jackson Pike	Southerly
FIRST STAGE BIOLOGICAL TREATMENT		
Pump Station	Construct a new pump station with five 50 mgd pumps.	Construct a new pump station with five 45 mgd pumps.
Trickling Filters	Construct eight synthetic media trickling filters; total area to equal 68,000 SF with 21.5 feet of depth.	Construct eight synthetic media trickling filters; total area to equal 58,000 SF with 21.5 feet of depth.
Intermediate Clarifiers	Construct eight intermediate clarifiers; total area to equal 84,375 SF.	Construct eight intermediate clarifiers; total area to equal 73,500 SF.
SECOND STAGE BIOLOGICAL TREATMENT		
Aeration Tanks	Existing twelve tanks to be improved, yielding a total capacity of 31.5 mg.	Existing ten tanks to be improved but total present capacity of the tanks will remain the same at 26.3 mg. Two new tanks, at 2.6 mg each, to be constructed bringing total future capacity to 31.5 mg.
Final Clarifiers	Existing twelve tanks to be improved but total present capacity of the tanks will remain the same at 110,000 SF. New clarifiers, adding 95,000 SF, to be constructed, bringing total future area to 205,000 SF. Revised return sludge capacity to yield 103 mgd maximum.	Existing facilities of eight tanks to be improved but total present area of the tanks will remain the same at 135,000 SF. New clarifiers, adding 37,400 SF, to be constructed, bringing total future area to 172,400 SF. Return sludge capacity defined at 87.5 mgd.

Table I-5 - Continued
Main Stream Treatment Improved Facilities
(Existing Facilities Identified in Appendix A)

Unit Process	Jackson Pike	Southerly
EFFLUENT POLISHING	New facilities to be constructed to accommodate fourteen effluent filters with a total area of 26,400 SF. New effluent pump station to be constructed with space for five 50 mgd pumps. Maximum backwash rate of filters to equal 60 mgd.	New facilities to be constructed to accommodate twelve effluent filters with a total area of 22,300 SF. New effluent pump station to be constructed with space for five 45 mgd pumps. Maximum backwash rate of filters to equal 60 mgd.
DISINFECTION	New facilities, including four chlorinators and four evaporators, to be constructed; tank capacity to equal 2.16 mg.	New facilities, including two chlorinators and two evaporators, to be constructed; tank capacity to equal 1.77 mg.
HIGH WATER PUMPS	Not defined.	Existing six 35 mgd pumps are adequate.

Table I-6
Main Stream Treatment Project Plan
Power Requirements

Unit Process	Jackson Pike		Southerly	
	Nameplate Horsepower	Operational Horsepower	Nameplate Horsepower	Operational Horsepower
PRETREATMENT				
Screening & Grit	159	56	88	46
Influent Pumps	2,000	800	2,200	745
PREAERATION	900	450	950	360
PRIMARY TREATMENT	50	50	40	40
1ST STAGE BIO-TREATMENT				
Pump Station	2,000	800	2,600	1,000
Trickling Filters	8	8	8	8
Intermediate Clarifiers	92.5	47.5	72.5	42.5
2ND STAGE BIO-TREATMENT				
Aeration System	3,600	2,763	6,000	4,350
Final Clarifiers	120	120	71	71
Return Sludge Pumps	590	225	520	200
Waste Sludge Pumps	120	60	160	80
EFFLUENT FILTRATION				
Filter Pumps	1,250	500	1,125	438
Backwash Pumps	820	410	880	440
Surface Water Pumps	300	150	310	155
Plant Water Pumps	240	120	360	180
DISINFECTION				
Booster Pumps	60	40	60	40
HIGH WATER PUMPS	-	-	900	0
MISCELLANEOUS HP	75	50	8	3.5
TOTAL HORSEPOWER	12,385+	6,650	16,350	8,200

Table I-7
Mainstream Treatment
Construction and Annual Operation and Maintenance Costs

I. CONSTRUCTION COSTS ($1,000)[1]

Unit Process	Jackson Pike		Southerly	
PRETREATMENT		$ 4,656		$ 0
Bar Screens & Racks	$ 783		$ 0	
Grit Facility	924		0	
Influent Pumps	2,949		0	
PREAERATION		1,898		66
PRIMARY TANKS		1,498		0
PHOSPHORUS REMOVAL		2,160		0
1ST STAGE BIO-TREATMENT		15,790		14,088
Pump Station	8,090		7,090	
Trickling Filters	3,335		3,022	
Intermediate Clarifiers	4,365		3,976	
2ND STAGE BIO-TREATMENT		13,941		5,472
EFFLUENT FILTRATION		11,705		10,158
Filters	9,029		7,511	
Pump Station	2,676		2,647	
ADDITIONAL CHEMICAL TREATMENT	-	-		1,080
DISINFECTION		1,225		764
HVAC, PLUMBING, ELECTRICAL, ETC.		3,287		3,163
TOTAL		$56,160		$34,791

II. ANNUAL OPERATION AND MAINTENANCE COSTS[2]

Item	Jackson Pike	Southerly
Chemicals	$1,961,000	$1,806,000
Power	761,000	937,000
Personnel	727,000	686,000
Material & Supply	287,000	241,000
Total	$3,736,000	$3,670,000

(1) Uses 1974-1975 basis; includes contingencies at 25%.
(2) Average costs developed over the planning period on an annual basis. Approximately 60 percent of chemical costs associated with alum for phosphorus removal.

I.3 WASTE SOLIDS HANDLING AND DISPOSAL

The development of the waste solids management program for the Columbus Water Pollution Control Facilities has been evaluated in two documents: the Facilities Plan and the Environmental Assessment. Although differing in scope, content, and detail, both documents have a similar format: preliminary screening, detailed evaluation, and project plan selection. The following summarizes the information contained in these reports.

I.3.1 Preliminary Screening

The Facilities Plan for waste solids management did not fully develop the unit process alternatives screened out prior to a detailed evaluation of processing alternatives. The seven alternatives evaluated in detail were as follows:

- Centrifugation before and after heat conditioning, incineration, and landfill
- Centrifugation and composting
- Centrifugation, heat treatment, and liquid disposal 365 days a year
- The preceding system with incineration utilized four months each year
- The preceding system with year around incineration both as backup and as a continuous heat source for thermal conditioning
- Centrifugation before and after heat conditioning, dry land disposal
- Centrifugation before and after heat conditioning, landfill disposal

The Environmental Assessment screened the 11 processing alternatives described in Table I-8 as a function of the defined categories in the matrix. If an alternative received favorable marks under two of the three categories, it was retained for detailed analysis. As can be seen in the Table, four waste solids management alternatives were retained for detailed evaluation. These alternatives were:

- Composting, preceded by centrifugation for thickening and dewatering, and dry land application;
- Aerobic digestion, chemical conditioning, centrifugal dewatering, and landfill disposal;
- Heat treatment, centrifugal dewatering, incineration, and landfill disposal; and
- Heat treatment, centrifugal dewatering, and dry land application.

Table I-8
Environmental Assessment of
Waste Solids Handling and Disposal Alternatives

Process Sequence	Past Performance (1)	Energy Usage (1)	Flexible Disposal (1)	Retained
Composting, Centrifugation, Dry Land Disposal	+	-	+	Yes
Aerobic Digestion, Chemical Addition, Centrifugation, Landfill	+	-	+	Yes
Aerobic Digestion, Chemical Addition, Centrifugation, Incineration, Landfill	+	-	-	No
Anaerobic Digestion, Chemical Addition Centrifugation, Flash Drying, Dry Land Disposal	-	-	-	No
Anaerobic Digestion, Pasteurization, Liquid Land Disposal	-	+	-	No
Heat Treatment, Liquid Land Disposal	-	-	-	No
Heat Treatment, Centrifugation, Incineration, Landfill	+	+	+	Yes
Heat Treatment, Centrifugation, Dry Land Disposal	+	-	+	Yes
Chemical Addition, Centrifugation, Wet Air Oxidation, Liquid Land Disposal	-	+	-	No
Chemical Addition, Centrifugation, Incineration, Landfill	-	-	-	No
Anaerobic Digestion, Chemical Addition, Vacuum Filtration, Incineration, Landfill	-	-	-	No

(1) "+" indicates a favorable evaluation; "-" is negative.

I.3.2 Detailed Alternative Evaluation

The three waste solids management alternatives surviving both screening processes are summarized in Table I-9, along with the parameters used in the evaluation matrix of the Facilities Plan. The following paragraphs describe these evaluation parameters in more detail.

(1) Costs

Costs were developed in the Facilities Plan to quantify the true system needs at each wastewater treatment plant from the point of solids generation through the final point of residue application. Costs for residual liquor (landfill leachate, compost drainage, etc.) and nonpoint surface runoff control and treatment were not developed for any of the remote handling or application site alternatives. These considerations were addressed in the subjective part of the matrix. From a strict cost standpoint, this creates a favorable bias towards the composting and land application alternatives in both first and annual costs. With this qualification, the incineration and land application alternatives are nearly equivalent on a present worth basis. The tradeoff involved is that the incineration alternative is first-cost intensive, while the land application alternative is intensive in operational costs.

(2) Implementation Capability

The Facilities Plan rated the incineration alternative as the most implementable since it continues the existing type of operation and largely manages the waste solids at the plant site. The two land-based alternatives have a poor implementation rating because of the necessity to rely upon favorable conditions, both natural and man-induced, beyond those normally associated with wastewater treatment and waste solids management at Columbus.

(3) Contribution to Water Quality Objectives

The Facilities Plan judged the incineration and composting alternatives as good in their contributions toward achieving water quality objectives. This judgment was based upon the fact that the pollutant emissions from both these systems are reasonably predictable, concentrated, and controllable in comparison to a broad-based land disposal scheme.

Table I-9
Waste Solids Handling and Disposal Evaluation Matrix

Parameters	Alternatives: Incineration (1)	Composting (2)	Land Application (3)
COSTS (4)			
First Cost	1.00	0.95	0.93
Annual Costs			
Electricity	0.62	0.80	1.00
Fuel	0.05	0.26	1.00
Manpower	0.52	1.00	0.59
TOTAL	0.59	1.00	0.98
Present Worth	0.82	1.00	0.84
SUBJECTIVE			
Implementation Capability	Excellent	Poor	Poor
Contribution to Water Quality Objectives	Good	Good	Fair
Reliability	Good	Good	Poor
Public Acceptability	Good	Good	Fair
OVERALL ATTRACTIVENESS	Good	Fair	Fair

(1) Centrifugation before and after heat conditioning, incineration, ash landfill, with heat recovery from incineration to conditioning.
(2) Centrifugation and composting.
(3) Centrifugation before and after heat conditioning, cake land application.
(4) Cost values developed as sum of Jackson Pike and Southerly expenditures, highest value assigned unity factor - all others defined as the calculated fraction of unity, based upon reported costs in the Facilities Plan.

(4) Reliability

The reliability of the incineration alternative was rated good, since final responsibility for day-to-day waste solids management rests with a single entity, unencumbered by climatological conditions and least impacted by the variables of manpower and energy availability. Although less so, the composting alternative was also given a good rating in the Facilities Plan due to the manageability, predictability, and buffer built into its unit operations.

(5) Public Acceptability

Public acceptability can only be addressed as a function of the entire community in the service area. The community is most sensitive to debt and service charge; the incineration alternative will minimize both. Special interest groups will respond also to environmental considerations. The incineration alternative, when examined from an energy usage viewpoint and with recognition of the pollutant emissions derived in other alternatives from electrical power generation and vehicle traffic, was judged to be less significant than the others in terms of collective atmospheric emissions. The Facilities Plan points out that although the incineration alternative does not recycle nutrients to the land, it does recover and use directly the latent energy available in the waste solids.

(6) Overall Attractiveness

In the final analysis of both costs and subjective considerations, the incineration alternative was judged most attractive and recommended to the City of Columbus as the preferred project plan for the Jackson Pike and Southerly Wastewater Treatment Plants. The documents prepared by the City's consultants indicated that the incineration alternative was the one system that gave day-to-day reliability with the benefit of future flexibility when and if land application schemes become a reality. In this scenario, the incinerator would be relegated in the future to a supportive position to assure a continuous on-demand solids processing capability.

I.3.3 The Project Plan

(1) Improved Facilities

Table I-10 summarizes the capital improvement program proposed for the two Columbus plants and the resulting unit process sizing. Special note should be made of the special primary sludge withdrawal system, which is proposed as an alternative to gravity thickening as a sludge concentrating concept. The design goal is to obtain a primary sludge concentration of about 5 percent solids.

(2) Cost Estimates

Table I-11 summarizes the estimated construction and operating costs for the improved waste solids management capability at both wastewater treatment plants. In total, the Facilities Plan contained a construction cost estimate of nearly $70 million, with an annual operating budget of about $3.8 million.

Table I-10
Waste Solids Handling and Disposal Facilities

Process Step	Jackson Pike	Southerly
Primary Sludge Withdrawal	Eighteen variable speed sludge pumps, flow meters, density meters, and indicating, recording, and control devices.	Same as Jackson Pike with twelve of each unit required.
Waste Sludge Concentration	Eighteen 200 gpm centrifuges.	Two additional air flotation units with a surface area of 1,900 SF each, giving a total of 11,400 SF for all six units.
Waste Sludge Conditioning and Settling	One additional 200 gpm thermal conditioning and one additional decant tank 45' in diameter 16' deep, giving a total of three 200 gpm conditioning units, 0.37 mg of decant volume, and 3,500 SF of decant area.	One additional 200 gpm thermal conditioning unit, giving a total of four 200 gpm conditioning units, 0.39 mgal of decant volume, and 3,800 SF of decant area.
Sludge Dewatering	Three additional 65 gpm centrifuges required along with the six 55 gpm units now being installed.	Six 65 gpm centrifuges for primary and recycle sludges and three 55 gpm units for conditioned sludges, giving a total of nine units.
Sludge Incineration	Two new 200 wet tons/day units in addition to the refurbishing and upgrading of two existing units to 170 wet tons/day.	Same addition as Jackson Pike, with the two existing units upgraded to 200 wet tons/day.

Table I-10 - Continued
Waste Solids Handling and Disposal Facilities

Process Step	Jackson Pike	Southerly
Ash Handling	1,000 gpm scrubbing water required per incinerator - 250 gpm to be mixed with bottom ash. Two new lagoons will be required at 192,500 SF x 12' deep each to replace existing lagoons. A pumping station for lagoon overflow will be required.	Same scrubbing and pumping requirements as Jackson Pike with no need for new lagoon construction. Existing ash lagoons provide 450,000 SF of total area and are six feet deep.
Recycle Treatment	A total of four aeration tanks must be constructed to provide a total volume of 5.1 mg with a total air supply of 35,600 cfm. Four settling tanks will also be required with a total area of 5,100 SF and a total volume of 0.46 mgal. Provisions will be incorporated to allow a 10% sludge return.	Same as Jackson Pike except air supply will be 38,200 cfm and the four settling tanks will provide a total area of 5,700 SF and a total volume of 0.51 mgd. *

Table I-11
Waste Solids Handling Project Plan
Construction and Annual Operation and Maintenance Costs

I. CONSTRUCTION COSTS

Unit Process	Jackson Pike	Southerly	
Primary Sludge Withdrawal	$ 500,000	$ 300,000	
Waste Sludge Concentration	8,000,000	2,300,000	
Waste Sludge Conditioning and Settling	4,000,000	1,800,000	
Sludge Dewatering	1,000,000	6,000,000	
Sludge Incineration	10,000,000	10,000,000	
Ash Disposal	500,000	100,000	
Recycle Treatment	5,500,000	5,800,000	
	$29,500,000	$26,300,000	
Contract Administration, Fees, and Contingencies	$ 6,900,000	$ 5,100,000	*
TOTAL CONSTRUCTION COST	$36,400,000	$31,400,000	*

II. ANNUAL OPERATION AND MAINTENANCE COSTS(1)

Chemicals(2)	$ -	$ 210,000	
Power	615,000	415,000	
Personnel	560,000	545,000	
Maintenance	760,000	700,000	
TOTAL	$ 1,935,000	$ 1,870,000	

(1) Operation and maintenance costs are for 1995. *
(2) No chemicals were assumed as necessary for centrifugal thickening and dewatering, chemical charge at Southerly was associated with dissolved air flotation thickening.

I.4 ENGINEERING ANALYSIS

State and Federal review of the Jackson Pike and Southerly Facilities Plans raised several fundamental questions concerning the basis of design for the proposed plant improvements. Collectively, these questions suggested the need for a baseline evaluation of the two treatment plants and a subsequent review of the proposed design criteria prior to the evaluation of any alternatives to the proposed action.

The baseline evaluation of the Jackson Pike and Southerly Wastewater Treatment Plants is provided in Appendix A. This evaluation contains the following:

- a description of the service area,
- a quantification of the influent wastewater characteristics,
- a description of the unit processes and their present mode of operation, and
- a characterization of the present performance.

These data provide the baseline information needed to review any basis of design considerations.

The value of the following engineering analysis is that it provides an independent development of design parameters and characterization of unit process performance. In recognition of the speculation and conjecture associated with the projection of future conditions and probable unit process performance, this analysis addresses only those facets of the conceptual design which may have a significant impact upon the success of the proposed installations and the performance of the unit processes contained therein. Accordingly, any interpretation of the results of this analysis bear the following qualifications:

- differences of 10 percent or less are insignificant,
- differences of 10 to 25 percent may or may not be significant depending upon the given parameter and its impact upon unit process performance, and
- differences of 25 percent or more may be significant.

I.4.1 Basic Data

Two parameters are of importance in the design of any wastewater treatment installation: influent wastewater characteristics, and final effluent quality objectives. The

latter will not be addressed here; it represents a given defined by the NPDES permits listed previously. Influent wastewater characteristics will be as formulated from the basis developed in Appendix A.

(1) Flow

Appendix A developed the approximate annual average flow for the two Columbus wastewater treatment plants in 1976 with an average annual precipitation of 37 inches. These flow characterizations provide the basis for the future flow projections shown in Table I-12.

The 1995-2000 flow projections in Table I-12 seem to pass a test of "reasonableness"; the 25 mgd difference between the Jackson Pike and Southerly flows is seen to be largely in the government and commercial flow source and in the magnitude of the inflow estimate. The older Jackson Pike service area, which serves the majority of the downtown Columbus area, would be expected to experience a higher average annual daily flow with a nearly equivalent domestic population.

The 110 mgd design flow developed for Jackson Pike is not significantly different than the 120 mgd defined in the Jackson Pike Facilities Plan.

The 85 mgd design flow developed for Southerly is some 35 mgd less than the average annual daily flow defined in the Southerly Facilities Plan. This difference is considered significant. The 85 mgd Southerly design flow is believed more nearly correct for the future condition at this installation. However, it should be noted that a combined overflow pollution abatement program which incorporates the Southerly collection system and treatment works could substantially increase this average day value.

Facility design entails more than the establishment of average day values, since hydraulically dependent unit processes are sized as a function of both process (successful treatment performance) and hydraulic capacity. In the absence of any information to the contrary, the process peak may be developed through the use of the following relationship:

$$\text{Process Peak} = 1.95\ (\text{Average Daily Flow})^{0.95}$$

Table I-12
Future Jackson Pike and Southerly Flow Estimates
(At 37 Inches Annual Precipitation)

I. JACKSON PIKE

Flow Source	Year 1975-1976	1985	1995-2000
Domestic Population[1]	500,000	550,000	600,000
Flow, mgd	26	28	30
Industry, mgd	9	10	11
Gov. and Comm., mgd	16	17	18
Infiltration, mgd	17	18	19
Inflow, mgd	32	32	32
TOTAL, mgd	100	105	110

II. SOUTHERLY

Flow Source	1975-1976	1985	1995-2000
Domestic Population[1]	300,000	400,000	500,000
Flow, mgd	16	21	27
Industry, mgd	6	8	11
Gov. and Comm., mgd	4	5	7
Infiltration, mgd	16	18	20
Inflow, mgd	18	19	20
TOTAL, mgd	60	71	85

III. RECOMMENDED FLOW PEAKS

	Jackson Pike	Southerly
Design Process Peak	170 mgd	130 mgd
Design Hydraulic Capacity[2]	200 mgd	230 mgd

(1) Nearest 50,000 people.
(2) Use 150 to 156-inch diameter interconnecting sewer to divert peak Jackson Pike flow to Southerly.

