STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
401 CHURCH STREET
L & C ANNEX SIXTH FLOOR
NASHVILLE TN 37243-1534
(615)532-0625

10 September 1996

Kevin Young
J R Wauford & Co.
16 Brentshire Square
Jackson Tn 38305

Re: Cleveland Utilities Wastewater System
Water Pollution Control Number 96-0194
Design Report WWTP

Dear Mr. Young:

Our Division acknowledges receipt of three (3) set(s) of construction documents on 2 March 1996. As indicated by our stamp, this project has NOT been approved.

This project has been disapproved because 1) holding basin does not remove I/I but does allow the further deterioration of the collection system, 2) the 54" staying in service will deteriorate and increase the I/I flow, 3) no mention of actual field measured dry weather flows to compare with wet weather flows are given, and the use the 85 percentile to design actually allows for plant bypassing or biological and flow violations which are illegal.

To expedite matters, please use the assigned project number on any resubmittal. If we may be of any assistance, please contact us at (615) 532-0625.

Sincerely,

SPW

S. P. Weiland
Municipal Facilities Section
Division of Water Pollution Control

cc: City of Cleveland - Fred Murphy
TDWPC - Jackson Field Office
TDWPC - Enforcement Section
File

J. R. WAUFORD & COMPANY
Consulting Engineers
16 BRENTSHIRE SQUARE, P. O. BOX 3516 (901) 668-1953
FAX-901-668-6809
JACKSON, TENNESSEE 38305

February 29, 1996

96-0194

Tennessee Department of
Environment and Conservation
Division of Water Pollution
Control
6th Floor, L & C Annex
401 Church St.
Nashville, Tennessee 37243-1534

Attention: Mr. Sam Weiland

Re: Design Memorandum (Report)
Hiwassee River Wastewater
Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Gentlemen:

Enclosed for your review are three (3) copies of the referenced design report. We understand there is no fee associated with the review of wastewater engineering reports. This report describes the conceptual aspects and preliminary layout and hydraulics for a proposed expansion of the referenced project. Final plans and specifications for the referenced project are scheduled for submittal within the next few months.

If you have any questions or require additional information, please do not hesitate to call me.

Yours very truly,

J. R. WAUFORD & COMPANY,
CONSULTING ENGINEERS, INC.

Kevin S. Young, P.E.
Manager/Jackson, Tennessee Office

KSY:sd

cc: Fred Murphy, Cleveland Utilities

DESIGN MEMORANDUM

HIWASSEE RIVER WASTEWATER TREATMENT PLANT EXPANSION

FOR

CLEVELAND UTILITIES

JRWCO 3193

MARCH 1995

REVISED DECEMBER 1995

KEVIN S. YOUNG
REGISTERED ENGINEER
AGRICULTURE
NO. 15505
STATE OF TENNESSEE

J. R. WAUFORD & COMPANY,
CONSULTING ENGINEERS, INC.
16 Brentshire Square
Jackson, Tennessee 38305
901/668-1953

JRWCO 3193
March 1995
Rev. Dec. 1995

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Revised Dec. 1995

NOTICE TO READERS

This Design Memorandum is intended to be a dynamic document which, in its final form, will represent the consensus agreement of Cleveland Utilities decision makers, management and operational staff; J. R. Wauford & Company, Consulting Engineers, Inc. designers; and Brasfield & Gorrie, General Contractor, Inc., construction managers, concerning the detailed conceptual design for the Hiwassee River Wastewater Treatment Plant expansion. Ultimately, the Memorandum will be used to support the Plans and Specifications during review by regulatory agencies. The Design Memorandum is formatted to allow quick and easy changes to the text and exhibits as the preliminary project conceptual design develops.

In order to reach this consensus agreement, the following schedule of activities is proposed.

	Activity	Anticipated Time Required/ Date Accomplished
1.	Review of First Draft of Design Memorandum by Cleveland Utilities and Brasfield and Gorrie	Two Weeks
2.	First meeting in Cleveland between Cleveland Utilities and J. R. Wauford & Company to discuss First Draft; select equipment and processes for alternatives presented; agree on additions, de-	April 11, 1995

letions and modifications to First Draft; agree on site layout; and agree on general scope of proposed construction project

3.	J.R. Wauford & Company revise First Draft to incorporate comments, selection of alternatives and agreements reached at meeting in Cleveland	December 21, 1995
4.	Review of Second Draft by Cleveland Utilities and Brasfield and Gorrie. Preparation of Preliminary Cost Estimate by Brasfield and Gorrie	Two Weeks
5.	Second meeting in Cleveland between Cleveland Utilities, J. R. Wauford & Company and Brasfield and Gorrie to discuss Second Draft, Preliminary Project Cost Estimates, and schedule for completing plans and specifications, project funding, receiving regulatory approval of plans and specifications, and constructing project.	March 5, 1996
6.	Prepare "Final" Draft of Design Memorandum for submittal to Tennessee Department of Environment and Conservation, Division of Water Pollution Control for review	One Week

The Design Memorandum is expected to continue to change throughout the development of Plans and Specifications for this project as the conceptual design details are refined. During the preparation of Plans and Specifications, J. R. Wauford & Company will meet several times with Cleveland Utilities managers and wastewater treatment plant operators and with Brasfield and Gorrie project managers and estimators to present ideas and seek input. Any modifications to the project design concept generated during these meetings will be incorporated into the Design Memorandum. Upon completion of the design process, the Design Memorandum will serve as a record of the design concept.

Please use the First Draft of this document to record your questions, comments and thoughts and to make notes concerning any additions, deletions or modifications you think should be incorporated into the design concept. These notes will serve as a foundation for our first review meeting.
Text shown as redline indicates revisions made since December 21, 1995.

JRWCO 3193
March 1995
Rev. Dec. 1995

A. Purpose

The purpose of this Design Memorandum is to present detailed design considerations prior to preparing Plans and Specifications for the expansion of the Cleveland Utilities Hiwassee River Wastewater Treatment Plant. Design of the expansion is based on recommendations presented in the engineering report entitled "A Comprehensive Evaluation of the Cleveland Utilities Wastewater Transportation and Treatment Systems" dated June 1993, revised December 1993, prepared by J. R. Wauford & Company, Consulting Engineers, Inc. This engineering report was approved by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control on _*_ as Project No. WPC 94-181.

*Note: Approval of the engineering report is pending satisfactory response to Division of Water Pollution Control comments issued in a letter dated June 15, 1994. Response to comments was transmitted to Division of Water Pollution Control on February 6, 1996.

B. Existing Flows, Waste Loads and Capacity

1. General

Existing flows and waste loads for biochemical oxygen demand (BOD_5) and total suspended solids (TSS) were established on a seasonal basis during the analysis of data for the 40 month period beginning January 1, 1990 and ending April 30, 1993. This information is reported in the engineering report entitled "A Comprehensive Evaluation of the Cleveland Utilities Wastewater Transportation and Treatment Systems". Existing peak flows were established on a seasonal basis after analysis of data for the period beginning January 1, 1990 and ending April 30, 1995. Existing ammonia nitrogen (NH_3-N) waste loads were established on a seasonal basis after analysis of data for the twelve month period beginning January 4, 1994 and ending December 12, 1994.

The seasonal basis established for waste load analysis includes "summer" encompassing the months May through November and "winter" encompassing the months December through April. "Summer" and "winter" periods were partitioned on the basis of wastewater temperature which ranges from 8°C to 16°C during "winter" and from 17°C to 24°C during "summer".

All existing flows and waste loads are established from the 85th percentile seasonal values.

2. Existing Seasonal Flow and BOD_5, TSS and NH_3-N Waste Loads

A summary of the existing 85th percentile seasonal flows and BOD_5, TSS and NH_3-N waste loads is listed in Table No. B-1.