This relationship was used to define the EIS design process peak for the Columbus plants. Facilities are normally designed to handle this flow with little or no performance deterioration. The design hydraulic capacity of a plant is normally selected at 2 to 2.5 times the average daily flow for facilities the size of the Columbus installation. The Columbus Facilities Plan defined a design hydraulic peak of 200 mgd at Jackson Pike and 180 mgd at Southerly. These hydraulic peaks are less than two times the average daily flow defined in the Facilities Plan. However, when viewed from the new average daily flows developed in this review, only the Jackson Pike Facilities Plan design hydraulic capacity remains in strict violation of a peaking factor of at least two times the avarage daily flow.

Rather than expand the Jackson Pike hydraulic capacity from 200 mgd, it is recommended that all Jackson Pike flows in excess of 200 mgd be diverted to Southerly through the 150 to 156-inch diameter connecting sewer until the 230 mgd existing conduit hydraulic capacity of Southerly is reached. This will yield a collective hydraulic capacity for the Columbus Plants of 2.2 times the average day design flow, or a peaking factor within the norm of conventional design. Table I-12 has also summarized the recommended flow peaks used in this review.

The decision to use the interconnecting sewer for Jackson Pike service area flow diversion to Southerly is also consistent with present planning at Columbus. Recently, the City let a construction contract to tie-in the Big Run and Frank Road Jackson Pike service area interceptors to the interconnecting 150 to 156-inch sewer. It was assumed that this tie-in will be used only until the Jackson Pike infiltration/inflow problem is reduced, an eventuality which should take place during the planning period.

(2) Quality

An approximation of the future influent wastewater characteristics can be developed from the "knowns" of today with the flow projections of Table I-12.

Jackson Pike's future influent BOD_5 and SS load is estimated in Table I-13. The technique incorporated starts with a definition of the total influent load as

Table I-13
Future Jackson Pike Influent Characteristics

	BOD5		SS	
I. 1975-1976 Conditions[1] with Domestic Contribution Range				
A. Total Influent at 100 mgd -mg/l (1)	190		230	
- lbs/day	160,000		190,000	
Domestic Contribution at 0.17 lbs/capita-day	85,000		85,000	
at 0.23 lbs/capita-day		115,000		115,000
Commercial, Government, etc., (2) - lbs/day	26,000	35,000	26,000	35,000
Infiltration at 17 mgd - mg/l	1	5	5	25
- lbs/day	Trace	1,000	1,000	4,000
Inflow at 32 mgd - mg/l	10	25	50	75
- lbs/day	3,000	7,000	13,000	20,000
B. Total Domestic, Comm., Gov., and I/I - lbs/day	114,000	158,000	125,000	174,000
C. Industrial (A-B) - lbs/day	46,000	2,000	65,000	16,000
II. 1975-1976 with Domestic Contribution at 0.2 lb/capita-day (nearest 5,000 lbs/day)				
Domestic - lbs/day	100,000		100,000	
Comm., Gov., etc., - lbs/day	30,000		30,000	
Infiltration/Inflow - lbs/day	5,000		20,000	
Industry - lbs/day	25,000		40,000	
(at 9 mgd) - (mg/l)	(330)		(530)	

Table I-13 Continued
Future Jackson Pike Influent Characteristics

	BOD_5	SS
III. 1995-2000 (nearest 5,000 lbs/day)		
Domestic - lbs/day	120,000	120,000
Comm., Gov., etc., - lbs/day	35,000	35,000
Infiltration/Inflow - - lbs/day	5,000	20,000
Industry - lbs/day	30,000	45,000
TOTAL	190,000	220,000
(at 110 mgd) - (mg/l)	(210)	(240)

(1) Estimated in Appendix A
(2) $0.50 \left(\frac{Q \text{ comm., gov.}}{Q \text{ Domestic}}\right)$ (Domestic Mass)

developed in Appendix A. From this total load, reasonable estimates of the domestic, commercial, government, infiltration, and inflow loads can be subtracted to establish an industrial contribution. Domestic loadings were checked at per capita contributions of 0.17 lbs/capita-day and 0.23 lbs/capita-day; values which bracket those conventionally used for facilities design. The pollutant concentrations of the calculated industrial contribution were then checked against what self-monitoring data the City had available; the average BOD_5 and suspended solids concentration for the five largest sources (0.2 to 0.4 mgd) averages 400 and 600 mg/l, respectively. Reasonably agreement with these industrial concentrations is obtained if the domestic load contribution is assumed to be between the values (0.17 and 0.23 lbs/capita-day) investigated. Therefore, the 1995-2000 influent pollutant mass was projected assuming a domestic contribution of 0.2 lbs per capita per day, a slight increase in the commercial and government load, no change in the infiltration/inflow pollutant mass, and a 5,000 lb/day increase in the industrial BOD_5 and suspended solids.

Collectively, it is anticipated that the influent pollutant strength at Jackson Pike will increase slightly in the future. Comparing these values with the average day basis of design used in the Facilities Plan, an insignificant difference is observed in the BOD_5 concentration and mass, whereas the suspended solids concentration and design flow of the Facility Plan (270 mg/l and 120 mgd, respectively) show a significant difference of 50,000 lbs/day of dry suspended solids. It is believed that the lower value developed in Table I-13 is more nearly correct.

Table I-14 develops the influent characteristics for Southerly in a similar manner as used with Jackson Pike. Here, the test of reasonableness centers around the waste load derived from the brewery. The 100,000 pounds per day estimated brewery waste load in 1976 appears reasonable when viewed from the dramatic rise and fall of influent BOD_5 characteristics through the last 14 months of record. As shown in Figure I-1, daily peaks in excess of 1,000 mg/l BOD_5 were observed during this time, in conjunction with maximum average monthly BOD_5 of about 500 mg/l. Future projections at Southerly are most tenuous due to the presence of the waste load from Anheuser-Busch. The brewery has made

Figure I-1

Chronological Variation of
Southerly's Influent Characteristics

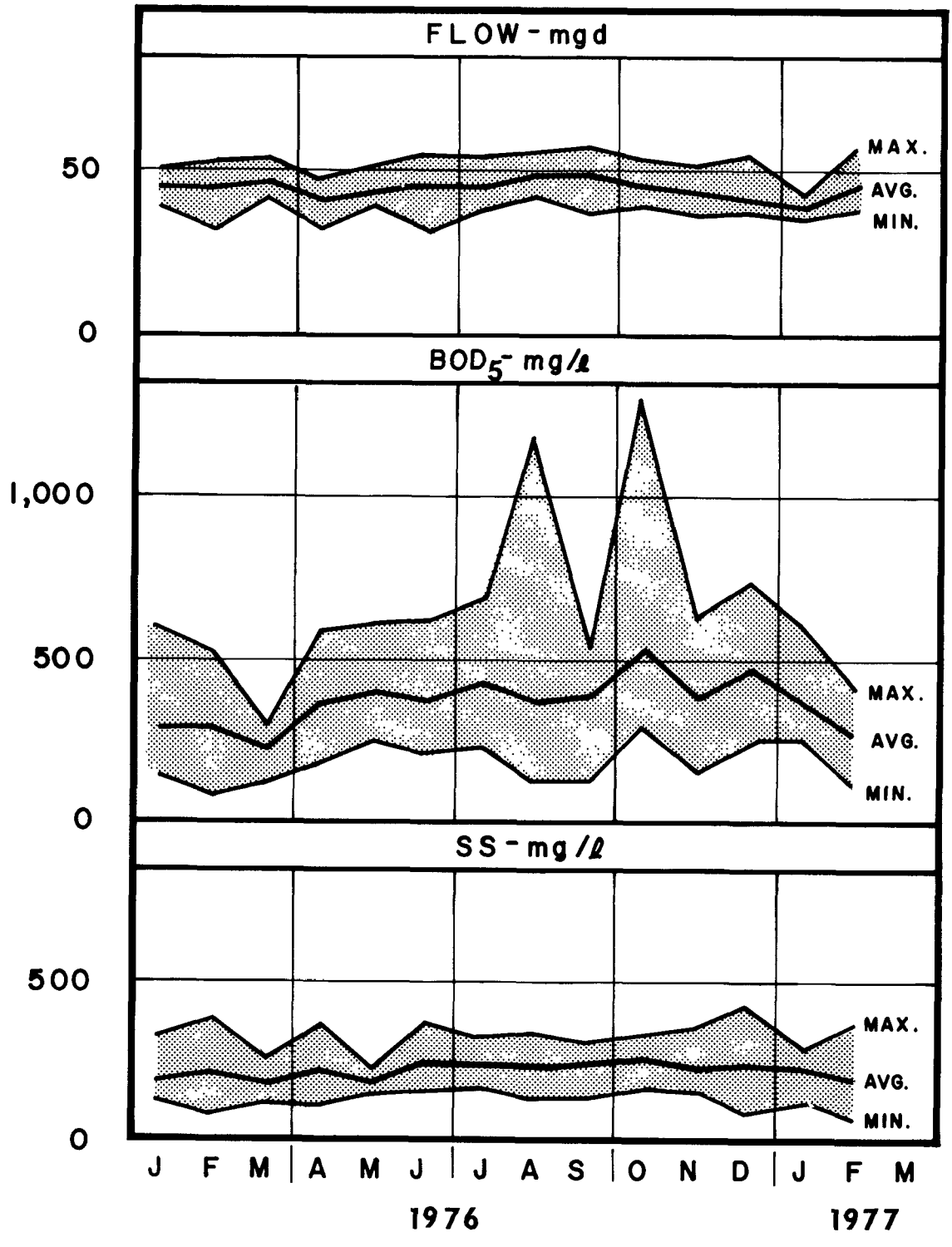


Table I-14

Future Southerly Influent Characteristics

I. 1976 Conditions (1)	BOD_5		SS	
A. Total Influent at 60 mgd -				
mg/l (1)	360		220	
lbs/day	180,000		110,000	
Domestic Contribution at 0.2 lbs/capita-day	60,000		60,000	
Commercial, Government, etc. - lbs/day(2)	6,000		6,000	
Infiltration at 16 mgd				
- mg/l	1	5	5	25
- lbs/day	Trace	1,000	1,000	4,000
Inflow at 18 mgd				
- mg/l	10	25	50	75
- lbs/day	2,000	4,000	8,000	11,000
Non-brewery Industrial Wastes at 3 mgd				
- mg/l	200	400	200	600
- lbs/day	5,000	10,000	5,000	15,000
B. Subtotal - lbs/day	73,000	81,000	80,000	96,000
C. Brewery Wastes at 3 mgd (A-B) - lbs/day	107,000	99,000	30,000	14,000
II. 1976 Conditions Use (nearest 5,000 lbs/day)				
Domestic - lbs/day	60,000		60,000	
Comm., Gov., etc. - lbs/day	5,000		5,000	
Infiltration/Inflow - lbs/day	5,000		10,000	
Nonbrewery Industrial - lbs/day	10,000		10,000	
Brewery - lbs/day (at 3 mgd) (-mg/l)	100,000 (4,000)		25,000 (1,000)	
III. 1995-2000 (nearest 5,000 lbs/day)				
Domestic - lbs/day	100,000		100,000	
Comm., Gov., etc. - lbs/day	15,000		15,000	
Infiltration/Inflow - lbs/day	5,000		10,000	

Table I-14 Continued
Future Southerly Influent Characteristics

	BOD_5	SS
Nonbrewery Industrial at 8 mgd - lbs/day(3)	25,000	25,000
Brewery at 3 mgd - lbs/day	60,000	15,000
TOTAL - lbs/day	205,000	165,000
(at 85 mgd) - (mg/l)	(290)	(230)

(1) Estimated in Appendix A

(2) $0.50 \left(\frac{Q.\ comm.,\ gov.}{Q\ Domestic}\right)$ (Domestic mass)

(3) Proposed U.S. EPA Guidelines (Federal Register, 42, 24, 6841-6844, February 4, 1977) allow the following future unforeseen industrial load to be eligible for grant funding if it is cost-effective:

a) not more than 10 percent of total future load exclusive of all industrial allowance, or
b) not more than 25 percent of the total existing and documented future industrial load.

These guidelines yield an allowable BOD_5 increase of 12,000 to 17,500 lbs/day and an allowable SS increase of 6,000 to 12,500 lbs/day. For simplicity, a BOD_5 and SS increase of 15,000 lbs/day was utilized.

a formal commitment to the City to keep its untreated waste BOD_5 load below 60,000 pounds per day following the near crisis release of the last three months of 1976. This commitment was assumed to be valid throughout the 20 year planning period. *

In comparison to the 1976 Southerly influent pollutant levels reported in Appendix A, the projected 1995-2000 influent wastewater characteristics show an estimated 90 mg/l BOD_5 decline with no change in the suspended solids concentration. The influent pollutant concentration values used for the Facilities Plan are less than 10 percent lower than the values listed in Table I-14. However, the higher average day design flow of the Facilities Plan (120 mgd) against the 85 mgd developed in this analysis results in approximately 29 and 35 percent more influent BOD_5 and suspended solids mass. It is believed that the lower mass values cited in Table I-14 are more correct if the brewery stays at a waste BOD_5 release of no more than 60,000 pounds/day on an average day basis.

(3) Design Wastewater Characteristics

Table I-15 reports the 1995-2000 design wastewater characteristics for the two Columbus treatment plants. As shown, the design values were developed from a variety of assumptions for each wastewater source. The final total pollutant concentrations were rounded off to the nearest 10 mg/l (SS, VSS, BOD_5, COD) and 0.5 mg/l (TKN, P) in recognition of the speculation associated with an attempt to define representative average day concentrations. In general, it is believed that the final estimated overall pollutant levels are within a tolerance of $\pm$10 percent; the tolerance associated with the specific source estimates may be somewhat greater. The nutrient levels associated with the brewery waste were estimated at one percent of the BOD_5 mass in recognition of its nutrient deficient nature and the absence of specific long term brewery waste analyses.

The final design criteria for unit process sizing is the influent pollutant mass peak. A design mass peaking factor of 1.9 was derived by multiplying the hydraulic process peak by 1.25, assuming this flow will carry a more concentrated waste load than that associated with the average day flow.

Table I-15
1995-2000 Design Wastewater Characteristics

I. JACKSON PIKE (2)(4)

Source	Pollutant (1)									
	SS	VSS	BOD_5		COD		TKN		Total P	
			Sus.	Sol.	Sus.	Sol.	Sus.	Sol.	Sus.	Sol.
POLLUTANT MASS - 1,000 lbs/day										
Domestic	120	100	80	40	160	80	5.2	13.0	1.0	4.0
Comm., Gov.	35	30	25	10	50	20	1.5	5.5	0.3	1.7
I/I	20	5	5	Trace	10	5	0.3	0.2	0.3	0.1
Industry	45	20	15	15	40	30	1.0	1.3	0.2	0.2
TOTAL - 1,000 lbs/day	220	155	125	65	260	135	8.0	20.0	1.8	6.0
POLLUTANT CONCENTRATION at 110 mgd - mg/l	240	170	140	70	280	150	8.5	22.0	4.0(3)	4.5

Table I-15 - Continued
1995-2000 Design Wastewater Characteristics

II. SOUTHERLY (2)(4)

Source	Pollutant (1)									
	SS	VSS	BOD_5		COD		TKN		Total P	
			Sus.	Sol.	Sus.	Sol.	Sus.	Sol.	Sus.	Sol.
POLLUTANT MASS - 1,000 lbs/day										
Domestic	100	85	70	30	140	60	4.3	11.0	0.8	3.3
Comm., Gov.	15	13	10	5	20	10	0.7	2.5	0.2	0.7
I/I	10	5	5	Trace	10	5	0.2	0.2	0.2	0.1
Industry w/o Brewery	25	20	15	10	30	20	0.6	0.9	0.1	0.2
Brewery	15	12	10	50	20	90	0.2	0.4	0.2	0.4
TOTAL - 1,000 lbs/day	165	135	110	95	220	185	6.0	15.0	1.5	4.7
POLLUTANT CONCENTRATION at 85 mgd	230	190	155	135	310	260	8.5	21.0	2.1	6.6

(1) Sus. = Suspended, Sol. = Soluble

(2)

	Jackson Pike	Southerly
Alkalinity - mg/l $CaCO_3$	250	200
Hardness - mg/l $CaCO_3$	300	300
Iron - mg/l	5	insignificant
Aluminum - mg/l	1	insignificant

(3) Assume 2 mg/l P insolubilization due to influent heavy metals.

(4) Pollutant Mass Peaking Factor

Jackson Pike = $\frac{170}{110}(1.25)=1.9$

Southerly = $\frac{130}{85}(1.25)=1.9$

The design influent wastewater characteristics reported in the Facilities Plans did not report alkalinity or TKN concentrations, nor the phase characterizations of the pollutants. The cited phosphorus levels are not significantly different than those proposed in Table I-15. The Facilities Plans estimated the volatile fraction of the influent suspended solids for Jackson Pike and Southerly at 60 and 70 percent, respectively; Table I-15 provides volatile suspended solids estimates of about 70 percent at Jackson Pike and about 80 percent at Southerly. It is believed that the latter values are more correct.

I.4.2 Evaluation of the Selection Procedure

(1) Main Stream Treatment

Table I-16 summarizes the processes screened and evaluated to select the main stream treatment system for Jackson Pike and Southerly. This array of unit processes, concepts, and techniques represents a fair appraisal of wastewater treatment technology in the 1974-1975 time frame. Although this study might have chosen the single stage air activated sludge system for detailed evaluation at Jackson Pike and might not have chosen the single stage air activated sludge system with powdered activated carbon addition for detailed evaluation, it is in agreement with the other five alternatives.

Conceptually, this analysis agrees with the selected and recommended main stream processing sequence for both plants. Two-stage treatment at Jackson Pike can be recommended if for no other reason than the need to maximize performance due to the critical position of the facility on the receiving stream. Technically, the isolated nitrification system has the greatest potential for ease of nitrification kinetics and production of an effluent free of ammonium. An upstream attached growth (fixed film) reactor provides an economical means of removing carbon with the potential corollary benefit of improved waste solids thickening characteristics. The upstream attached growth reactor at Southerly can be considered mandatory as long as the highly soluble carbohydrate wastes from the brewery significantly impact the plant's influent pollutant load.

Table I-16
Main Stream Treatment Selection
Process of the Facilities Plan

Processes Considered	Evaluation Outcome[1]
Preliminary Treatment	
Grit Removal	3
Screening	3
Preaeration	3
Primary Treatment	
Gravity Sedimentation	3
Phosphorus Removal	
Metal Salt Addition	3
Lime Addition	1
Biological Uptake	1
CBOD and NBOD Removal[2]	
Physical-Chemical:	
Activated Carbon	1
Reverse Osmosis	1
Breakpoint Chlorination	1
Ion Exchange	1
Ammonia Stripping	1
Biological:	
Single Stage Activated Sludge	
Air	1
Air with activated carbon	2
O_2	2
Single Stage Attached Growth	
Rock trickling filter	1
Synthetic trickling filter	1
Rotating contactor	1
Two Stage Systems[3]	
Synthetic TF and	
Air activated sludge	3
O_2 activated sludge	2
Air activated sludge	2
O_2 activated sludge	2
Effluent Polishing	
Filtration	3
Microscreening	1
Disinfection	
Chlorination	3
Ozonation	1

(1) 1 = dropped during preliminary screening; 2 = retained for detail analysis; 3 = part of recommended plan.
(2) Carbonaceous (CBOD) and Nitrogenous (NBOD) oxygen demand.
(3) All considered with and without intermediate sedimentation - final plan includes settling between stages.