Table No. B-1
Summary of Existing 85th Percentile Seasonal Flows and Waste Loads
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Parameter	Winter (December - April)	Summer (May - November)
Flow	16.0 MGD	9.0 MGD
$CBOD_5$ Loading	10,500 Lbs/Day	11,000 Lbs/Day
TSS Loading	18,000 Lbs/Day	17,000 Lbs/Day
NH_3-N Loading	525 Lbs/Day	1,120 Lbs/Day

3. Existing Capacity

Several numerical models exist to predict the capacity of a wastewater treatment plant. However, if sufficient data exist which define process effluent quality during periods when no process upset occurs, these data offer the most definitive measure of process capacity. Seasonal effluent quality data for the period from January 1, 1990 through April 30, 1995 are listed in Table No. B-2.

Table No. B-2
Summary of Actual Effluent Quality
Hiwassee River Wastewater Treatment
Plant Expansion
Cleveland Utilities
JRWCO 3193

		CONCENTRATION (mg/l)			MASS (Lbs/Day)		
Parameters	Period Covered	NPDES Permit Value	Maximum Value 50 Percent of Time	Maximum Value 85 Percent of Time	NPDES Permit Value	Maximum Value 50 Percent of Time	Maximum Value 85 Percent of Time
BOD_5	01-01-90 to 04-30-90 (W)	30[2]	16[2]	22[2]	2302	1257	2131
	05-01-90 to 10-31-90 (S)[3]	30[2]	26[2]	40[2]	2302	1095	1936
	11-01-90 to 04-30-91 (W)	30[2]	21[2]	27[2]	2302	1173	1892
	05-01-91 to 10-31-91 (S)	30[2]	12[2]	16[2]	2302	439	743
	11-01-91 to 04-30-92 (W)	30[2]	18[2]	29[2]	2302	1203	1949
	05-01-92 to 10-31-92 (S)[4]	30[2]	19[2]	30[2]	2302	1032	1915
	11-01-92 to 02-28-93 (W)	30[2]	19[2]	29[2]	2302	1414	3075
$CBOD_5$	03-01-93 to 04-30-93 (W)[1]	25	17	36	1918	1451	4182
	05-01-93 to 10-31-93 (S)	25	11	16	1918	589	938
	11-01-93 to 04-30-94 (W)	25	17	30	1918	1337	4087
	05-01-94 to 10-31-94 (S)	25	13	23	1918	746	1556
	11-01-94 to 04-30-95 (W)	25	17	30	1918	1033	2672
TSS	01-01-90 to 04-30-90 (W)	30	13	27	2302	921	3453
	05-01-90 to 10-31-90 (S)[3]	30	14	28	2302	788	1539
	11-01-90 to 04-30-90 (W)	30	16	28	2302	1073	2046
	05-01-91 to 10-31-92 (S)	30	10	15	2302	452	799
	11-01-91 to 04-30-92 (W)	30	15	21	2302	951	1700
	05-01-92 to 10-31-92 (S)[4]	30	12	18	2302	635	1325
	11-01-92 to 04-30-93 (W)	30	15	25	2302	1185	2977
	05-01-93 to 10-31-93 (S)	30	14	20	2302	701	1016
	11-01-93 to 04-30-94 (W)	30	23	36	2302	1927	4237
	05-01-94 to 10-31-94 (S)	30	14	20	2302	905	1509
	11-01-94 to 04-30-95 (W)	30	22	31	2302	1331	2645
NH_3-N	01-01-90 to 04-30-90 (W)	15	4	10	1151	386	633
	05-01-90 to 10-31-90 (S)[3]	15	8	12	1151	378	658
	11-01-90 to 04-30-91 (W)	15	7	10	1151	445	675
	05-01-91 to 10-31-91 (S)	15	2	4	1151	70	196
	11-01-91 to 04-30-92 (W)	15	5	9	1151	365	685
	05-01-92 to 10-31-92 (S)[4]	15	8	13	1151	457	782
	11-01-92 to 04-30-93 (W)	15	8	11	1151	596	791
	05-01-93 to 10-31-93 (S)	15	8	12	1151		
	11-01-93 to 04-30-94 (W)	15	4	8	1151		
	05-01-94 to 10-31-94 (S)	15	3	7	1151		
	11-01-94 to 04-30-95 (W)	15	6	9	1151		