Although the proposed main stream treatment system provides the greatest assurance of producing an effluent essentially free of oxygen demanding materials and suspended solids, it does not fully address the NPDES effluent permit standards nor the water quality criteria of the State of Ohio. One parameter of concern is the dissolved oxygen standard of 6 mg/l or greater for a 30-day average; nowhere in either Facilities Plan was a post-aeration capability mentioned. Another parameter not addressed in the Facilities Plan is the impact of the plant's chlorinated release or instream chlorine toxicity. To assure complete freedom from chlorine toxicity (instream Cl_2 < 0.01 mg/l) the stream flow above each plant must be 100 times the plant's discharge rate for each mg/l of total chlorine carried in the effluent. Effluent disinfection by chlorination would still remain the system of choice for disinfection even with a dechlorination capability. These two considerations (post-aeration and dechlorination) are discussed in more detail in Chapter IV of the main text.

(2) Waste Solids Handling and Disposal

Table I-17 summarizes the unit processes and processing sequences screened and evaluated to select the waste solids handling and disposal system for Jackson Pike and Southerly. A review of this array and the documents associated with its development reveals the following:

- alternatives for waste biological solids thickening were not formally evaluated;
- alternatives to centrifugation for solids dewatering were not evaluated in the project plan's processing sequence;
- alternatives for obtaining an autogenous cake other than thermal conditioning were not evaluated; and
- the energy impact associated with oxidizing the nitrogen solubilized during anaerobic digestion and thermal conditioning that escapes resynthesis was not included in the evaluation.

The existing commitment to thermal sludge conditioning at Jackson Pike and Southerly and the state of the art of equipment available in the mid-seventies may explain the third point. A similar present commitment to

Table I-17
Waste Solids Handling and Disposal Selection Process

Stabilization	Conditioning	Dewatering	Reduction	Detailed Evaluation(1) EA	Detailed Evaluation(1) FP	Project Plan
I. LAND APPLICATION						
Compost	-	Centrifuge	-	●(2)	●	
Anaerobic Dig.	Elutriation/Chemical	Centrifuge	Flash Drying	●		
Anaerobic Dig.	Pasteurization	-	-	●		
-	Thermal	-	-	●	●	
-	Thermal	Centrifuge	-	●(2)	●	
-	Chemical	Centrifuge	Wet Air Reduction	●		
II. LANDFILL						
Aerobic Dig.	Chemical	Centrifuge	-	●(2)		
Aerobic Dig.	Chemical	Centrifuge	Incineration	●		
-	Thermal	Centrifuge	Incineration	●(2)	●	●(3)
-	Thermal	Centrifuge	Incineration	●		
Aerobic Dig.	Chemical	Vacuum Filter	Incineration	●		
-	Thermal	Centrifuge	-		●	
III. LAND APPLICATION/LANDFILL						
(four mo./year) - (eight mo./year)	Thermal	Centrifuge	Incineration			
		-	-			
Above system with fractional continuous incineration during eight month period for backup and heat source for thermal conditioning.					●	

(1) EA = Environmental Assessment, FP = Facilities Plan.
(2) Considered as viable alternatives and retained for detailed analysis.
(3) Centrifugation thickening of biological solids recommended at Jackson Pike, dissolved air flotation thickening of biological solids recommended for Southerly.

centrifugal dewatering at Jackson Pike may explain the second point. The experience factor with dissolved air flotation at both plants may explain the first point. However, it is believed that unfavorable Columbus experience with a given waste solids handling process represents tenuous grounds for unit process rejection because of severe solids recycle problems at both plants and a bulking secondary sludge at Southerly which is difficult to thicken and dewater. These points are further addressed in Chapter IV of the main text.

(3) The Project Plan

Figure I-2 schematically illustrates the proposed main stream treatment and waste solids management system for the two Columbus Plants. Conceptually, the unit processes recommended at both plants differ only in the means for waste secondary sludge thickening - centrifugation at Jackson Pike and dissolved air flotation at Southerly.

Table I-18 summarizes the estimated expenditures defined in the Facilities Plans to fully implement the project plan at the two Columbus Wastewater Treatment Plants. The plan has an estimated first cost of $159 million with an approximate annual operation and maintenance cost of $11.2 million. The O&M charge averages about $170 per million gallons of flow for an assumed average daily flow of 180 mgd. As previously mentioned, this analysis is basically in agreement with these Facilities Plan costs.

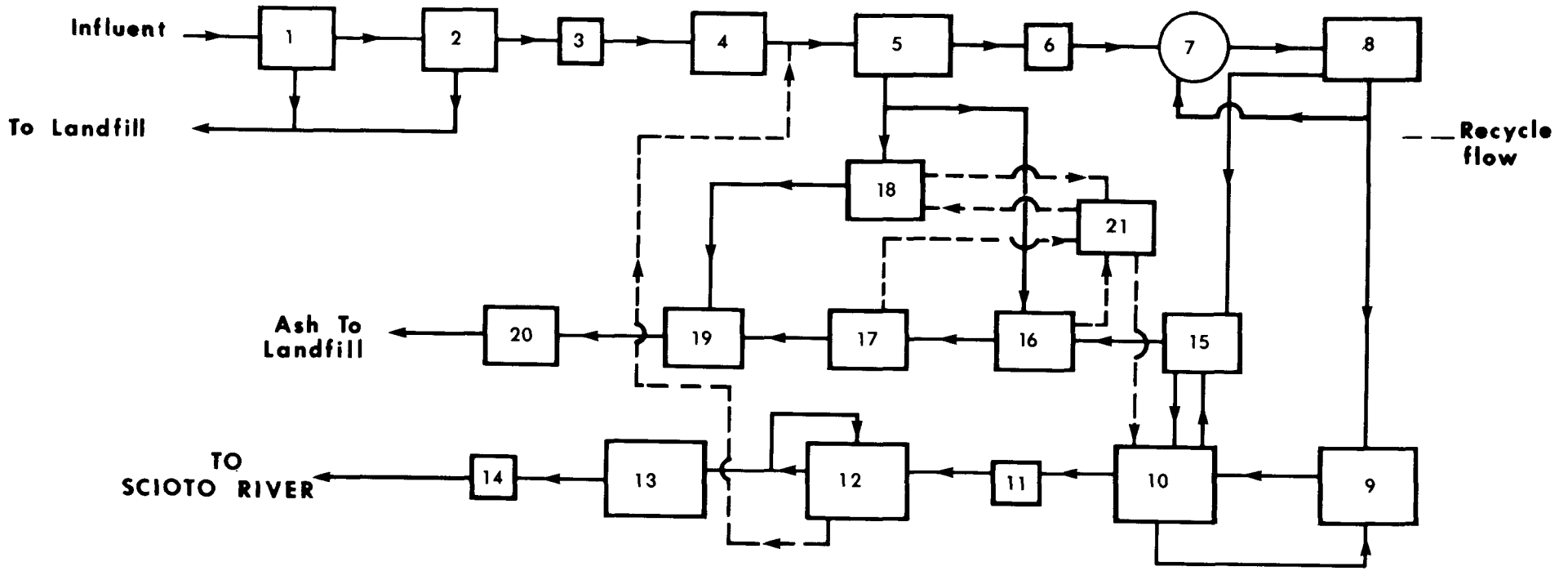
I.4.3 Evaluation of the Project Plan

The evaluation of the proposed project plan took the form of a completely independent development of design quantities applied to any given unit process. The technique incorporated the design wastewater characteristics previously established in Table I-15 of the preceding section. A series of unit process performance assumptions were then made consistent with the historic practice of Havens and Emerson. The most significant of these assumptions was the following estimate for the degree of pollutant solubilization during thermal conditioning:

	Applied Pollutant Solubilization-%				
	VSS	BOD_5	COD	TKN	P
Primary sludge	15	15	15	30	2
Secondary sludge	33	33	33	67	5

FIGURE I-2

PROPOSED
PROCESS FLOW SCHEMATIC



1. Screens
2. Grit Removal
3. Influent Pumps
4. Preaeration
5. Primary Settling
6. Trickling Filter Pumps
7. Synthetic Media Trickling Filters
8. Intermediate Clarifiers
9. Aeration Tanks
10. Final Clarifiers
11. Effluent Filter Pumps
12. Effluent Filters
13. Chlorine Contact Tanks
14. High Water Effluent Pumps
15. Waste Sludge Thickening Centrifuges (Air Flotation at Southerly)
16. Heat Conditioning and Settling
17. Conditioned Sludge Dewatering Centrifuges
18. Primary and Recycle Sludge Thickening Centrifuges
19. Incinerators
20. Ash Lagoons
21. Recycle Aeration and Settling

Table I-18
Project Plan Cost Information
(Millions of Dollars)

I. CAPITAL COSTS (1974-1975 Basis)

Process Stream	Jackson Pike	Southerly	Total
Main Stream Treatment	$56.2	$34.8	$ 91.0
Waste Solids Management	31.4	31.6	63.0
Total	87.6	$66.4	154.0

II. ANNUAL OPERATING AND MAINTENANCE COSTS
(Average for the year 1995)

Category(1)	Jackson Pike			Southerly			Total		
	MST	WSM	Total	MST	WSM	Total	MST	WSM	Total
Chemicals	$1.96	$ -	$1.96	$1.80	$0.21	$2.01	$3.76	$0.21	$ 3.97
Power	0.76	0.62	1.38	0.94	0.42	1.36	1.70	1.04	2.74
Personnel	0.73	0.56	1.29	0.69	0.54	1.23	1.42	1.10	2.52
Maintenance	0.29	0.76	1.05	0.24	0.70	0.94	0.53	1.46	1.99
Total	$3.74	$1.94	$5.68	$3.67	$1.87	$5.54	$7.41	$3.81	$11.22

(1) MST = Main Stream Treatment.
WSM = Waste Solids Management.

The following deviations from the proposed plant flow diagram were also made:

- Ash lagoon overflow returned to the plant influent;
- Two-stage phosphorus removal with application of aluminum salts to the influent of the intermediate and final clarifiers (reason: not described in facility plans);
- Filter backwash returned to the final settler (reasons: recycle of lost nitrifiers, avoid hydraulic surge at upstream unit processes;, and
- All biological sludge applied to thickening and thermal conditioning systems (reason: consistent treatment of dilute, difficult to thicken and dewater biological solids).

Design equilibrium pollutant quantities were then established through mass balance concepts at each unit process. These results were used to check the recommended facility requirements at each installation. The results of this evaluation are described in the following sections.

(1) Jackson Pike

The results of the engineering evaluation of the proposed Jackson Pike treatment system are summarized in Table I-19. From an overall standpoint, several potential opportunities for capital savings were found. The net impact of these opportunities depends upon the various tradeoffs incorporated in the integrated flow sheet.

In the main flow stream, it appears that savings can result in trickling filter sizing and the required area for final solids-liquid separation. In the sludge handling sequence, savings appear likely in the selection of thickening centrifuges and the elimination of the new 200 gpm thermal conditioning system and one new 200 ton/day incinerator. These savings can be realized due to the backup provided by some 12 million gallons of storage available within the plant's original anaerobic digestion system and the 8-inch, 500 to 600 gpm, interconnecting Jackson Pike-Southerly sludge force main presently nearing completion. The recycle aeration and settling system appears, at a minimum, to be oversized in all considerations except the magnitude of return sludge. It may even be possible to completely eliminate

Table I-19
Engineering Evaluation of the Proposed Jackson Pike Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
① Screens, ② Grit Removal, ③ Influent Pumps, and ④ Pre-aeration with Grit Removal	Good grit removal is mandatory to protect dewatering centrifuges.	No disagreement with Facilities Plan.
⑤ Primary Sedimentation	Rehabilitation of four 120' x 60' x 15' SWD tanks may not be necessary due to downstream roughing filter.	Opportunity for slight savings.
⑥ Pump Station, ⑦ Synthetic Media Trickling Filter, ⑧ Intermediate Clarifier	A 50 percent reduction of the proposed trickling filter would potentially reduce the soluble organic removal from 70 to 75 percent to 60 to 65 percent.	Opportunity for first cost savings.
⑨ Activated Sludge Aerators, ⑩ Final Clarification and Return Sludge	Estimated MLSS volatility is about 55 percent. At a nitrification rate of 0.12 lb/lb MLVSS·day, an operating MLSS of about 2,000 mg/l is required in an operating volume of 31.5 MG with a peak nitrogen mass of 32,000 lbs/day to be oxidized. Minimum system requirements would be a maximum firm return capability of about 50 mgd and 154,000 SF of final sedimentation area. An average day air supply of 65,000 cfm (Peak = 110,000 cfm) is predicted at an 8 percent oxygen transfer efficiency.	Opportunity for first cost savings in final clarification area and return sludge capacity.

Table I-19 - Continued
Engineering Evaluation of the Proposed Jackson Pike Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
(11) Effluent Filter Pumps, (12) Effluent Filters	Proposed installation is not clear as to type. With one unit out of service, the maximum hydraulic load is 5.7 gpm/SF at 200 mgd. Unit needs surge tank for maximum backwash control (60 mgd).	May violate conventional design criteria, savings may be developed if filter does not treat entire flow, not known if surge needs were considered.
(13) Chlorine Contact Tank	15 mg/l at 200 mgd (25,000 lbs/day) would allow breakpoint chlorination backup for 1.5 mg/l NH_3-N at peak flow. A dechlorination and post-aeration capability will be needed to satisfy NPDES and water quality standards.	Backup support would be recommended for insignificant capital expenditure.
(14) High Water Pumps	System or capability not described	No disagreement with facilities plan.
(15) Thickening Centrifuges	Seven 200 gpm machines are predicted as required to satisfy average day requirements with an applied solids concentration of 10,000 mg/l. Concentration of trickling filter sludge should be greater than 10,000 mg/l.	13-14 machines would seem to satisfy system needs (including standby) when storage capability of system is considered. Opportunity to reduce first cost.
(16) Thermal Conditioning and Sludge Settling	Two 200 gpm thermal conditioning systems satisfy average and peak processing needs (1.5 times average day). Maximum day solids loading on two decant tanks is 100 lbs/SF·day.	A more economical option may include standby equipment auxiliaries to the heat exchanger and reactor (i.e., pumps, grinders, etc.). When a heat exchanger goes down sludge would either be stored

Table I-19 - Continued
Engineering Evaluation of the Proposed Jackson Pike Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
(16) Thermal Conditioning and Sludge Settling - Continued		or routed directly to dewatering. Add one 45 foot diameter decant tank.
(17) and (18) Dewatering Centrifuges	Estimated average day sludge flows are: Prim. Sl. = 175 gpm at 5% SS, and Cond. Sl. = 105 gpm at 10% SS. Needed average day value = 5 machines, 8 machines would satisfy probable maximum day requirement.	No significant disagreement with selection of 9 machines.
(19) Incineration	Average day dry tonnage = 110 tons/day at 32% solids wet tonnage = 350 tons/day.	Provide only one new incinerator (3 total).
(20) Ash Lagoons	Ash production - 85,000 lbs/day, each lagoon will have to be cleaned every 3 to 6 years at design conditions.	No disagreement with Facilities Plan.
(21) Recycle Aeration and Settling	5.2 mgal aeration volume called for will yield a MLSS concentration of about 2,000 to 2,500 mg/l at a cell residence time of 5 days for the assumed conditions. Maximum return sludge should be about 0.3 mgd, settling tanks could be reduced by 75 percent or more. Average day air requirement at 8 percent oxygen transfer = 12,500 cfm; suggested maximum day = 25,000 cfm.	Excess main stream treatment capacity makes complete abandonment possible.

this treatment system through direct return of the recycle liquors to the main flow stream, in either a continuous or staged fashion.

(2) Southerly

The results of the engineering evaluation of the proposed Southerly treatment system are summarized in Table I-20. From an overall standpoint, several potential opportunities for first-cost savings were found. The net impact of these opportunities depends upon the various tradeoffs incorporated in the integrated flow sheet. The following presents a brief overview of the findings of the engineering evaluation.

In the main flow stream, first-cost savings can be developed with a more optimum use of the existing activated sludge system. However, working against this savings is the need to expand the main stream pumping capability to match the hydraulic peak. In the sludge handling sequence, an additional 200 gpm thermal conditioning system is unnecessary but additional thickening, decanting, and dewatering capabilities are suggested. Other than this change, no significant disagreement exists with the selected unit process inventory. As at Jackson Pike, the recycle aeration and settling system is oversized. The optimum cost-effective means of handling the recycles may incorporate total abandonment of the proposed system due to the extra treatment capacity contained in the main flow stream.

I.4.4 Conclusions of the Engineering Analysis

(1) Basic Data

- The average day design flow for the Southerly wastewater treatment plant may be overstated in the Facilities Plan by 30 mgd (85 mgd was the recommended value of this review).
- The average day design influent suspended solids mass at Jackson Pike may be overstated by 50,000 lbs/day (220,000 lbs/day was the recommended value of this review).

Table I-20
Engineering Evaluation of the Proposed Southerly Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
① Screens, ② Grit Removal, ③ Influent Pumps, and ④ Pre-aeration	Increased pumping capacity due to flow diversion from Jackson Pike.	Increase present firm capacity from 185 mgd to 230 mgd. Additional first cost required.
⑤ Primary Sedimentation		No disagreement with Facilities Plan.
⑥ Pump Station, ⑦ Synthetic Media, Trickling Filter, ⑧ Intermediate Clarification	Expand pump station from 180 mgd to 230 mgd firm capacity excluding recycles, expand intermediate clarification from 90,000 to 100,000 SF.	Additional first cost required
⑨ Activated Sludge Aerators, ⑩ Final Clarification and Return Sludge	Estimated MLSS volatility is about 70 percent. An operating MLSS of about 2000 mg/l is required in the existing aeration volume of 26.3 MG to achieve a 15 day cell residence time. A minimum maximum return sludge capability of 50 to 80 mgd would be recommended. An average day air supply of 65,000 cfm (peak = 105,000 cfm) is predicted at an 8 percent oxygen transfer efficiency.	Existing plant's capabilities appear adequate for future needs. Opportunity for first cost savings.
⑪ Effluent Filter Pumps, ⑫ Effluent Filters	Proposed installation is not clear as to type, effluent filter pumps will have to be expanded to meet 230 mgd capacity, exclusive of recycles. The maximum load is 7.8 gpm/SF at 230 mgd with one unit out of service. Unit needs surge tank for maximum backwash (60 mgd) control.	May violate conventional design criteria, savings may be developed if filter does not treat entire flow.

Table I-20 - Continued
Engineering Evaluation of the Proposed Southerly Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
(13) Chlorine Contact Tank	230 mgd flow peak requires an expansion from 1.8 MG to 2.4 MG to satisfy 15 minutes at peak flow contacting time requirement breakpoint chlorination capability should be considered. A dechlorination and post-aeration capability will be needed to satisfy NPDES and water quality standards.	Slight increase in first cost required.
(14) High Water Pumps	Needs 230 mgd firm capacity.	Slight increase in first cost may be required if present mode of anticipated operation is continued.
(15) Dissolved Air Flotation Thickening	Average day solids load calculated at about 12 lbs/SF·day.	No disagreement with Facilities Plan.
(16) Thermal Condi-	Average day requirements estimated at 260 gpm, with secondary sludge concentrated to 4% suspended solids. Average day solids load on present decant tanks is 35 lbs/SF·day with one out of service.	The need for one additional thermal conditioning system over the present 600 gpm (3 units) is questionable.
(17) and (18) Dewatering Centrifuges	Estimated average day sludge flows are: Prim. Sl. = 160 gpm at 5% SS and Cond. Sl = 80 gpm at 10% SS. Eight to ten machines should satisfy max. day, standby, and Jackson Pike diversion needs. Five machines are required for average day.	No disagreement with the nine machines proposed in the Facilities Plan.