Notes: (1) Cleveland Utilities began monitoring CBOD in lieu of BOD on March 1, 1993.
(2) CBOD values may be approximated by subtracting 5 mg/l from BOD values.
(3) Process upset due to bulking sludge and foaming.
(4) Only three of four $ICEAS_{TM}$ units in service at any time due to maintenance.
(W) indicates winter season.
(S) indicates summer season.

The seasonal effluent quality data listed in Table No. B-2 indicate the following:

- Beginning with the winter season in 1990-91, comparison of the 85th percentile BOD_5 and carbonaceous biochemical oxygen demand ($CBOD_5$) concentration values for winter seasons with NPDES permit effluent quality requirements indicates that during the winter season the existing $ICEAS_{TM}$ cyclical activated sludge wastewater treatment process is operating at, or in excess of, capacity. Analysis of the various factors which can limit process capacity indicates the high effluent $BOD_5/CBOD_5$ concentrations are due to marginal or inadequate hydraulic residence time in the $ICEAS_{TM}$ process during the winter season.

  For a given process basin volume, hydraulic residence time is controlled by influent flow rate. The magnitude of the current winter season flows causes the $ICEAS_{TM}$ process to operate at or above its capacity based on the hydraulic residence time required for necessary $BOD_5/CBOD_5$ reduction to occur.

- The 85th percentile TSS and NH_3-N concentration values indicate that the existing $ICEAS_{TM}$

process has a slight excess capacity for TSS and NH_3-N reduction. However, since the removal capacities of the $ICEAS_{TM}$ process for the parameters $BOD_5/CBOD_5$, TSS and NH_3-N are interrelated, the capacity of the entire $ICEAS_{TM}$ process is controlled by the parameter which first depletes process capacity for adequate removal.

- The occasional exceedences of effluent mass $BOD_5/CBOD_5$ and TSS limitations are related to the flow used by the permitting authority to calculate the mass pollutant limitations. The flow used to calculate mass pollutant limitations in the current NPDES permit is 9.2 MGD. These occasional exceedences of NPDES permit mass limitations are artifacts of the permit writing process and do not indicate the capacity of the $ICEAS_{TM}$ process.

The existing $ICEAS_{TM}$ process has reached its capacity to remove $BOD_5/CBOD_5$ to the concentrations necessary to consistently comply with NPDES permit limitations during the winter season. The factor limiting this capacity is hydraulic residence time.

C. Projected Flows and Waste Loads

1. General

Municipal wastewater flows and waste loads are generated from two broad categories of sources: (1) water use by residences, businesses, institutions and industries ("water use") and (2) inflow and infiltration of rainwater and groundwater into the sanitary sewer system ("I/I"). Increases in wastewater flow and waste loads over time in the "water use" category can occur due to residential population growth and the associated growth of businesses and institutions, and due to location of new industries and/or expansion of existing industries. Projections of wastewater flows and waste loads in the "water use" category are usually developed based on population projections and an arbitrary percentage increase in industrial water usage. Projections of wastewater flows and waste loads due to "I/I" are problematic due to the unpredictable nature of rainfall and groundwater levels and the effects of these phenomena on flow rates in the wastewater transportation system.

The flows and waste loads used to evaluate the capacity of the expanded Hiwassee River Wastewater Treatment Plant are projected for the year 2015.

2. Projections of Flows and Waste Loads in "Water Use" Category

a. Projected Population Growth

Information presented in the report entitled "Cleveland Urban Fringe Area Study, 1990-2000" dated July 1989 and in memoranda from Fred Murphy, Cleveland Utilities Water Manager, to the Cleveland Utilities General Manager regarding Plan of Services Studies for proposed annexations during the years 1987 through 1992, indicate that almost all of the actual and projected population growth in the Cleveland Utilities service area is through annexation of areas adjacent to the existing corporate limits. A summary of the wastewater customers and population added to the Cleveland Utilities wastewater service area through annexation between the years 1987 and 1992 taken from the Plan of Services Studies memoranda prepared by Fred Murphy are presented in Table No. C-1.