Table I-20 - Continued
Engineering Evaluation of the Proposed Southerly Treatment System

Unit Processes (Figure I-2)	Design Analysis	Conclusion
(19) Incineration	Average day dry tonnage = 90 tons/day at 32% solids, wet tonnage = 280 tons/day. Max. day plus failure at Jackson Pike could approach the firm rated capacity of 600 tons/day with one 200 tons/day standby unit.	No disagreement with Facilities Plan.
(20) Ash Lagoons	Ash production = 50,000 lbs/day, each lagoon will have to be cleaned every 4 to 8 years at design conditions.	No disagreement with Facilities Plan.
(21) Recycle Aeration and Settling	Called out aeration volume (5.2 MG) will yield a MLSS concentration of about 1,600 mg/l at a cell residence time of 5 days for the assumed conditions. Return sludge capability should be increased to about 0.4 mgd. Settling tanks could be significantly reduced. Average day air requirement at 8 percent oxygen transfer - 12,000 cfm; suggested maximum day = 24,000 cfm.	Proposed system presents opportunity to develop significant first cost savings through modification or complete abandonment.

- At Jackson Pike and Southerly, respectively, this review has selected an influent suspended solids volatility of 70 and 80 percent as more nearly correct than the 60 and 70 percent values cited in the Facilities Plans.
- No other significant disagreement in pollutant mass characterizations to the extent defined in the Facilities Plans.

(2) Selection Process

- No significant disagreement with recommended conceptual main stream treatment sequence with the qualification that post-aeration and instream chlorine toxicity considerations were not addressed.
- No significant disagreement with recommended conceptual waste solids handling and disposal system with the qualification that several internal unit process alternatives were not fully addressed.

(3) The Project Plan

- Opportunities for significant first-cost savings at Jackson Pike are found with the following unit processes:
  - trickling filtration
  - final sedimentation
  - thickening centrifuges
  - thermal conditioning
  - incineration
  - recycle treatment

- Additional first costs at Jackson Pike may be developed at the following unit processes:
  - final effluent filtration
  - post-aeration and dechlorination
  - decanting of thermally conditioned product

- Opportunities for significant first-cost savings at Southerly are found with the following unit processes:
  - activated sludge system
  - thermal conditioning
  - recycle treatment

Additional first costs at Southerly may be developed at the following unit processes:

- all pump stations associated with handling flow peaks
- intermediate sedimentation
- final effluent filtration
- chlorine disinfection
- post-aeration and dechlorination

APPENDIX J

INTERNAL UNIT PROCESS ALTERNATIVES

APPENDIX J

INTERNAL UNIT PROCESS ALTERNATIVES

This Appendix examines the resource savings that may be available through the use of alternate treatment technology at the Columbus plants. Its emphasis is not upon the alternatives examined by the City's Consultants during the course of preparing the Facilities Plans, but rather upon the technology which has come into additional exposure or acceptance over the intervening years. Mention of trade names or proprietary systems should not be construed as an endorsement of or a recommendation for a particular manufacturer's product.

J.1 SECONDARY SOLIDS THICKENING

The Facilities Plans for the Columbus Plants recommend the use of centrifugation and dissolved air flotation for waste secondary solids thickening at Jackson Pike and Southerly, respectively. The type of centrifugation is not mentioned, nor is the reason for differentiation between the two plants. The 200 gpm sizing of the centrifuge suggests a preliminary selection of a scroll or decanter type. This unit is certainly more economical than smaller basket alternatives and probably more dependable than the larger disc nozzle alternatives. Whether or not it is more economical than dissolved air flotation is a matter of conjecture without a detailed engineering evaluation. It is certain that centrifugation offers advantages in terms of product solids concentration, first cost, and space. It is equally certain that dissolved air flotation offers an advantage by eliminating the pretreatment needs of centrifugation (degritting and/or screening with subsequent residual management and disposal), and savings in terms of operation and maintenance expenditures. Both thickening alternatives can be designed to achieve similar levels of applied solids capture with polymer applications limited to maximum loading periods. It is recommended that the City consider a side-by-side comparison of representative centrifugation and flotation units prior to selection of the preferred unit process. At a minimum, the design engineer should perform a detailed evaluation of the two before making a final commitment to either alternative at Jackson Pike. At Southerly, with pretreatment of the brewery waste and elimination of the roughing trickling filter and intermediate sedimentation system as per the recommendation in Section 4.1.3, the existing dissolved air flotation system should be adequate for the future needs of the plant.

J.2 CONDITIONING AND DEWATERING

The Columbus plants, for all intents and purposes, are fully committed to thermal conditioning to obtain a dry cake and minimize, if not eliminate, the need for auxiliary fuel during incineration. When this commitment was made in the early seventies, the engineer and the City had little choice but to select thermal conditioning to achieve the sludge processing goals. Today, this is no longer true.

In the past two to three years a variety of belt press configurations for waste solids dewatering have been introduced. These systems have the potential of competing with thermal conditioning as a means of achieving an autogenous cake (30 to 35 percent cake solids) both alone and as a post-dewatering step following conventional centrifugal or vacuum filtration procedures. Elimination of thermal conditioning, of course, reintroduces the need for chemical conditioning by either inorganic (lime and ferric) or organic additives. The potential for post-dewatering is nearly unlimited, but full-scale experience is essentially nonexistent. Certainly, it will have none of the recycle management problems found with thermal conditioning, and it is difficult to imagine how its operation and maintenance requirements could be as severe. The City should maintain the option of abandoning or gradually phasing out the thermal conditioning system through a staged conversion should its operation become untenable. Abandonment of the thermal conditioning system is not recommended without a long-term trial evaluation of a prototype chemical conditioning - conventional dewatering - belt pressing system to assure that a positive improvement in plant operation will be derived.

J.3 RECYCLE MANAGEMENT

Effective management of the liquid recycles derived from a thermal conditioning system represents a formidable task. These recycles can cause aesthetic impacts due to their odors, and may require large cash outlays due to special treatment process considerations and operational expenses. The cost of operation will be magnified for plants such as Columbus' that are required to nitrify, due to the extra energy necessary to oxidize the recycled solubilized nitrogen which is not resynthesized.

The Facilities Plan for the Columbus Wastewater Treatment Plants proposed an isolated air activated sludge system to stabilize the recycled liquors derived from the decanting

and dewatering processes that follow the thermal conditioning units. Plant practice has found that this technique, although effective, results in the greatest generation of odors due to the stripping of the concentrated organics from the recycle mixed liquor into the air. Superficially, the enclosed reactor configuration of a pure oxygen activated sludge alternative would appear attractive, but hydrocarbon stripping would remain, and the potential for shut-down would increase. Technical journals and literature offered by the manufacturers note no such pure oxygen application to date. The odor potential would still remain as off-gases are released to the atmosphere, but their reduced volume and concentrated source might make deodorization a feasible consideration.

In summary, it would appear that aerobic stabilization of the concentrated liquors would be most applicable with attached growth systems, such as a rotating biological contactor, which have minimum liquid stripping. These units could be enclosed and the building air deodorized prior to release to the atmosphere. However, deodorization of large air volumes is an expensive proposition. It is probable that the most economical means of aerobic treatment when odor control is a vital concern will be co-processing with the raw wastewater on a programmed basis, i.e., return to the main flow stream during non-peak loading periods.

The previous remarks have centered on aerobic stabilization of the concentrated liquors. With organic concentrations of several thousand milligrams per liter, it is probable that the preferred treatment concept should incorporate anaerobic stabilization with subsequent aerobic polishing of the residual pollutant fraction. Investigations recently reported at the 49th Annual Conference of the Water Pollution Control Federation by Dr. R. T. Haug and his co-workers of the Los Angeles/Orange County Metropolitan Area Regional Wastewater Solids Management Program have shown the validity of this concept. Although Dr. Haug's goal was to improve the digestibility of waste activated sludge by thermal preconditioning prior to anaerobic digestion, the results of his bench and prototype investigations have similar applicability to minimizing the recycle impact of the liquors derived from thickening and dewatering the thermally conditioned sludge. The observations of the California investigations for a 60 percent volatile activated sludge applied to a thermal conditioning system and subsequent anaerobic digestion are as follows:

- Volatile solids destruction increased from 30 percent in the control to 50 percent.
- The dewaterability of the solids remained only marginally less than the undigested thermally conditioned product.
- Digester heating requirements will be reduced if not totally eliminated.
- Odorous compounds were largely destroyed during digestion.

The investigations also mentioned the need for patient acclimation of the digester to the thermally conditioned sludge. Repeated observations noted initially high digestion performance followed by a decline, with an ultimate recovery and return to the high performance condition after about one and a half months of operation. Optimum laboratory performance was found at about 175°C (350°F), with complete failure at temperatures above 200°C (390°F). Failure was originally thought to be due to ammonia toxicity, but the possibility of the production of inhibitory substances (heavy metal release) during thermal conditioning was also suspected. Subsequent studies at diluted ammonia concentrations and temperatures above 200°C indicated the inhibition was due to other toxic materials. In May of 1977 Dr. Haug was contacted by Havens and Emerson to obtain an update on his investigations. He reported that field experience has shown no inhibition with thermal pretreatment temperatures as high as 215°C (420°F). Other than this comment, no other changes were made in the original observations.

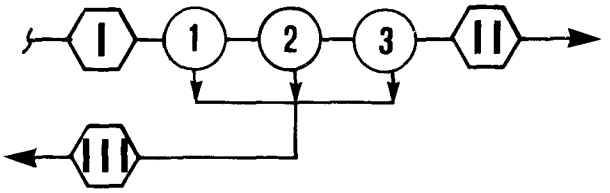
Figure J-1 shows the recycle management alternatives that could be considered at Columbus. Alternative A may have future applicability, but can be considered theoretically implementable today. Alternative B2 summarizes the concept proposed in the Facilities Plan. The differentiation between Alternatives C1 and C2 is whether the entire thermally conditioned product or only the subsequently derived liquors receive anaerobic stabilization. In each case a storage reservoir could be provided for the product liquors derived from thickening and dewatering the thermally conditioned sludge for a programmed pumped return to the main flow stream.

Table J-1 summarizes the results of a hypothetical examination of each alternative with a secondary solids exhibiting a nominal volatility of 67 percent. Each parameter value in Alernative B2, the recycle management system proposed in the Facilities Plan, was given a value of unity to facilitate a rapid comparison of the processing options.

Figure J-1

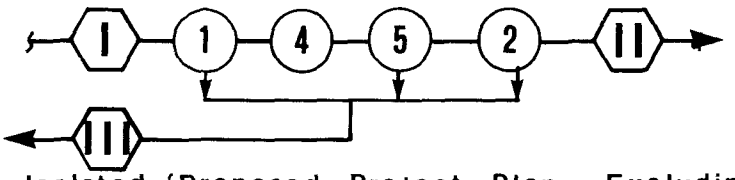
Recycle Management Alternatives

(A.) No Thermal Conditioning – Additional Physical Dewatering

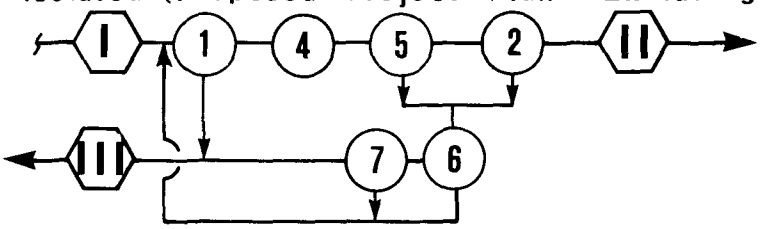


(B.) Thermal Conditioning – Aerobic Stabilization

1. Concurrent

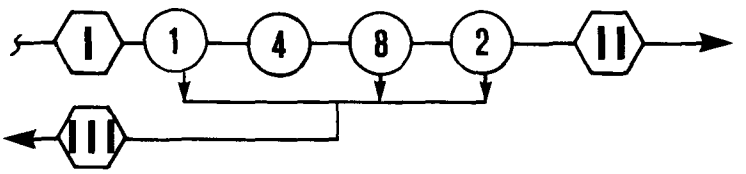


2. Isolated (Proposed Project Plan – Excluding Primary Sludge Addition

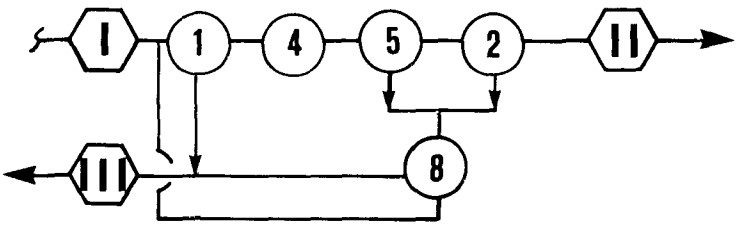


(C.) Thermal Conditioning – Anaerobic Stabilization

1. Complete



2. Liquor Limited



CODE

I	Secondary Solids	1	Thickening	5	Decanting
II	Sludge Cake	2	Dewatering	6	Aerobic Stabilizatio
III	Recycles to Main Flow Stream	3	Post Dewatering	7	Sedimentation
		4	Thermal Conditioning	8	Anaerobic Stabilizatior (Primary & Secondary Digestion)

Table J-1
Hypothetical Relative Comparison of Recycle Management Alternatives

Parameter	Alternatives (1)				
	A	B1	B2	C1	C2
Solids Applied to Thickener	0.81	0.97	1.00	0.88	0.91
Solids Applied to Thermal Conditioning	not applicable	0.97	1.00	0.88	0.91
Solids Applied to Final Dewatering Unit	1.07	0.97	1.00	0.71	0.94
Volatility of Final Sludge Cake	1.08	0.99	1.00	0.74	0.98
Net Nitrogen Removal	2.02	0.98	1.00	0.77	0.89
Volume Applied to Isolated Biological Reactor	not applicable	not applicable	1.00	0.91	0.93
Volume of Recycles Returned to Main Flow Stream	0.83	0.96	1.00	0.88	0.91
Recycled Oxygen Demand to be satisfied					
Carbonaceous	0.25	1.08	1.00	0.17	0.92
Nitrogenous	0.04	1.04	1.00	1.31	1.13
Total	0.12	1.05	1.00	0.91	1.05

(1) See Figure J-1 for description.

Alternative A is seen to be clearly advantageous for every parameter except the solids load applied to the final dewatering unit; however, this load increase is less than 10 percent over that expected for Alternative B2. The differences between Alternatives B1 and B2 are insignificant, and can largely be attributed to Alternative B1's longer overall cell residence time for the net solids applied to the solids processing stream. If the main process stream has the treatment capacity, the preferred B Alternative is B1 due to its ease of operation.

A comparison of Alternatives C1 and C2 shows slight processing advantages for C1 in every instance except the volatility of the final sludge cake. Alternative C1 appears to offer clear processing advantages over Alternative B1 in every instance except the nitrogen removal derived and, in turn, the nitrogenous oxygen demand that must be satisfied.

Table J-2 summarizes the relative advantages and disadvantages of the recycle management alternatives. Alternative A would appear most attractive, but is not presently implementable. At a new plant with a thermal conditioning commitment and an incineration system, Alternative B1, with a programmed return of pumped thermally conditioned liquors to the main flow stream, is most attractive due its operational ease and the avoidance of the expensive anaerobic digestion structures. At a plant with a desire to maximize the production of digester gas as well as to produce a stabilized end product for land application, Alternative C1 would be the system of choice.

The presence of the existing anaerobic digestion systems (which were to be delegated to a storage service) at the Columbus plants presents the opportunity to implement Alternative C1 without the economic consequences of new digester construction. The implementation of this concept is strongly recommended as soon as possible to determine its practical application. If fully implemented, the needed improvements would consist of some new piping to allow thermally conditioned sludge to be fed to the first stage digester, new pumps and/or piping to allow the return of settled digester sludge to the first stage digester for direct management of the cell residence time, and programmed return of the supernatant to the main flow stream. If this concept proves invalid, then the plant operation should return the nonstabilized liquors through the supernatant return system. Construction of the isolated aerobic activated sludge system for the thermally conditioned sludge liquors is not recommended for the Columbus plants at this time.

Table J-2

Relative Advantages and Disadvantages of Recycle Management Alternatives

Alternative (See Figure J-1 for description)	Advantages	Disadvantages
A. No thermal conditioning - Additional Physical Dewatering	. Least impact upon thickener. . Highest net removal of nitrogen. . Lowest impact due to recycles. . Highest cake volatility with organic polyelectrolyte conditioning; high volatility advantageous for incineration. . Least odor potential.	. Not readily implementable due to existing recent commitment to thermal conditioning. . Post dewatering equipment largely unproven. . Cake may contain more moisture. . Highest solids load on dewatering system. . Product not pasteurized.
B. Thermal Conditioning - Aerobic Stabilization	. Greatest probability of dry cake. . Pasteurized product amenable to land application. . Alternative B1 is implementable at existing plants with following relative advantages (B1 vs. B2) . Less odor . No capital and operating expense with isolated treatment system . Slightly less solids load	. Thermal conditioning odors remain. . Maintenance problems remain. . Highest impact due to recycles. . Thermal conditioning maintenance and operating problems remain.

Table J-2
Relative Advantages and Disadvantages of Recycle Management Alternatives

Alternative (See Figure J-1 for description)	Advantages	Disadvantages
C. Thermal Conditioning - Anaerobic Stabilization	. Similar cake characteristics as Alternate B with less volatile content, Alternative C1 significantly so. . Least solids load. . Less odor than Alternative B, Alternative C1 significantly so. . Similar recycle impact as Alternative B. . Both alternatives are completely to fractionally implementable at the existing plants with minor improvements.	. Potential of ammonia and heavy metal toxicity to digester, Alternative C1 less so due to suspended solids. . Greater nitrogen impact on main flow stream. . Thermal conditioning maintenance problems remain.

J.4 PYROLYSIS

Much has been written about sludge pyrolysis in the last year or two. Engineers and municipalities increasingly face the question of incineration or pyrolysis for disposal of municipal wastewater sludges. Presently, the Eimco BSP Division of Envirotech and Nichols Engineering and Research, among others, are actively engaged in research and development of what they term to be pyrolysis systems. If should be noted that these systems do not represent true pyrolysis (a chemical change brought about by heat alone) but rather starved-air combustion (a chemical change resulting from the controlled presence of oxygen with heat). Regardless, a successful full-scale demonstration project has been conducted with a converted multiple hearth furnace (MHF) at the Central Contra Costa Sanitary District. The conversion of an existing MHF to a starved air combustion reactor is reported to involve only minor changes, with costs dependent upon the existing system and air pollution criteria. Retrofitting needs are described as follows:

- Addition of an afterburner (required to burn exhaust for heat recovery or release to the atmosphere - exhaust gas has a heating value of about 10 percent of natural gas).
- Additional instrumentation and controls.
- Reduction of fan speed or damper position connection to provide less air to the system.
- Modification of scrubbing system to maintain high efficiency with reduced air flow rates.
- General "tightening up" of furnace system.

The manufacturers presently list the following advantages and disadvantages for starved air combustion versus incineration as a result of their test works:

Advantages:

- Operation is more stable and easier to control.
- More feed capacity per equivalent area for incineration.
- Less air pollutants and easier particulate size to scrub.

- Lower sludge solids content required for autogenous combustion.

- Slightly lower operating costs.

Disadvantages:

- Afterburner requirement may limit use in existing installations due to space problems.

- More instrumentation.

- Must be very careful of bypass stage exhaust due to high hydrocarbon content which may be combustible in air. Thus, bypassing may be possible only following afterburning with appropriate emergency controls.

- Exhaust gases are more corrosive.

- Combustibles in ash (up to 30 percent with up to 10 percent fixed carbon) may create ultimate disposal problems.

At this time, it cannot be concluded that starved air combustion necessarily represents a superior option to incineration. Preliminary conclusions, based upon limited operational experience, show it to be competitive with, but not a replacement for, incineration. Starved air combustion appears to be attractive only in those situations where a firm commitment to recover energy exists. Without this final recovery of energy, the system will produce some 50 percent more waste solids residue for ultimate disposal with special considerations involved in the selection of the disposal site.

The application of starved air combustion cannot be recommended for Columbus except on an experimental basis. Even then, to assure future reliability, it would be recommended that the proposed conventional incineration furnace also be designed with a view towards starved air combustion. These considerations limit the specific application of starved air combustion to only new incineration systems. Provision of this flexibility will increase the first cost of the conventional multiple hearth incinerator by about 15 to 20 percent. This investment would not be totally lost, as equivalently sized incineration systems have some 10 to 30 more capacity when operating in a starved combustion mode.

J.5 PHOSPHORUS REMOVAL

The Linde Division of the Union Carbide Corporation is vigorously marketing the proprietary "Phostrip" phosphorus removal system through onsite bench and pilot demonstrations. In essence, this system relies upon the luxuriant uptake of phosphorus within the activated sludge culture (whether the uptake is metabolic or a precipitated complex is not clearly established) and subsequent phosphorus desorption from a fraction of the return sludge in an anoxic stripping tank. The stripper is designed as a thickener with a detention time of some 10 hours. The thickened solids are returned to the aerator, and the phosphorus-enriched decantate is treated with lime to precipitate a calcium phosphate complex. The precipitated solids are dewatered and introduced into the ultimate disposal process of the wastewater treatment plant.

The "Phostrip" concept has been advanced for over a decade in various forms of the described processing sequence. It has yet to achieve wide acceptance, although it normally offers an opportunity for an appreciable operating cost savings. This lack of acceptance has been largely due to stability concerns (founded in phosphorus uptake debate) and an apparent inability to achieve extremely low soluble final effluent phosphorus residuals.

Union Carbide has offered to conduct an onsite "Phostrip" demonstration study at Columbus. To evaluate its applicability for the Columbus situation without such a study, a preliminary investigation was conducted. Typical performance data supplied by Union Carbide at other test installations show a total soluble phosphorus concentration of about 0.5 to 1.0 mg/l in the final effluent, and a nominal phosphorus desorption of about 0.006 ± 0.004 pounds per pound of volatile suspended solids. Phosphorus desorption data was not available from a nitrifying activated sludge system as proposed for Jackson Pike. Intuitively, slower phosphorus desorption would be expected from this type of activated sludge than the norm found in the Union Carbide studies.

Preliminary cost estimates were developed to evaluate the proposed Facilities Plan phosphorus removal concept of metal salt addition against the "Phostrip" system. This evaluation was conducted at both the assumed influent phosphorus levels for the present conditions and the calculated influent concentrations if a statewide detergent phosphorus ban was in effect (assuming a two-thirds reduction of the baseline soluble domestic, commercial, and industrial phosphorus load).

The latter consideration was included in the analysis since legislation supporting a phosphorus ban as a builder in detergents is now pending in both Ohio and on the Federal level. This legislation has the full backing of the State Environmental Protection Agency, and, to the extent that Ohio lies in the Great Lakes Drainage Basin, it is also advocated by the International Joint Commission and Region V of the Federal EPA. On August 4, 1977, the United States Senate voted overwhelmingly to amend the water pollution laws to ban the sale of phosphate detergents in all of the Great Lakes States. House approval is expected.

The results of the evaluation are summarized in Table J-3. The estimates are specific for Columbus, since background phosphorus removals are assisted by the metal load at Jackson Pike and the high carbonaceous load at Southerly. The phosphorus ban in detergents would cause approximately a 50 percent reduction in influent phosphorus levels, with an 80 percent decline in chemical usage. The range in first costs for the "Phostrip" system reflect assumed desorption values of 0.006 and 0.003 pounds of phosphorus per pound of volatile suspended solids. The total present worth figures show a slight economic advantage (2 to 25 percent savings) with the "Phostrip" system under the present conditions. However, this advantage is lost if and when a phosphorus detergent ban is implemented, with the final total present worth of the "Phostrip" system some 55 to 115 percent more than that estimated for the metal salt system.

The preceding discussion points toward the retention of metal salt addition for phosphorus removal for the following reasons:

- The closeness of the two systems under present conditions;
- The clear economic advantage of the metal salt system at lower influent phosphorus level;
- The probability of a statewide, if not nationwide, phosphorus ban in detergents.

J.6 INTERMEDIATE SEDIMENTATION

The value of providing intermediate sedimentation between the roughing trickling filter and the activated sludge system may be questioned by some. In an effort to determine its value or liability, a rough design was prepared and costed for direct comparison with the system proposed in the Facilities Plans.

Table J-3
Evaluation of Metal Salt (Al^{+3}) and Phostrip (Ca^{+2})
Phosphorus Removal Systems
(1974 Price Structure)

	Jackson Pike		Southerly		Totals	
	Al^{+3}	Ca^{+2}	Al^{+3}	Ca^{+2}	Al^{+3}	Ca^{+2}
PRESENT CONDITIONS						
Influent Phosphorus-lb/MG	70	70	75	75		
Precipitating Ion added-lb/MG	50	170	80	270		
Precipitated Solids-lb/MG	170	900	280	1500		
First Cost - 10^6 $	2.2	3.6-5.7	0.1	5.9-9.4	2.3	9.5-15.1
Operating Cost-10^6 $/Yr(1)	0.84	0.32	0.94	0.37	1.78	0.69
Total Present Worth-10^6 $(2)	11.2	6.8-8.6	10.4	9.4-12.5	21.6	16.2-21.1
POTENTIAL FUTURE CONDITIONS WITH DETERGENT PHOSPHORUS BAN						
Influent Phosphorus-lb/MG	35	35	40	40		
Precipitating Ion added-lb/MG	10	35	20	70		
Precipitated Solids-lb/MG	40	200	80	400		
First Cost - 10^6 $	2.2	3.6-5.7	0.1	5.9-9.4	2.3	9.5-15.1
Operating Cost-10^6 $/Yr(1)	0.23	0.17	0.32	0.19	0.54	0.36
Total Present Worth-10^6 $(2)	4.5	5.1-7.0	3.6	7.4-10.6	8.1	12.5-17.6

Notes:
Al^{+3} - two stage aluminum dosage to influent of intermediate and final settlers.
Ca^{+2} - Phostrip process incorporating second stage return sludge bleed off, stripping, lime addition to stripper overflow, precipitated solids dewatering by centrifugation and incineration.
(1) Includes costs for chemicals, manpower, maintenance, power. Al^{+3} system sludge handling costs taken as percentage of total sludge handling costs (lime assumed as \$0.015/lb Ca^{+2}, alum assumed as \$0.40/lb Al^{+3})

The results of the comparison are summarized in Table J-4. The advantage to be derived by eliminating the intermediate sedimentation system is found in the lower waste secondary solids. However, when the treatment system is called upon to nitrify, the elimination of the intermediate settler results in a significant increase in the system's oxygen demand and operating solids requirements. The preliminary costing data contained in Table J-4 reveal that the net impact of eliminating the intermediate sedimentation system is an economic liability in terms of both first cost and operating expenditures. It is the high operating solids mass or cell residence time required for nitrification that ultimately dictates the retention of the intermediate settlers as a cost-effective treatment alternative.

J.7 OXYGEN PRODUCTION AND DISSOLUTION

Generalizations concerning the economics of oxygen versus air activated sludge are difficult to draw, since costs for the two systems are close and individual circumstances affect economics to a large degree. The original economic studies of the main stream treatment Facilities Plan showed the proposed trickling filter-air activated sludge system, with a total operating horsepower of about 14,800, to have an annual cost advantage of about one million dollars over the trickling filter-pure oxygen activated sludge system with a total operating horsepower of about 12,100. A review of pure oxygen versus air system costs produced no significant disagreement with the Facilities Plan estimate. Thus, at an assumed motor efficiency of 90 percent, the price of electrical energy would have to increase to approximately $0.05 per kwh before it would be advantageous to go to the pure oxygen alternative. Since it is believed that the proposed aeration and/or final sedimentation expansion can be reduced or eliminated with an optimized project plan at both plants (see Appendix I), the overall economic liability of the pure oxygen alternative at Columbus will only increase. Thus, it is recommended that Columbus stay with an air activated sludge system at both treatment facilities.

This conceptual commitment to air activated sludge suggests an examination of the oxygen dissolution system. The present sock diffusion system offers the potential of efficient fine bubble oxygen transfer, a theory which is not fully realized due to rapid clogging and development of a high back pressure. The existing sock diffusion system suffers from a lack of manufactured replacement socks and

Table J-4
Impact of Eliminating Intermediate
Sedimentation at Jackson Pike as
Compared to the Proposed Facilities Plan

Parameter	
Advantages:	
Percent reduction in waste secondary solids	20
Percent reduction in total waste solids	10
Disadvantages:	
Percent increase in nitrogen to be oxidized	10
Percent increase in average day oxygen demand	40
Percent increase in mixed liquor suspended solids mass for CRT = 15 days	230
First Cost - 10^6 $	
Main Stream Treatment(1)	70
Waste Solids Management	31
Total	101
Percent increase over Facilities Plan(2)	9
Operating Cost - 10^6 $/Year	
Main Stream Treatment	4.2
Waste Solids Management	1.7
Total	5.9
Percent increase over Facilities Plan(2)	4

(1) Activated sludge system designed for CRT = 15 days, plug flow aeration pattern; final sedimentation system designed for maximum solids loading rate of 25 lbs/sf.day.

(2) Refer to Table I-18 for costs associated with the Facilities Plan.

fittings coupled with a manpower-intensive cleaning program. It is reported that the latter amounts to some 1400 manhours per year for a biannual cleaning program at both plants. The manpower cost is incurred at an overtime rate, since it requires an intensive short-term effort on the part of the plant staff in order to minimize the downtime of an aeration tank and the consequent drop in overall plant performance.

Primarily due to the maintenance considerations, it is obvious that the sock diffusion system at both Columbus plants should be replaced. Several alternatives exist which more or less maximize the use of existing equipment (blowers and air headers) while minimizing the energy input in a system that responds economically through the potential five to seven fold change in oxygen transfer needs (winter minimums without complete nitrification to summer maximums with full nitrification requirements). Table J-5 lists four feasible alternatives with budgetary estimates for installation in 1975 and a sliding price for electrical energy. The first two alternatives use either coarse or fine bubble aeration to assure mixing with mechanical aerators satisfying the remainder of the oxygen demand. The third alternative incorporates fine bubble diffusion (ceramic tubes or domes) to the full extent of the existing plant blowers with only a minor addition of mechanical aeration. Alternative 4 considers the use of a directional mix jet aeration system as manufactured by the Pentech Division of Houdaille Industries.

With reported standard oxygen transfer efficiencies as high as 5 lbs per brake horsepower hour at 15 feet of water depth, the jet aeration system is competitive with optimum use of cryogenic oxygen generation and subsequent dissolution and mixing in the aerator (a wire to water efficiency of 2.6 pounds of oxygen transferred per horsepower hour is reported by Union Carbide--a major supplier of pure oxygen equipment). Acceptance of the jet aeration system, which combines compressed air and recirculated mixed liquor within the jet and subsequent injection back into the aeration tank, has been limited in the past due to high installation costs, cheap energy, and fears concerning excessive maintenance. The present jet aerator has been increased in size (one inch minimum opening) and simplified in construction to minimize clogging and reduce fabrication costs. Full scale performance data supplied by Pentech indicate that this type of aerator is now ready for consideration in municipal applications, with the higher installed costs being reduced in significance as the price of energy increases.

Table J-5 shows that jet aeration would not be the system of choice under the energy price, 1.5¢/KWH used in preparing the Columbus Facilities Plans. However, with increasing energy expenditures it does become progressively more attractive. It is recommended that jet aeration be given a detailed evaluation for application at Columbus by the design consultant that prepares the plant improvements. The City may wish to conduct a jet aeration demonstration/ evaluation to derive operational experience with its own staff and to derive a firm quantification of the actual energy requirements for oxygen dissolution before commencing with final design activities. The final EIS will consider the results of such an evaluation in the selection of a proposed dissolution system.

J.8 CONCLUSIONS

An examination of several alternatives to the proposed treatment technology of the Facilities Plans leads to the following conclusions and recommendations.

- It is recommended that the selection of centrifugation over dissolved air flotation at Jackson Pike for secondary solids thickening be reviewed in the detailed design phase of the Columbus project to assure cost-effective use of treatment technology. (Preliminary costing of the two systems is extremely close). The City may wish to conduct a side-by-side comparison of representative units prior to selection of the preferred unit process.

- The City is presently fully committed to thermal sludge conditioning as a means of achieving an autogenous dewatered sludge cake. Recent capital expenditures require the continuation of this treatment concept. Future flexibility considerations and present dissatisfaction with thermal conditioning point toward continued testing of a chemical conditioning-belt press system which, if shown to be implementable, could be provided in the future if the thermal conditioning system operation becomes untenable.

- Recent investigative efforts have suggested that the most effective means of managing the recycles associated with thermal conditioning of secondary sludge is to apply the entire thermally conditioned

Table J-5
Economic Examination of Alternate Means for Oxygen Dissolution
(Combined Costs for both Columbus Wastewater Treatment Plants)

Parameter	Alternative			
	Low Speed Surface Aeration			Directional Mix Jet Aeration
	with coarse bubble diffusion for mixing	with fine bubble diffusion		
		for mixing	at maximum existing capability	
	1	2	3	4
Standard Overall Efficiency -lbs O_2/bhp-hr(1)	2.9	3.1	2.5	3.5
Installed Cost - 10^6 $	4.3	3.8	4.0	6.4
Energy Cost-10^6 $/Year(2)				
at 1.5 ¢/kwh	0.91	0.85	1.06	0.76
at 3.0 ¢/kwh	1.83	1.71	2.11	1.51
at 4.5 ¢/kwh	2.74	2.57	3.17	2.27
Total Present Worth-10^6 $(3)				
at 1.5 ¢/kwh	13.9	12.8	15.3	14.1
at 3.0 ¢/kwh	24.0	22.2	26.8	22.4
at 4.5 ¢/kwh	34.0	31.7	38.5	30.7

(1) Assumptions: Standard Efficiencies for:
Coarse Bubble Aeration = 1.6 lbs O_2/bhp-hr
Fine Bubble Aeration = 2.4 lbs O_2/bhp-hr
Low Speed Surface Aeration = 3.2 lbs O_2/bhp-hr
Jet Aeration = 3.5 lbs O_2/bhp-hr
Actual Efficiency at 18°C liquid temperature with α = 0.75, β = 0.93, and DO = 2.5 mg/l = (standard efficiency) /2
(2) Year round nitrification assumption due to present NPDES requirements.
(3) Present Worth at 6-3/8 percent = 0.9 (installed cost) + 11 (energy cost)

product sludge to an anaerobic digester. This concept (Alternative C1 of Section J-3), which makes use of the present anaerobic digester capacity, is recommended at the Columbus Plants, with a programmed return of the supernatant to the main flow stream during low loading periods. Accordingly, it is recommended that isolated treatment of the recycles by an air activated sludge system, as proposed in the Facilities Plant, be eliminated.

- Starved air combustion is not clearly superior to incineration. It still must be considered as unproven technology with its ultimate attractiveness dependent upon a commitment to maximize the recovery of waste heat. The City may wish to construct one or more of its new incinerators with the flexibility to convert to starved air combustion in the future.

- The economic attractiveness of a "Phostrip" phosphorus removal system at Columbus will be lost with any state or national ban on phosphorus based detergents. The probability of this legislative action leads to the recommendation that Columbus retain the proposed metal salt addition capability for phosphorus removal.

- An examination of intermediate sedimentation between the roughing trickling filters and the activated sludge at Jackson Pike reveals distinct first cost and minor operating cost advantages for a plant required to achieve year-round nitrification. It is recommended that intermediate sedimentation be retained in the main flow stream Jackson Pike processing sequence.

- A review of the operating horsepower and capital expense for the proposed project plan and a pure oxygen activated sludge system shows that the price of electrical energy would have to increase to $0.05 per kwh before pure oxygen is attractive. Since it is believed that the proposed expansion of the aeration and final sedimentation systems can be fractionally or completely eliminated, the overall economic liability of the pure oxygen system will only increase. Thus, it is recommended that the air activated sludge systems be retained at both Columbus wastewater treatment plants.

A preliminary evaluation of several air based oxygen dissolution systems which maximize the retention of existing facilities while minimizing the oxygen transfer energy requirement show the jet aeration system to be most attractive from the standpoint of energy demands, but unattractive from an overall basis until the price of energy exceeds 3¢/KWH. It is likely that even at the present electrical energy cost of 2.3¢/KWH, the jet aeration system is well within ten percent of the least cost dissolution method investigated. The oxygen transfer capacity of the jet aeration system is superior to other air systems, and approaches that reported for optimum cryogenic oxygen generation and dissolution and mixing in the reactor. It is recommended that the jet aeration system be evaluated in detail during the design phase of the Columbus project, and that consideration be given to a full-scale demonstration of its efficiency with quantification of its maintenance needs.

APPENDIX K

DESIGN QUANTITIES AND UNIT PROCESS SIZING FOR THE RECOMMENDED TREATMENT FACILITIES

APPENDIX K

DESIGN QUANTITIES AND UNIT PROCESS SIZING FOR THE RECOMMENDED TREATMENT FACILITIES

K.1 DESIGN QUANTITIES

The proposed project plan is shown schematically in Figure K-1, while Table K-1 provides the average day process stream characterization at the year 2000 design conditions at Jackson Pike and Southerly with two stage metal salt addition for phosphorus removal and all recycles returned to the primary effluent. As shown, it is expected that the nitrogen returned in the recycle will amount to an applied TKN mass in the primary effluent approaching that found in the raw wastewater. The basis of design additives of aluminum ion and resultant net production of waste metal hydroxy phosphate precipitates are as follows:

	Quantity, lbs/day	
	Jackson Pike	Southerly
Al+3 added to influent to		
First-stage	3,300 (T.F.Effl.)	4,800 (Infl.)
Second-Stage	2,300	1,800
Total	5,600	5,300
Total Metal Precipitate Produced	21,000	22,000

Table K-2 summarizes the average and maximum day waste solids production values used as a basis of design. As can be seen, two 200 gpm thermal conditioning systems are assumed to be in constant operation at Southerly, where varying mixtures of primary and secondary solids are used as the feed sludge. The Jackson Pike thermal conditioning system sees only waste seconary sludge. Further, as shown in the Table, the present sizing of the Southerly anaerobic digesters prevents their receipt of all of the thermally conditioned solids. If influent phosphorus levels were reduced to the point that no chemical additions were required, the solids mass applied to the incinerators would reduce by about 10 and 15 percent at Jackson Pike and Southerly, respectively, with a subsequent 25 to 35 percent reduction in each plant's ash production.