The "Cleveland Urban Fringe Area Study, 1990-2000" reports a projected annexation of 11.5 square miles and an associated population increase of 4,026 persons between the years 1990 and 2000. The study also reports an additional 46 square miles under initial study for annexation after the year 2000.

Table No. C-1
Summary of Population and Customers in Annexation Areas Between 1987 and 1992[1]
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Year	Population Annexed	Sewer Customers Annexed
1987	1384 (est.)[2]	556
1988	1404	618
1989	39	16 (est.)[2]
1990	282	121
1991	254 (est.)[2]	102
1992	815	439
Average Annual Increase	696 Persons/Yr.	309 Customers/Yr.

Notes:

(1) From Plan of Services Study memoranda prepared by Fred Murphy.
(2) Estimated based on 2.49 persons per customer.

Population growth within the Cleveland Utilities service area over the 20 year planning life of the expanded Hiwassee River Wastewater Treatment Plant is projected by two methods. First, the approximate 4,000 person increase in the Cleveland Utilities service area population between 1990 and 2000 projected in the "Cleveland Urban Fringe Area Study, 1990-2000" is extrapolated through the year 2015. This extrapolation results in a projected 40,000 person wastewater service area population in the year 2015. Second, the 696 person per year average wastewater service area population increase due to annexation during the period between 1987 and 1992 is extrapolated through the year 2015. This extrapolation results in a projected 44,820 person wastewater service area population in the year 2015. Historical and projected population data are listed in Table No. C-2.

b. Projected Flows and Waste Loads Due to "Water Use"

Flows and waste loads due to "water use" by residential customers added to the Cleveland Utilities wastewater service area through annexation and general population growth and the additional flows and waste loads from associated new and expanded businesses and institutions can be estimated by applying values for per capita flow and loading rates reported in technical literature to the projected additional population. The literature values for per capita rates used in this projection are listed in Table No. C-3.

Table No. C-2
Historical and Projected Population Data
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Year	Corporate Limits Population	Housing Units	Persons Per Housing Unit	Incorporated Area (Sq.Miles)	Population Density (Persons/ Sq.Mi.)
1950	12,605[1]	N/A	N/A	7±[2]	1,800
1960	12,196[1]	N/A	N/A	N/A	N/A
1970	21,446[1]	7,130[1]	3.00[1]	N/A	N/A
1980	26,415[1]	10,605[1]	2.49[1]	N/A	N/A
1990	30,354[1]	N/A	N/A	18±[2]	1,686
2000	34,380[2]	N/A	N/A	29.45[2]	1,167
2010	38,000[3] to 41,340[4]	N/A	N/A	40±[3]	950
2015	40,000[3] to 44,820[4]	N/A	N/A	45±[3]	889

NOTES:

(1) From U.S. Dept. of Commerce, Bureau of Census.
(2) From "Cleveland Urban Fringe Area Study, 1990-2000", dated July 1989.
(3) Projection based on approximately 11 square miles and 4000± persons per decade being annexed between years 2000 and 2015.
(4) Projection based on 696 persons per year average annual annexed population for years between 1987 and 1992.
N/A - information not available.