K.2 UNIT PROCESS SIZING

Table K-3 summarizes the changes in unit process sizing derived from the recommended alternative in comparison to the improvements originally proposed in the Columbus

Table K-1

Major Process Stream Characterization at Design Conditions (1)
(Two Significant Figures)

Process Stream	Pollutant Mass - 1000 lbs/day **							
	Jackson Pike (2)				Southerly (3)			
	SS	BOD_5	TKN	P	SS	BOD_5	TKN	P
Influent	220	190	28	7.8	180	180	23	6.3
Primary Effluent	92	120	23	5.7	53	100	17	2.5
Primary Effluent*	120	140	29	7.2	70	110	22	3.8
First Stage Effl.	32	46	22	2.7	-	-	-	-
Second Stage Effl.	18	3.7	2.3	1.6	4	4.9	2.0	1.1
Final Effluent	4.6	2.7	1.6	0.8	3.5	3.5	1.3	0.6

* With recycles ** Assumes Pretreatment of Brewery Waste
(See Chapter 4 for discussion)

(1) Phosphorous removal concept at Jackson Pike incorporates two stage aluminum addition at influent to intermediate and final sedimentation system; alternate addition to raw sewage should also be provided for system flexibility. Aluminum additions to the influent wastewater and the effluent of the activated sludge aerators were used at Southerly. Recycles shown applied to the primary effluent, alternate addition points should be provided at the influent to activated sludge system (Jackson Pike only) and the plant influent. Both plants should have the capability for alkalinity addition (lime or caustic) to activated sludge system for emergency use; none is believed required for average day needs at Jackson Pike; about 4,000 pounds per day of CaO is believed necessary at Southerly. Both plants should have the capability for polymer addition to the influent to the final sedimentation and filtration systems, none is believed required for average day needs.

(2) Average Daily Flow=110 mgd; Design Hydraulic Capacity=200 mgd

(3) Average Daily Flow= 85 mgd; Design Hydraulic Capacity=230 mgd

Figure K-1
The Preferred Alternative

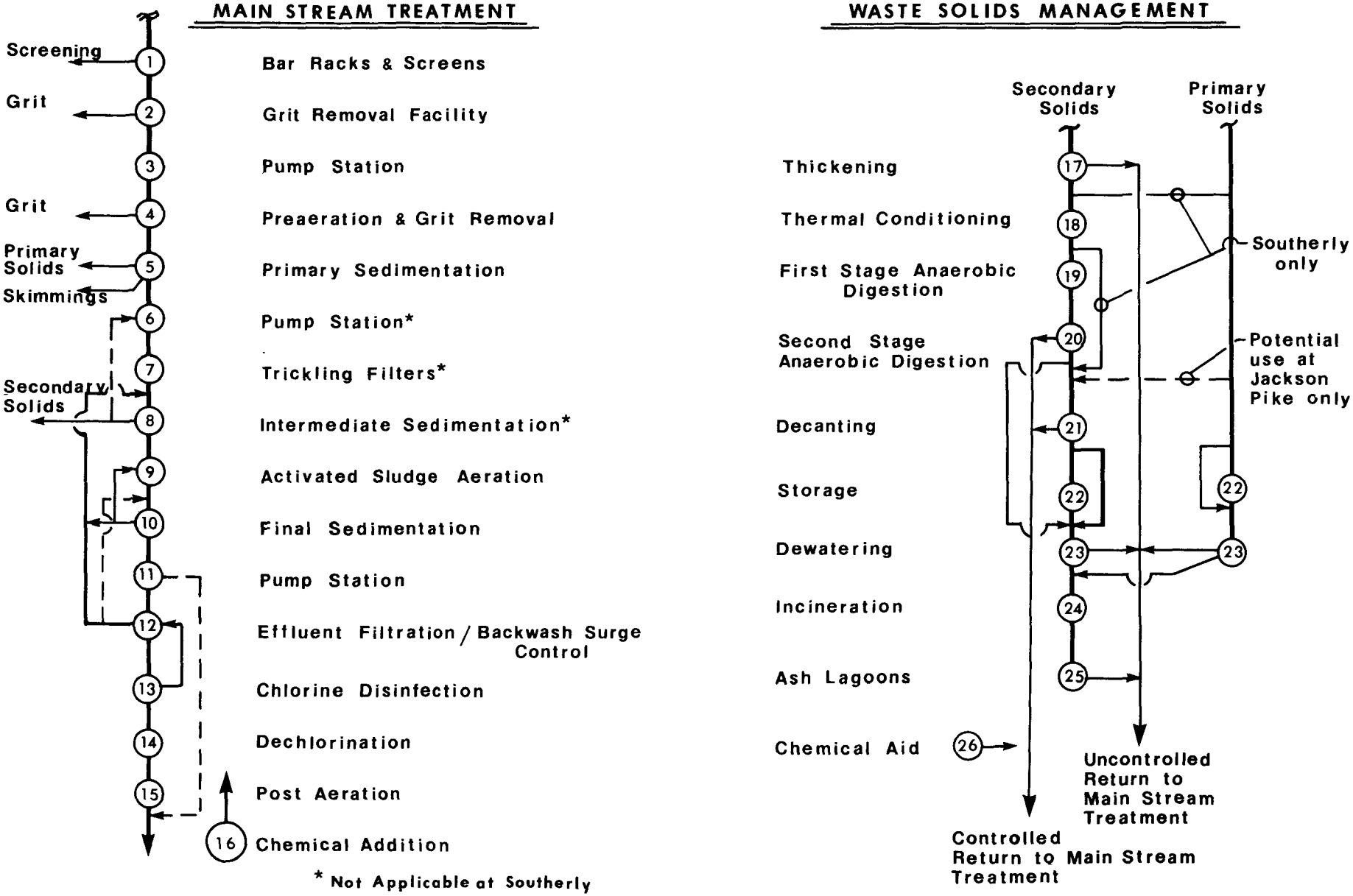


Table K-2

Sludge Process Stream Characterization at Design Conditions (1)*
(Two Significant Figures)

Process Stream	Jackson Pike				Southerly			
	Average Day		Minimum Maximum Day		Average Day		Minimum Maximum Day	
	lbs dss / day(2)	gpm	lb dss / day(2)	gpm	lb dss / day(2)	gpm	lb dss / day(2)	gpm
Primary Solids	130	210	330	550	150	400	350	840
Dewatered Prim. Solids	120	34	180 (4)	51(4)	48	22	72(4)	26
Secondary Solids	140	1,170	240	2,000	75	630	110	875
Thickened Sec. Solids	130	210	220	360	67	140	94	200
Thermal Cond.Sec. Solids	100	220(5)	180	380(5)	140	420(5)	150	420(5)
To Digestion	100	220	180	380	48	150	52	150
To Decant	0	0	0	0	87	270	94	270
Dig. Solids to Dewater	82	85	98(4)	100(4)	29	30	35(4)	36(4)
Decant Solids to Dewater	0	0	0	0	86	72	100(4)	84(4)
Total Solids to Dewater	82	85	98	100	115	102	135	120
Dewatered Sec.Solids	78	19	94	23	109	27	128	32
Total Solids to Incineration (3)	200	53	270	84	160	49	200	58
Approximate Volatility of Sludge Cake	58%	-	-	-	65%	-	-	-

* Notes are described on next page.

Table K-2 (Continued)

Sludge Process Stream Characterization at Design Conditions (1)
(Two Significant Figures)

(1) Polymer addition capability recommended at thickening and dewatering systems; not believed required for average day performance

(2) Expressed as 1000 lbs/day of dry suspended solids

(3) Skimmings not included for calculation convenience

(4) After i.e. storage

(5) Volume expansion reflects 5 percent credit due to steam addition

Facilities Plan. Where no change from the originally proposed project plan is indicated, the reader is referred to Appendix I for the unit process's sizing. The following sections describe the recommended unit process sizing and, where applicable, provide additional discussion of the rationale leading to the final recommendations.

K.2.1 Pretreatment and Primary Sedimentation

With the exception of a slight expansion of the Southerly influent pumping station to provide a firm pumping capacity of 230 mgd (Facilities Plan proposed 185 mgd), no expansion of the two plant's pretreatment and primary sedimentation facilities is recommended. The pumping station at the terminus of the 156-inch diameter interconnecting sewer, with a firm capacity of 70 mgd, is also considered adequate.

It should be noted that the reason Jackson Pike's pretreatment system is considered adequate is due to the presence of the interconnecting sewer, which allows all flows above 200 mgd (1.8 times greater than the average annual design flow) to be diverted to Southerly. Failure to use the interconnecting sewer would necessitate a design hydraulic capacity of at least 220 mgd at Jackson Pike. Although a flow peak of this magnitude could be easily incorporated in the new Jackson Pike structures and conduits, its selection may force a major revamping of the existing transfer conduits within the plant. Therefore, the soundest decision appears to be one that makes maximum use of the rated hydraulic capacity of both plants and the interconnecting sewer.

As noted in Appendix I, rehabilitation of the four 120 feet by 60 feet by 15 feet side water depth primary sedimentation tanks at Jackson Pike is not a strong requirement for successful wastewater treatment. However, it was decided to recommend rehabilitation of those tanks and their associated collector mechanisms in order to derive a modernized facility with all tankage suitable for service. The primary sedimentation surface overflow rates at design conditions for both plants are given below:

	Surface Overflow Rates	
	Jackson Pike	Southerly
Average Day	880 gpd/sf @ 110 mgd	710 gpd/sf @ 85 mgd
Process Peak	1360 gpd/sf @ 170 mgd	1080 gpd/sf @130 mgd
Hydraulic Capacity	1600 gpd/sf @ 200 mgd	1840 gpd/sf @230 mgd

Table K-3

Changes Associated with the Recommended Alternative

Unit Processes (Refer to Figure K-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
1. Bar Racks and Screens	x							x						
2. Grit Removal	x							x						
3. Pump Station	x									x				
4. Preaeration/Grit Removal	x							x						
5. Primary Sedimentation	x							x						
6. Pump Station			x											x
7. Trickling Filters				x										x
8. Intermediate Sedimentation			x											x
9. Activated Sludge Aeration		x		x					x		x			
10. Final Sedimentation				x							x			
11. Pump Station			x							x				
12. Effluent Filtration/Backwash			x		x					x		x		
13. Chlorine Disinfection			x							x				

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Table K-3 (Continued)

Changes Associated with the Recommended Alternative

Unit Processes (Refer to Figure K-1)	Jackson Pike							Southerly						
	a	b	c	d	e	f	g	a	b	c	d	e	f	g
14. Dechlorination					x							x		
15. Post Aeration					x							x		
16. Chemical Addition					x							x		
17. Thickening				x							x			
18. Thermal Conditioning	x								x		x			
19-20. Anaerobic Digestion						x							x	
21. Decanting	x							x						
22. Storage				x							x			
23. Dewatering	x										x			
24. Incineration		x		x							x			
25. Ash Lagoons	x							x						
26. Chemical Aide					x							x		

(a) No change
(b) Change in auxiliaries
(c) Expansion
(d) Contraction
(e) Addition
(f) Change from proposed utilization
(g) Elimination

Note: Recommended alternative calls for complete elimination of the proposed isolated activated sludge system for stabilization of the product liquors derived from concentration of the thermally conditioned secondary solids.

K.2.2 First Stage Biological Treatment

The first stage biological treatment system is only recommended at Jackson Pike. It incorporates a pumping station, synthetic media trickling filtration, and intermediate sedimentation. The recommended changes impact the entire facility. Final configurations and the attendent rationale for their selection are given below:

	Pump Station
Minimum Firm Capacity	220 mgd

This sizing reflects the firm capacity of the plant plus a 20 mgd credit for recycled flows. The original Facilities Plan did not consider recycles in its pump station sizing.

	Trickling Filter
Sizing	78'-dia x 21.5' depth
Number	8
BOD_5 load, lbs/1000 cf.day	170
Hydraulic load, gpm/sf	2.0

The originally proposed Jackson Pike trickling filter had a diameter of 104 feet. As shown above, the proposed 78 foot Jackson Pike filters have the same organic loading rate as originally proposed at Southerly, which nearly doubles the hydraulic rate. The anticipated removal of soluble substrate through the filter is on the order of 65 percent. It is recommended that the original installation be designed with the flexibility to divert flow around the filter. This improvement may allow operational savings when complete nitrification is not a treatment requirement by avoiding the energy associated with pumping the wastewater.

	Intermediate Sedimentation Surface Overflow Rates
Eight tanks with total of 88,000 sf	
Average Day	1360 @ 120 mgd
Process Peak	2160 @ 190 mgd
Maximum Rate	2500 @ 220 mgd

The intermediate sedimentation system was designed for a maximum surface overflow rate of 2500 gpd/sf with 20 mgd of recycled flow. It is believed that the resultant sizing is completely adequate for intermediate solids-liquid separation. It is recommended that the system be designed with the capability to supply waste sludge to the influent to the

trickling filter and the activated sludge system for process flexibility. The Facilities Plan proposed 84,400 square feet of sedimentation area at Jackson Pike.

K.2.3 Second Stage Biological Treatment

The design of an activated sludge system entails an optimized interrelated blend of aeration and sedimentation tankage. Up to a certain point, hydraulic surface overflow rates are secondary to successful performance. The key to successful sedimentation is to maintain a reasonable solids loading with sufficient return sludge capacity. Both are related to the operating mixed liquor suspended solids (MLSS) applied to the sedimentation system. The operating MLSS is related to the cell residence time (or nitrification requirements), the mode of applying both flow and return sludge to the aerator, and the aeration tankage.

In Section 4.5.3, it was recommended that the activated sludge systems at the Columbus plants be optimized to incorporate a modified step feed aeration pattern in order to avoid an expansion of either the existing aeration or sedimentation systems. Table K-4 shows the recommended design for the Columbus activated sludge systems. At Southerly, the most cost effective design is to provide the additional 5.2 million gallons of tankage defined in the Facilities Plan. The proposed improvements at Southerly will allow one 5.2 million gallon aeration system to be completely committed to return sludge aeration. This commitment will allow successful obtainment of a nomlimiting cell residence time during the critical winter condition. The return sludge systems of both plants should be revamped for ease of operation, with return to the beginning of each aeration tank and, at Southerly, full return to an isolated aeration tank. The variable MLSS concentrations noted in the first and second compartment of the first aeration pass reflect a single point addition of settled intermediate effluent at the beginning of each compartment (low MLSS), or multipoint addition throughout the aeration compartment (high MLSS). If possible, the latter is recommended for ease of oxygen transfer. The lower nitrification rate at Southerly reflects the "dilute out" of nitrifying organisms due to the higher magnitude of sludge synthesis.

It should be noted that the 1090 gpd/sf average day surface overflow rate at Jackson Pike is higher than the normally suggested 800 gpd/sf standard of regulatory agencies. This standard is typically associated with a MLSS concentration of 2000 to 3000 mg/l in the aerator effluent, whereas the proposed Jackson Pike aerator effluent concentration is 1500

Table K-4

Recommended Activated Sludge System Design

I. Existing Physical Sizing

	Jackson Pike	Southerly
Aeration Tank, million gallons	31.5	26.3
Sedimentation, Square Feet	110,000	135,000
Total Return Sludge, mgd,	42.1	142
firm, mgd	23.6	115

II. Recommended Design

Expand aeration tankage at Southerly by 5.2 million gallons as proposed in Facilities Plan. Use one 5.2 MG tank to receive only return activated sludge in wintertime operation, effluent from this system is applied to the first compartment of the remaining aeration tanks.

		Jackson Pike	Southerly
MLSS			
Return Sludge Aeration	- mg/l	Not	10,000
	- lbs	Applicable	434,000
First Compartmentψ	- mg/l	6800*-3500*	7200*-4300*
	- lbs	447,000-230,000	395,000-236,000
Second Compartmentψ	- mg/l	2800*-2100*	3500*-2700*
	- lbs	184,000-138,000	192,000-148,000
Thirdψ and Fourth	- mg/l	1,500	2,000
Compartments	- lbs	197,000	219,000
Total	- lbs	828,000*-565,000*	1,240,000*-1,037,000*

* Based upon a return sludge concentration of 10,000 mg/l

ψ Assumes influent split of 1/3 to first, second and third compartment

Percent Volatile		50	68
Cell Residence Time - days		20-14	16-13
Assumed Nitrification Rate at 10°C	$\frac{\text{lb TKN}}{\text{lb MLSS,day}}$	0.12	0.08
Maximum Design Nitrogen Load to Nitrify	lbs/day	29,000	28,000

Table K-4 (Continued)

	Jackson Pike	Southerly
Required recycle fraction, R/Q, at sludge conc. = 10,000 mg/l	0.18	0.25
= 7,500 mg/l	0.25	0.36
Recommended minimum maximum firm recycle rate, mgd	55	90
Solids loading rates, lbs/sf day		
Ave. day	16 @ Q=120 mgd, R/Q=0.18	15 @ Q=95 mgd, R/Q=0.25
Process Design Peak	25 @ Q=190 mgd, R/Q=0.18	23 @ Q=150 mgd, R/Q=0.25
Surface Overflow Rate, gpd/sf		
Ave. day	1,090 @ 120 mgd	700 @ 95 mgd
Process Peak	1,730 @ 190 mgd	1,110 @ 150 mgd
Maximum Rate	2,000 @ 200 mgd	1,850 @ 250 mgd

mg/l. It is believed that Jackson Pike can maintain a suitable performance level with the lower MLSS concentration and higher surface overflow rate, and deviation from the conventional standard is strongly recommended.

As mentioned in Appendix J, total revamping of the Columbus plant's oxygen transfer capacity is recommended. The calculated oxygen demands for design load satisfaction are given below:

	Design Oxygen Demand to be Satisfied, lbs/day	
	Jackson Pike	Southerly
Average Day		
Carbonaceous	35,000	120,000
Nitrogenous	90,000	75,000
Total	125,000	195,000
Maximum Day		
Carbonaceous	50,000	180,000
Nitrogen	135,000	130,000
Total	185,000	310,000

The firm oxygen transfer capability at both plants should address these needs. It should be noted that the maximum day values take no credit for load dampening due to controlled release of the recycles at both plants, or the controlled release of the pretreated brewery waste to the Southerly collection system.

K.2.4 Final Effluent Filtration

The considerations associated with the final effluent filtration system were developed in Section 4.5.4. The recommended installations at Jackson Pike and Southerly, using the nominal filter size of the Facilities Plan, are as follows:

	Jackson Pike	Southerly
Nominal Filter Size, sf	1860 sf	1860 sf
No. of Filters	16	16
Maximum Flow Applied to Filters, mgd	180	205
Maximum Filtration Rate with one filter out of service, gpm/sf	4.5	5.0
Average Filtration Rate gpm/sf	2.8 @ 120 mgd	2.2 @ 95 mgd
Maximum Backwash rate @ 15 gpm/sf	40 mgd firm capacity	
Maximum Air Supply @ 2 cfm/sf	3700 cfm firm capacity	

	Jackson Pike	Southerly
Storage Volume @ Maximum Backwash for 10 minutes and 30 minute cycle time	0.19 million gallons with 13.5 mgd maximum return	

The preceding sizing is specific for a Hydro-Clear installation. The storage volume and maximum backwash rate are provided in the interest of completeness. A wide variety of combinations are possible; in the tabulated system, the elapsed time for cleaning the entire installation is eight hours under the worst conditions.

K.2.5 Effluent Disinfection, Dechlorination, and Post Aeration

The Facilities Plan did not include dechlorination or post aeration. The suggested contact time for the entire sequence of these two treatment concepts is 20 minutes at the hydraulic peak. This yields a total volume of about 3.0 and 3.5 million gallons at Jackson Pike and Southerly, respectively. The suggested maximum chlorination capacity of 12,000 pounds/day at both plants will allow the breakpoint elimination of 1 to 1.5 mg/l of ammonium nitrogen under average daily flow conditions. The dechlorination feed capacity for SO_2 should be a similar order of magnitude as that provided for chlorine addition.

K.2.6 Secondary Solids Thickening

The Facilities Plan for the Jackson Pike Plant recommended thickening of waste activated sludge by centrifugation. The nominal sizing for each centrifuge is 200 gpm. Table K-2 cites an estimated maximum flow of waste secondary solids at 2000 gpm with a solids concentration of 10,000 mg/l for this reasonable action alternative. This yields a total of 12 units, with two standby, for the maximum day condition. This selection is recommended for the Jackson Pike installation, since the waste secondary solids are dominated by sloughed filter humus (which should be at a solids concentration of one percent or higher), and since it is possible to realize a greater hydraulic capacity for a scroll centrifuge without a significant sacrifice in solids capture through the addition of organic polyelectrolytes. This selection of equipment appears to be more justified than the Facilities Plan's callout of 18 units, which provide approximately three times the average day operating requirement of the system.

The Southerly Facilities Plan recommended two additional dissolved air flotation units at 1900 square feet each for waste secondary solids thickening. This 50 percent expansion is unnecessary with the recommended project plan as the existing 7600 square feet of thickening area will yield an average and maximum day solids loading of 10 and 14 pounds/SF.day, respectively.

A standby polyelectrolyte addition capability is recommended as a contingency should one or more units be out of service under maximum day conditions.

K.2.7 Thermal Conditioning

The Facilities Plan recommended that one additional 200 gpm thermal conditioning system be added to the existing two units at Jackson Pike and three units at Southerly. The recommended project plan does not differ with this selection at Jackson Pike, as both the average day and maximum day needs defined in Table K-2 require the use of two 200 gpm systems. It does differ with the recommendations at Southerly, since the average and maximum day requirement is also for two units. Here, it is believed more sound to provide extra standby auxiliaries (i.e., grinders, high pressure pumps, high pressure compressors, etc.) and extra dewatering capacity rather than one complete standby heat exchanger and reactor for the maximum day condition.

K.2.8 Anaerobic Digestion, Decanting, and Storage

Anaerobic solids destruction of the thermally conditioned solids is recommended at both plants. The primary digestion capacity less the cone volume at Jackson Pike and Southerly is 6.3 and 4.3 million gallons, respectively. With a design volumetric displacement time of about 20 days, the Jackson Pike capacity matches the system needs perfectly. At Southerly, only 36 percent of the average design day thermally conditioned solids can be applied to the anaerobic digestion system; the remainder must be decanted and directly dewatered or stored.

The second stage anaerobic digester volume at Jackson Pike and Southerly totals 8 and 2.2 million gallons, respectively. It is recommended that two of the eight second stage digesters at Jackson Pike and one of the two second stage digesters at Southerly be committed to decanting and thickening the digested thermally conditioned secondary solids. The average day solids loading on these units is about 7.3 and 5.1 lbs/sf day at Jackson Pike and Southerly, respectively.

The remaining existing digestion and decanting capacity at the two plants is as follows:

	Jackson Pike	Southerly
Digestion	6 tanks @ 85 feet diameter, 6 million gallons, 34,000 sf	1 tank @ 85 feet diameter, 1.1 million gallons, 5,670 sf
Decant Tanks	3 tanks*, 0.37 million gallons, 3,500 sf	4 tanks @ 35 feet diameter, 0.39 million gallons, 3,800 sf

* includes proposed additional unit

These tanks provide the storage capabilities of the wastewater treatment plants. Storage requirements vary as a function of the maximum day processing capabilities provided at the dewatering and incineration complex and the maximum consecutive days of waste solids production. For ease of analysis, the following peaking factors for waste solids production were assumed:

	Peaking Factors		
Day	Primary Solids	Secondary Solids	
		Jackson Pike	Southerly
1	2.6	1.7	1.4
2	2.3	1.5	1.3
3	1.7	1.3	1.2
5	1.5	1.2	1.1
7	1.3	1.1	1.0
10	1.2	1.0	1.0
15	1.1	1.0	1.0

The required storage volume with these peaking factors and the assumptions that (1) the minimum maximum day dewatering capability should be 1.5 and 1.2 times the average dry primary and secondary solids production, respectively, and (2) on the first day of maximum sludge production, the dewatering system is run at average day values, the required approximate storage volume is about one million gallons at each plant. This volume is presently available in the uncommitted secondary digestion capacity at both plants.

The decant tanks at Jackson Pike can be committed to fractional or complete primary sludge thickening uses if the need so arises. If so used, the average day solids loading rate for the entire primary solids mass is about 34 lbs/sf day. At Southerly, the decant tanks should remain in service to concentrate (and store) the thermally conditioned solids bypassed around the anaerobic digestion system. The average day solids loading rate on the Southerly decant tanks will be about 24 lbs/sf day.

Thus, the recommended alternative proposes to more fully develop the use of existing equipment at the two wastewater treatment plants. Implementation of this alternative will necessitate both major and minor piping changes, additional pumping capabilities to derive an optimum controlled return of the digester supernatant and decanting liquors, and "as required" rehabilitation of the existing digesters. Particular attention should be given towards efficient mixing in the primary digesters and the capability to return settled digested solids to the first stage digester. Heating requirements of the digesters will be lessened due to the elevated temperature (100 to 120°F) of the thermally conditioned feed sludge. (The advantages of incorporating the anaerobic digestion system in the project plan are developed Appendix J.)

K.2.9 Dewatering and Incineration

The dewatering and incineration capabilities of any plant are intimately related. Often, the incineration capability of a plant is limited by its upstream dewatering capacity and the routing of dewatered sludge to any incinerator. Care should be exercised to assure that the capacity of a given incinerator and the capability of a dewatering system effectively match. If at all possible, a given incineration system should be designed to share the product solids from two banks of dewatering equipment. Coupled with these considerations is the reality that normal operation will require the programmed shutdown on an incinerator two to three times a month for inspection. Typically, this inspection requirement will encompass two to three days due to slow cooling and heating considerations as the unit is taken out of and then returned to service.

With the preceding comments in mind, the dewatering and incineration needs of the Columbus plants were determined for the reasonable action alternative. The results of this evaluation are summarized in Table K-5. The Columbus Facilities Plan proposed nine dewatering centrifuges (3 at 65 gpm, 6 at 55 gpm) and four incinerators (2 at 170 wet tons/day, 2 at 200 wet tons/day) at Jackson Pike; and nine dewatering centrifuges (6 at 65 gpm, 3 at 55 gpm) and four incinerators (all at 200 wet tons/day) at Southerly. As can be seen from Table K-5, when the maximum solids loading of the incinerators are considered, neither plant has any standby centrifugation equipment. Thus, it is probable that if the recommendations of the Facilities Plan were implemented, each plant could never realize its maximum incineration potential. As a consequence, if the Facilities Plan's recommended inciner-

Table K-5

Evaluation of Dewatering and Incineration Needs

Waste Solids Production Condition	Jackson Pike	Southerly
Average Day Waste Solids Production*	295 gpm yields 310 wet tons/day of cake-use 5 centrifuges and 2 incinerators	235 gpm yields 250 wet tons/day of cake-use 4 centrifuges and 2 incinerators
Minimum Maximum Day Waste Solids Production* (based upon the development of reasonable sludge production peaking factors and nominal sludge storage considerations)	415 gpm yields 420 wet tons/day of cake-Option 1-use 7 centrifuges and 3 incinerators Option 2-330 gpm yields 340 wet tons/day of cake using 7 centrifuges and two incinerators; store and/or divert 50,000 pounds of dry suspended solids (105 gpm at 4%-equivalent to 80 wet tons/day of cake) to Southerly	300 gpm yields 310 wet tons/day of cake-use 5 centrifuges and 2 incinerators With 50,000 pounds diversion from Jackson Pike, 350 gpm yields 390 wet tons/day of cake-use 6 centrifuges and 2 incinerators
Maximum Maximum Day Waste Solids Production (based upon back calculations which reflect the handling capabilities of the incinerators)	At 100 percent incinerator capacity, 530 gpm yields 540 wet tons/day of cake-use 9 centrifuges and 3 incinerators At 90 percent incinerator capacity, 480 gpm yields 490 wet tons/day of cake-use 8 centrifuges and 3 incinerators	At 100 percent incinerator capacity, 570 gpm yields 600 wet tons/day of cake-use 9 centrifuges and 3 incinerators At 90 percent incinerator capacity, 510 gpm yields 540 wet tons/day of cake-use 8 centrifuges and 3 incinerators

* Reference Table K-2

ators were installed, it would be necessary that at least one additional new dewatering centrifuge (65 gpm capacity) be provided at each plant.

In previous Appendices and in the main text of this report, use of the nearly completed Jackson Pike to Southerly sludge force main has been mentioned. The price for completing this force main with the provision of two stage pumping is about the same as a new 200 wet ton/day incinerator, while the committed investment for the force main totals on the order of $300,000. As shown in Table K-5, two Southerly incinerators are capable of handling the diverted Jackson Pike load concurrently with its minimum maximum day waste solids production. This consideration, plus the extra existing 5 million gallons of storage volume at Jackson Pike to further reduce the potential peak of sludge transfer, makes this option even more viable. Further, the potential codisposal of sludge solids with refuse at the proposed municipal refuse/coal fired power plant suggests a planning desire to minimize the capital investment for sludge solids incineration at Jackson Pike. The long-term potential of applying dewatered thermally conditioned solids to reclaim strip mined land also makes a centralized point of solids collection attractive at Southerly. Finally, it is noted that the Southerly incineration needs under the minimum maximum day with a 50,000 pound/day diversion from Jackson Pike remains at two incinerators, thus making one additional incinerator unnecessary. In view of these considerations, it is recommended that one incinerator be eliminated from the Facilities Plan proposal at both Jackson Pike and Southerly. Consideration should be given to transporting digested thermally conditioned secondary solids on an "as required" basis to Southerly for ease of conveyance and subsequent processing. (If the power plant is constructed it may be more cost-effective to pump sludge to Jackson Pike for incineration). Capability should be provided to deliver these solids to the primary sedimentation system at Southerly with an optional application to the existing decant tanks. The orginally proposed nine centrifuges at Jackson Pike should be adequate for the revised incineration complex. At Southerly, one 65 gpm centrifuge could be eliminated from the Facilities Plan recommendation.

A final consideration concerning dewatering needs is whether or not the existing Southerly vacuum filtration system should be expanded or replaced with centrifugation, as recommended in the Facilities Plan. With an assumed yield rate of 5 pounds of dry suspended solids per hous per

square foot of vacuum filtration area, the existing vacuum filtration complex would have to be expanded by 50 percent for design loadings. This need translates to two new 425 square foot filters or two new 65 gpm centrifuges with a 6.5 percent feed sludge concentration. Provision of either of these two options would require a new structure to house the new units. With total abandonment of the vacuum filtration system and subsequent replacement with centrifugation it may be possible to fit the required eight centrifuges in the existing dewatering structure.

This option would result in significant first cost savings by eliminating the requirement for a new building. Expansion needs will be immediate upon provision of the recommended main stream facilities, meaning an early decision has to be made as to whether the existing filters are to be retained and a new building constructed for new dewatering equipment, or if the filters should be abandoned and the existing space used for a centrifuge complex. Other salient advantages derived from replacing the vacuum filters with centrifuges are as follows:

- The present 10 year old vacuum filtration facility will be near the end of its effective life by the time the improvements are provided. Extensive rehabilitation of the filters and replacement of many auxiliaries is likely as a design requirement to assure a reliable operation for another twenty years of service.

- The centrifuge, with its enclosed means of sludge dewatering, is aethetically attractive, especially when processing thermally conditioned solids.

- A total centrifugal dewatering capability will minimize operator training considerations and the needed spare part inventory required at Southerly. These benefits will also facilitate the transfer of operation and maintenance personnel between the two plants as well as allow the pooling of spare parts between the two installations.

Thus, this review is in agreement with the recommendation that the Southerly vacuum filter system be replaced with a centrifugation complex. The final recommended improvements at both facilities are as follows:

	Jackson Pike	Southerly
Dewatering Centrifuges	6 @ 55 gpm 3 @ 65 gpm (3 banks of 3)	6 @ 65 gpm 2 @ 55 gpm (2 banks of 4)
Incinerators	2 @ 170 wet tons/day 1 @ 200 wet tons/day (one standby)	3 @ 200 wet tons/day (one standby)
Miscellaneous	Completion of interconnecting sludge force main, provision of polyelectrolyte addition capability for "as required" use.	

K.2.10 Ash and Sludge Lagoons

The preferred ultimate disposal scheme for the incinerator ash from the two wastewater treatment plants incorporates the same quarry presently used by the City for water plant waste solids disposal. Whether this is done on a periodic or continuous basis dictates the volumetric requirements of the ash lagoons. It is recommended that the City explore this consideration in full to determine the most cost-effective, implementable program of ash handling before new ash lagoons at Jackson Pike are constructed. Whatever capacity is finally provided, the lagoon overflow should be returned to the main processing stream.

Presently, Jackson Pike makes use of a lagoon to relieve its inadequate solids handling facilities. This lagoon has been a source of odor complaints, and its eventual abandonment is recommended. The question remains as to how to dispose of this historic inventory of partially stabilized digested solids. It is recommended that after the provision of the required sludge handling improvements for Jackson Pike, Southerly, and the interconnecting sewer, the solids be left in place. The lagoon should then be backfilled and compacted with suitable cover made available during the Columbus improvement program. Displaced liquid should be returned through a temporary drainage ditch (and, if needed, a temporary pumping station) to the main processing stream at Jackson Pike.

APPENDIX L

Considerations for Applying Sewage Sludge on Agricultural Land*

*adapted from: "Application of Sludges and Wastewater on Agricultural Land: A Planning and Educational Guide" in Section 3 by L.E. Sommers and D.W. Nelson. North Central Regional Committee (ND-118) and Wester Regional Committee (W-124), North Central Regional Research Publication 235, October 1976

This procedure for calculating sludge application rates is intended for use on privately owned and managed agricultural land. On large-scale, municipally owned and managed systems, where monitoring is regularly performed, the use of higher sludge loading rates may be possible. Determination of such loading rates is site specific as described in the Bulletin.

The following information is needed prior to calculating the rate of sludge application:

- Sludge composition
- Soil pH, cation exchange capacity, and lime requirement to adjust soil to pH 6.5
- Soil test for available P and K; P and K fertilizer recommendation for crop to be grown
- Crops to be grown

The rate of sludge application to land is based on the nitrogen requirement of the crop grown and the metal content of the sludge. If the sludge being applied has a low metal content, then it is possible to use sludge as nitrogen fertilizer material. However, if the sludge contains high concentrations of metals (i.e., Zn>5000ppm, Cu>1000ppm, Ni>500ppm, or Cd>50ppm, all on a dry weight basis), then the sludge may be used as a supplemental nitrogen source only. In either case, it may be necessary to use commercial fertilizer materials to furnish potassium for crop growth. The ranges of nitrogen, phosphorus, and potassium contents found in anaerobically digested sewage sludges are shown in Table 3.2.

TABLE 2.3--Composition of Representative Anaerobic Sewage Sludges

Component	Range*	Lb./Ton**
Organic nitrogen	1% - 5%	20 - 100
Ammonium nitrogen	1% - 3%	20 - 60
Total phosphorus	1.5% - 3%	30 - 60
Total potassium	0.27%- 0.8%	4 - 16

*Percent of oven-dry solids
**Lb./ton dry sludge

After addition to soil, sewage sludge is slowly decomposed, resulting in release of nitrogen available for plant growth. Available data suggest that 15-20% of the organic nitrogen is converted to plant available forms the first year and that 3% of the remaining organic nitrogen is

released each year for at least three subsequent years. Thus, plant available nitrogen is released for several years after sludge has been added to soils. For example, decomposition of a sludge containing 3% organic nitrogen applied at 10 tons/acre/year for 3 years will release 41 lbs. of nitrogen the fourth year. Thus, sludge application rates are based on the quantity of readily available nitrogen in sludge (i.e., NH_4^+ and NO_3^-) and on the amount of nitrogen released during sludge decomposition in soil. Because of nitrogen losses from denitrification, ammonia volatilization, etc., nitrogen from sludge approximately equal to or 50% higher than the crop nitrogen requirement can be applied to soils with minimal environmental risk. If sludge is incorporated immediately (e.g., injected), then available nitrogen from sludge equal to the crop nitrogen requirement should be added. Although phosphorus toxicity to crops is not a problem in most cases, the level of available phosphorus in soils receiving sludge should be checked and serious consideration given to discontinuing sludge applications if available phosphorus exceeds 1500 lb/acre. The crop most susceptible to injury from excess phosphorus appears to be soybeans.

The criteria used to prevent metal injury from sludge application on land are based upon the total amount of Pb, Cu, Zn, Ni, and Cd added in sludges. Whereas nitrogen commonly limits the annual application rate of sludge, metals in sludge will determine the length of time a given acreage can receive sludge. The upper limit for metal addition is given in Table 3.3. In addition to the maximum accumulation of Cd shown, the rates of sludge application should result in no more than 2 lb of Cd per acre being applied on an annual basis.

TABLE 3.3--Total Amount of Sludge Metals Allowed on Agricultural Land

	Soil Cation Exchange Capacity (meq/100g)*		
Metal	0 - 5	5 - 15	>15
	Maximum Amount of Metal (Lb/Acre)		
Pb	500	1000	2000
Zn	250	500	1000
Cu	125	250	500
Ni	50	100	200
Cd	5	10	20

*Determined by the pH 7 ammonium acetate procedure.

These values are the total amounts of metals which can be added to soils. With metal contaminated sludges, one of the above criteria may be met with a single application, whereas 5, 10, or 20 applications may

be needed for "clean" domestic sludges. A soil pH >6.5 must be maintained in all sites after sludge is applied to reduce the solubility and plant uptake of these potentially toxic heavy metals.

Calculation of Annual Application Rate

Step 1. Obtain N requirement for the crop grown from Table 3.4.

Step 2. Calculate tons of sludge needed to meet crop's N requirement

a. Available N in sludge

% Inorganic N (N_i) = (% NH_4-N) + (% NO_3-N)

% Organic N (N_o) = (% total N) - (% inorganic N)

Lb available N/ton sludge = (% N_i x 20) + (% N_o x 4)

b. Residual sludge N in soil

If the soil has received sludge in the past 3 years, calculate residual N from Table 3.5.

c. Annual application rate

i) tons sludge/acre = $\frac{\text{crop N requirement - residual N}}{\text{lb available N/ton sludge}}$

If sludge is surface applied this rate can be doubled

ii) Tons sludge/acre = $\frac{\text{2 lb Cd/acre}}{\text{ppm Cd x .002}}$

iii) The lower of the two amounts is applied.

TABLE 3.4--Annual Nitrogen, Phosphorus, and Potassium Utilization by Selected Crops.*

Crop	Yield	Nitrogen	Phosphorus	Potassium
		Lb per Acre		
Corn	150 bu.	185	35	178
	180 bu.	240	44	199
Corn silage	32 tons	200	35	203
Soybeans	50 bu.	257+	21	100
	60 bu.	336+	29	120
Grain sorghum	8,000 lb.	250	40	166
Wheat	60 bu.	125	22	91
	80 bu.	186	24	134
Oats	100 bu.	150	24	125
Barley	100 bu.	150	24	125
Alfalfa	8 tons	450+	35	398
Orchard grass	6 tons	300	44	311
Brome grass	5 tons	166	29	211
Tall fescue	3.5 tons	135	29	154
Bluegrass	3 tons	200	24	149

*Values reported above are from reports by the Potash Institute of America and are for the total above-ground portion of the plants. Where only grain is removed from the field, a significant proportion of the nutrients is left in the residues. However, since most of these nutrients are temporarily tied up in the residues, they are not readily available for crop use. Therefore, for the purpose of estimating nutrient requirements for any particular crop year, complete crop removal can be assumed.

+Legumes get most of their nitrogen from the air, so additional nitrogen sources are not normally needed.

Table 3.5--Release of Residual Nitrogen During Sludge Decomposition in Soil.

Years After Sludge Application	Organic N Content of Sludge %						
	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	Lb N Released per Ton Sludge Added						
1	1.0	1.2	1.4	1.7	1.9	2.2	2.4
2	0.9	1.2	1.4	1.6	1.8	2.1	2.3
3	0.0	1.1	1.3	1.5	1.7	2.0	2.2

Step 3. Calculate total amount of sludge allowable.

a. Obtain maximum amounts of Pb, Zn, Cu, Ni, and Cd allowed for CEC of the soil from Table 3.3 in lb/acre.

b. Calculate amount of sludge needed to exceed Pb, Zn, Cu, Ni, and Cd limits, using sludge analysis data.

Metal

Pb: $$\text{Tons sludge/acre} = \frac{\text{lb Pb/acre}}{\text{ppm Pb} \times .002}$$

Zn: $$\text{Tons sludge/acre} = \frac{\text{lb Zn/acre}}{\text{ppm Zn} \times .002}$$

Cu: $$\text{Tons sludge/acre} = \frac{\text{lb Cu/acre}}{\text{ppm Cu} \times .002}$$

Ni: $$\text{Tons sludge/acre} = \frac{\text{lb Ni/acre}}{\text{ppm Ni} \times .002}$$

Cd: $$\text{Tons sludge/acre} = \frac{\text{lb Cd/acre}}{\text{ppm Cd} \times .002}$$

(Note: Sludge metals should be expressed on a dry weight ppm (mg/kg) basis.)

The lowest value is chosen from the above five calculations as the maximum tons of sludge/acre which can be applied.

Step 4. Calculate amount of P and K added in sludge.

Tons of sludge x % P in sludge x 20 = lb of P added

Tons of sludge x % K in sludge x 20 = lb of K added

Step 5. Calculate amount of P and K fertilizer needed.

(lb P recommended for crop)* - (lb P in sludge) = lb P fertilizer needed

(lb K recommended for crop)* - (lb K in sludge) = lb K fertilizer needed

*P and K recommendations based on soil tests for available P and K

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APPENDIX M

WARRANTY TESTS ON THE INCINERATOR AT MIDDLETOWN, OHIO

HAVENS AND EMERSON
LIMITED

Subject: Middletown Incinerator Study — Date August 20, 1975

From M. C. Mulbarger — File 0000-20

To Record

I. BACKGROUND

On March 18 and 20, 1974, a variety of special samples were collected during the first Middletown Incinerator Warranty Test. The purpose of this memorandum is to summarize the results of the study. Data are only presented with the incinerators operating a full-load conditions or approximately 7500 lbs/hr of wet cake. The two incinerators are Herreshoff type multiple hearth units with six hearths. The unit was receiving lime and ferric conditioned sludge from a vacuum filtration dewatering system. Flue gases pass through a Sly Impingjet two tray scrubber with an approximate head loss of seven inches of water.

Nominal temperature conditions for the data given in the memorandum are summarized below:

Item	Incinerator 1	Incinerator 2
Hearth 1	880°F	890°F
2	1120	1080
3	1220	1120
4	1600	1530
5	1400	1450
6	250	400
Shaft cooling air	300	320
Flue gas entering scrubber (after quench)	225	230
Flue gas after scrubber	110	135

Temperature conditions were somewhat more erratic for incinerator 2 with some burning indicated on the lower hearth.

II. SOLIDS AND ORGANIC CHARACTERIZATION (Ref. Tables 1 and 2)

The first step in the data analysis is to calculate the wet weight of ash flow. This is done using the lbs/day data from Table 1, as follows:

	Incinerator 1	Incinerator 2
Cake		
Total Solids In	44,040	43,310
Less TVS In	19,480	17,670
Total Inert Solids In, (1)	24,560	25,640

	Incinerator 1	Incinerator 2
Scrubber Water		
Total Solids Out	3,180	2,460
Total Volatile Solids Out	370	390
Total Inert Solids Out, (2)	2,810	2,070
Total Solids In	1,820	1,690
Total Volatile Solids In	260	90
Total Inert Solids In, (3)	1,560	1,600
Total Inert Solids Gain, (4)=(2)-(3)	1,250	470
Particulate Loss		
Lbs/Ton	1.17	0.70
Tonage - ton/day	22.02	21.65
Loss, lbs/day, (5)	26 (use 30)	15 (use 20)
Ash		
Inert Solids Flow=(1)-(4)	23,310	25,170
Less Particulate Loss, (5)	30	20
Inert Ash Flow, (6)	23,280	25,150
Total Solids Factor, (7)	$\frac{998}{998-6.3}$ $\frac{TS}{TS-TVS}$	$\frac{999}{999-8.1}$
Wet Cake Factor, (8)	$\frac{1}{1,998}$	$\frac{1}{1,999}$
Wet Cake Flow=(6)(7)(8)	23,470	25,380

It should be noted that these calculations exclude losses associated with chemically bound water, such as associated with $CaCO_3$ and $Fe(OH)_3$. The cited wet cake mass flows are therefore quantified high which introduces a consistent positive error in all subsequent ash pollutant mass calculations.

The data cited in Table 1 show that the total solids in the scrubber water increase by a nominal 400 mg/l (range 289-509 mg/l), approximately 87 percent of this increase is associated with the suspended solids pickup. A 10 mg/l COD increase is also found in the scrubber water which is superficially inconsistent with the gain in total volatile solids (40-110 mg/l). The inability of the COD test to truly measure some of the organics appears more likely than a volatility associated with inorganic consistuents as the cause for this observation. The exiting scrubber water also experiences a 3-5 mg/l (4-5 fold) increase is measured aliphatic hydrocarbons. This grouping contains the short-chain compounds which may be distilled in the upper hearths of the furnace. The COD test is not particularly effective in the measurement of aliphatic and aromatic hydrocarbons. The reader will note the slightly higher COD and VS valves found in the ash from incinerator No. 2, which is the one still experiencing some burning on the lower hearths. Particulate and carbonaceous

atmospheric releases are summarized in Table 2. Incinerator 2 indicates a poorer operation, most likely due to combustion temperature rather than a lack of combustion air which is assumed proportional to the air flow valves reported. The mass of carbon measured in the stack per mass of applied available carbon ranged from 8.8 to 17.9 percent in incinerator 1 and 2, respectively. The poorer performance of incinerator 2 is consistent with the aliphatic hydrocarbon increases in Table 1. It is not known if the high carbon losses as CO and CH_4 are representive but, if so, they lead to some questions concerning the efficiency of the multiple hearth incinerator as a combustion device without an afterburner.

III. NITROGEN AND SULPHUR (Reference Tables 3 and 4)

Scrubber water values are seen to increase by 70-100 mg/l in terms of sulfate levels. This reflects the efficiency of the scrubber in terms of SO_x removal. The data show that only about 6 percent of the applied sulphur is ultimately released to the atmosphere. The mass balances indicate that approximately 60-65 percent of the applied sulphur will be retained in the incinerator ash.

The nitrogen analyses and mass balances show on the order of only 6 percent accountability. It would appear that approximately 94 percent of the applied nitrogen is lost as N_2. In terms of measurable releases, the scrubber water picks up less than 3 percent of the applied nitrogen while the stack effluent shows a similar loss of nitrogen in the form of NO_x. Incinerator 1, which was previously cited as producing the least amount of carbon monoxide and hydrocarbons due to higher burning temperatures, produces twice as much NO_x as incinerator 2. Such an observation would be expected.

IV. HEAVY METALS (Reference Tables 5, 6 and 7)

Table 5 gives the wet weight metal concentration and mass flow. Table 6 examines each metal in order of declining volatility for the metal and its oxide for their mass balance accountability. The temperature in the burning hearth of the incinerators was on the order 830 to 870°C. The mass balances results for the metals are generally considered excellent with the exception of silver. Table 7, based upon the average results of the mass balances, characterizes where we can expect the applied metals to appear. The reader will note that with the exception of arsenic, which only had one good mass balance, those metals with the lowest melting and boiling points are the ones showing the greatest loss to the atmosphere. (Reference attached paper by B. J. Copeland, "A Study of Heavy Metal Emissions From Fluidized Bed Incinerators"). It is also significant to note that a heavy metal pickup is

consistently shown in the scrubber water for all the metals examined. The data indicate that the existing scrubber system was essentially completely effective for the capture of flue gas copper, arsenic, chromium, iron, silver, and nickel.

V. FUTURE WORK

Future work by Havens and Emerson should include the following:

1. Laboratory analysis of ash to identify sulphur content

2. Continued analysis for CO and hydrocarbon levels in stack emission

3. Repeat carbon and sulphur mass balances with more careful attention to operating conditions during time of sampling

4. Repeat heavy metal balances for mercury, cadmium, zinc, lead and arsenic with emission sampling for each of these constituents

5. Examination of (2) and (3) under variety of operating conditions, i.e., temperature, combustion air or oxygen level, and cake loading.

MCM:pab

TABLE 1

SOLIDS AND ORGANIC CHARACTERIZATION

ITEM / INCINERATOR NO.		FEED SLUDGE 1	FEED SLUDGE 2	ASH 1	ASH 2	SCRUBBER WATER 1	SCRUBBER WATER 2	1	2
Flow Rate	- lb/day	169,400	165,310	23,470	25,380	--	--	--	--
	- mgd					0.32	0.32	0.32	0.32
Total Solids	- mg/gm*	260	262	998	991	--	--	--	--
	- mg/l	--	--	--	--	681	633	1190	922
	- lbs/day	44,040	43,310	--	--	1820	1690	3180	2460
Total Vol. Solids	- mg/gm*	115	107	6.3	8.1	--	--	--	--
	- mg/l	--	--	--	--	98	(35)	138	146
	- lb/day	19,480	17,670	--	--	260	90	370	390
Total Diss. Solids	- mg/gm*	10.3	8.6	--	--	--	--	--	--
	- mg/l	--	--	--	--	660	608	750	690
	- lb/day	1,740	1,420	--	--	1760	1620	2000	1840
SS	- mg/l	--	--	--	--	21	25	440	302
VSS	- mg/l	--	--	--	--	14	14	24	18
COD	- mg/gm	195	160	16.6	29.5	--	--	--	--
	- mg/l	--	--	--	--	46	41	58	51
Aliphatic HC	- mg/gm*	--	--	0.16	0.35	--	--	--	--
	- mg/l	--	--	--	--	0.9_{1}	1.3	3.8_{2}	6.9
Aromatic HC	- mg/gm*	--	--	0.31	0.14	--	--	--	--
	- mg/l	--	--	--	--	0.9	--	1.1	1.0_{3}

DRY WEIGHT ANALYSES

BTU/Lb		3740	3910
Carbon	lbs/lb	.209	.227
	lbs/day	9200	9830
Fixed Carbon	lbs/lb	.010	.021
	lbs/day	440	910
Hydrogen	lbs/lb	.033	.035
	lbs/day	1450	1510
Oxygen	lbs/lb	.224	.229
	lbs/day	9860	9920

( ) appears invalid
(1) 0.9 was used instead of reported 90
(2) 3.8 was used instead of reported 38
(3) 1.0 was used instead of reported 10
* wet weight basis

TABLE 2

PARTICULATE AND CARBONACEOUS ATMOSPHERIC RELEASES

	SCRUBBER INLET	INCINERATOR 1		INCINERATOR 2	
Temp - °F	960	188	183	215	213
DSCFM	3690	5400	6250	6240	6310
ACFM	14900	7620	8890	9150	9190
Particulate - gr/DSCF	1.47	0.025		0.0092	
lb/DTF	51.4	1.17		0.60	
Opacity, %	--	0-5		0-5	
CO - ppm by volume		3190		5910	
lb/DTF		81		169	
lb/day		1780		3660	
HC as CH_4 - ppm by volume			48		99
lb/DTF			0.81		1.66
lb/day			18		36
Carbon Equivalent					
In Stack - CO, lb/day		763		1569	
CH_4 lb/day		14		27	
Σ, lb/day (1)		777		1596	
Total Carbon Applied, lb/day		9200		9830	
- Fixed Carbon, lb/day		440		910	
Carbon Available, lb/day (2)		8760		8920	
Percent Carbon in Stack of mass available		8.8		17.9	

(1)/(2) x 100

DTF = Dry Ton Feed

TABLE 3

SULPHUR AND NITROGEN CHARACTERISTICS

ITEM		FEED SLUDGE		ASH		SCRUBBER WATER IN		SCRUBBER WATER OUT	
INCINERATOR		1	2	1	2	1	2	1	2
Flow Rate	- lb/day	169,400	165,310	23,470	25,380	--	--	--	--
	- mgd	--	--	--	--	0.32	0.32	0.32	0.32
Sulphur	- lb/lb	0.0056	0.0055	--	--	--	--	--	--
	- lb/day	247	238	--	--	--	--	--	--
SO_4	- mg/l	--	--	--	--	150	112	244	182
SO_3	- mg/l	--	--	--	--	<0.5	<0.5	<0.5	<0.5
$S^{=}$	- mg/l	--	--	--	--	<0.5	<0.5	<0.5	<0.5
Σ as S	- mg/l	--	--	--	--	50	37	81	61
	- lb/day	--	--	--	--	133	99	217	162
Nitrogen	- mg/gm*	5.91	5.84	0.25	0.26	--	--	--	--
(TKN)	- mg/l					7.3	3.6	14.9	14.0
	- lb/day	1001	965	6	7	19	10	40	37
NO_2+NO_3-N	- mg/l	--	--	--	--	0.03	0.04	0.29	0.31
	- lb/day					TR	TR	1	1

ATMOSPHERIC RELEASES	INCINERATOR 1	INCINERATOR 2
SO_2 - ppm by volume	29	24
- lb/DTF	1.5	1.4
- lb/day	33	30
NO_2 - ppm by volume	127	58
(1) - lb/DTF	5.6	2.9
- lb/day	123	63

* wet weight measurement

(1) reported as oxides of nitrogen, assumed as NO_2

TABLE 4

SULPHUR AND NITROGEN MASS BALANCES - lbs/day

ITEM	SULPHUR		NITROGEN	
INCINERATOR	1	2	1	2
In	247	238	1001	965
Out:				
Gain in Scrubber Water	84	63	22	28
Gas	16	15	37	19
Ash	--	--	6	7
Σ	100	78	65	54
% Accounted For	40	33	6.5	5.6

TABLE 5

HEAVY METAL CHARACTERIZATION

ITEM		FEED SLUDGE		ASH		SCRUBBER WATER IN		SCRUBBER WATER OUT	
INCINERATOR		1	2	1	2	1	2	1	2
Flow Rate	- lb/day	169,400	165,310	23,470	25,380	--	--	--	--
	- mgd	--	--	--	--	0.32	0.32	0.32	0.32
Arsenic	- mg/gm	0.0028	(0.0018)	0.020	0.019	--	--	--	--
	- mg/l	--	--	--	--	<0.006	0.008	0.013	0.025
	- lb/day	0.474	0.296	0.469	0.482	<0.016	0.021	0.035	0.067
Cadmium	- mg/gm	0.001	0.001	0.0025	0.002	--	--	--	--
	- mg/l	--	--	--	--	<0.002	<0.002	(0.063)	0.032
	- lb/day	0.169	0.165	0.058	0.051	<0.005	<0.005	0.168	0.086
Chromium	- mg/gm	0.078	0.077	0.517	0.518	--	--	--	--
	- mg/l	--	--	--	--	0.015	0.01	0.365	0.180
	- lb/day	13.2	12.7	12.1	13.1	<0.1	<0.1	1.0	0.5
Copper	- mg/gm	0.132	0.100	0.935	0.800	--	--	--	--
	- mg/l	--	--	--	--	0.112	0.031	0.99	0.65
	- lb/day	22.4	16.5	21.9	20.3	0,3	0.1	2.6	1.7
Iron	- mg/gm	5.00	3.52	37.5	25.0	--	--	--	--
	- mg/l	--	--	--	--	0.24	0.26	21.8	8.5
	- lb/day	847	581	880	634	<1	<1	58	23
Lead	- mg/gm	0.14	0.11	1.0	0.65	--	--	--	--
	- mg/l	--	--	--	--	0.027	0.025	1.4	0.38
	- lb/day	23.7	18.2	23.5	16.5	0.1	0.1	3.7	1.0
Mercury	- mg/gm	0.00007	(<0.000007)	0.00003	0.00004	--	--	--	--
	- mg/l	--	--	--	--	<0.00007	0.00092	0.0012	0.001
	- lb/day	0.0118	<0.0012	0.0007	0.0010	<0.0019	0.0025	0.0032	0.0030
Nickel	- mg/gm	0.013	0.013	0.090	0.085	--	--	--	--
	- mg/l	--	--	--	--	0.002	<0.002	0.070	0.0045
	- lb/day	2.20	2.15	2.11	2.16	0.01	<0.01	0.19	0.01
Silver	- mg/gm	0.002	0.002	0.047	0.043	--	--	--	--
	- mg/l	--	--	--	--	0.006	<0.0025	0.022	0.022
	- lb/day	0.339	0.331	1.103	1.091	0.016	<0.007	0.059	0.059
		0.38	0.34	2.15	2.19	--	--	--	--
						0.22	0.125	2.75	1.19

TABLE 6

HEAVY METAL VOLATILITY AND MASS BALANCES

METAL	MELTING PT. °C	BOILING PT. °C	VAPOR PRESS @760°C	IN (1) 1	IN (1) 2	OUT (2) 1	OUT (2) 2	Percent In Stack 1	Stack 2	Scrubber H_2O 1	Scrubber H_2O 2	Ash 1	Ash 2
Mercury Hg	- 38.9	356.6	>760 mm Hg	0.0118	--	0.0104*	0.0073*	80.8		1.25		6.7	
HgO	d 500°C			% Acc. for =		88	--	79.4		13.7		6.9	
Arsenic As		613	>760 mm Hg	0.474	--	0.488	0.528	0	--	3.9	--	96.1	--
AsO_3		457	>760 mm Hg	% Acc. for =		103	--	0		8.7		91.3	
Cadmium Cd	320.9	765	≈400 mm Hg	0.169	0.165	--	0.131	--		--		--	
CdO	1426	Sub 1559	<1 mm Hg	% Acc. for =		--	79	20.6		48.5		30.9	
Zinc Zn	419.4	907	60-100 mm Hg	64.4	56.2	57.2	58.5	11.2		10.4		78.4	
ZnO	1975			% Acc. for =		89	104	0		5.0		95.0	
Lead Pb	327.5	1744	<1 mm Hg	23.7	18.2	27.1	17.4	0		13.3		86.7	
PbO	888			% Acc. for =		114	96	4.4		4.9		90.7	
Silver Ag	960.8	2212	<1 mm Hg	0.339	0.331	1.143	1.143	0		3.5		96.5	
AgO	d 300			% Acc. for =		337	345	0		4.6		95.4	
Copper Cu	1083	2595	<1 mm Hg	22.4	16.5	24.2	21.9	0		9.5		90.5	
CuO	1326			% Acc. for =		108	132	0		7.3		92.7	
Iron Fe				847	581	937	953	0		6.1		93.9	
Fe_3O_4	1420	--	--	% Acc. for =		111	112	0		2.9		97.1	
Nickel Ni	1455	2900	<1 mm Hg	2.20	2.15	2.29	2.16	0		4.1		95.9	
NiO	2090	--		% Acc. for =		104	100	0		0.5		99.5	
Chromium Cr	1890	2492	<1 mm Hg	13.2	12.7	13.0	13.4	0		7.0		93.0	
Cr_2O_3	2435	4000		% Acc. for =		98.5	106	0		2.2		97.8	

* Hg Emissions: Incinerator #1 = 0.0084 lbs/day
#2 = 0.0058 lbs/day

(1) Cake Feed

(2) Ash + Gain in Scrubber Water + Emission

TABLE 7

HEAVY METAL CHARACTERIZATION - PERCENT

METAL	RETAINED IN ASH	RETAINED IN SCRUBBER	LOST TO ATMOSPHERE
Mercury	6.8	13.1	80.1
Cadmium	30.9	48.5	20.6
Zinc	86.7	7.7	5.6
Lead	88.7	9.1	2.2
Copper	91.6	8.4	0.0
Arsenic	93.7	6.3	0.0
Chromium	95.4	4.6	0.0
Iron	95.5	4.5	0.0
Silver	96.0	4.0	0.0
Nickel	97.7	2.3	0.0

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