Existing flow and waste loads are based on data for the period between January 1, 1990 and April 30, 1995. These data are assumed to represent the flows and waste loads contri-

Table No. C-3
Literature Values for Per Capita
Flows and Waste Loads
Hiwassee River Wastewater Treatment
Plant Expansion
Cleveland Utilities

Parameter	Value
Flow	120 Gallons Per Person Per Day[1]
$CBOD_5$	0.22 Lbs. Per Person Per Day[2]
TSS	0.26 Lbs. Per Person Per Day[2]
Total Nitrogen	0.027 Lbs. Per Person Per Day[3]

Notes:

(1) From Table 2-1 "Wastewater Engineering-Treatment Disposal and Reuse", 3rd Edition, Metcalf & Eddy, Inc.
(2) From Table 5-4 "Wastewater Engineering-Treatment Disposal and Reuse", 3rd Edition, Metcalf & Eddy, Inc.
(3) From "Manual-Nitrogen Control", EPA/625/R-93/010.

buted by the population in 1990. Estimated flows and waste loads contributed by the projected additional population in the Cleveland Utilities wastewater service area through the year 2015 are listed in Table No. C-4.

Table No. C-4
Projected Flows and Waste Loads
Due to "Water Usage" by Projected
Additional Wastewater Customers
in the Cleveland Utilities Wastewater
Service Area Through the Year 2015
Hiwassee River Wastewater Treatment
Plant Expansion
Cleveland Utilities
JRWCO 3193

Year	Projected Additional Flow (MGD)	Projected Additional $CBOD_5$ Loading (Lbs/Day)	Projected Additional TSS Loading (Lbs/Day)	Projected Additional Total Nitrogen Loading (Lbs/Day)
2000	0.48	886	1047	109
2010	0.92(1)-1.32(2)	1682(1)-2417(2)	1988(1)-2856(2)	206(1)-297(2)
2015	1.16(1)-1.74(2)	2122(1)-3182(2)	2508(1)-3761(2)	260(1)-390(2)

NOTES:

(1) Based on minimum value of projected population range listed in Table No. C-2.
(2) Based on maximum value of projected population range listed in Table No. C-2.

The projected additional flows and waste loads listed in Table No. C-4 may be added to the existing seasonal flows and waste loads listed in Table No. B-1 to calculate projected seasonal flows and waste loads due to projected increases in "water usage" in the Cleveland Utilities wastewater service area through the year 2015. These total projected flows and waste loads for the year 2015 are listed in Table No. C-5.

Table No. C-5
Total Projected Flows and Waste Loads Due to Projected Increase in "Water Usage" for the Year 2015[1]
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Parameter	Winter (December - April)	Summer (May - November)
Flow (MGD)	17.16[2] - 17.74[3]	10.16[2] - 10.74[3]
$CBOD_5$ Loading (Lbs/Day)	12,622[2] - 13,682[3]	13,122[2] - 14,182[3]
TSS Loading (Lbs/Day)	20,508[2] - 21,761[3]	19,508[2] - 20,761[3]
NH_3-N Loading (Lbs/Day)	785[2] - 915[3]	1,380[2] - 1,510[3]

NOTES:

(1) Projected flow and waste load values due to projected increase in "water usage" do not include any projected flows and waste loads due to increase in "water usage" by industrial customers.
(2) Based on minimum value of projected population range listed in Table No. C-2.
(3) Based on maximum value of projected population range listed in Table No. C-2.

In order for the range of projected values listed in Table No. C-5 to occur, the following conditions must be met.

- The rate of annexation between the years 1987 and 1992 must continue through the year 2015.

- All residences in these annexed areas must be provided with sanitary sewer service by the year 2015.

- The population density in areas annexed between the years 1990 and 2015 must remain at levels between 889 and 1686 persons per square mile.

The probability that all three of these conditions will occur is low. **Therefore, the projected flows and waste loads listed in Table No. C-5 are believed to represent maximum possible values due to "water usage" for the year 2015. THESE VALUES DO NOT INCLUDE ADDITIONAL CONTRIBUTIONS FROM NEW OR EXISTING INDUSTRIAL PROCESS WASTEWATER DISCHARGES.**

Cleveland Utilities' managers report that preliminary planning is underway to develop approximately 500 acres located along the Charleston Access Road (SR 308) as industrial sites. Cleveland Utilities' managers also report that leaders of the City of Charleston (estimated population 650) have expressed an interest in using the Hiwassee River Wastewater Treatment Plant as a means of wastewater disposal. Since definite plans do not currently exist for development of these potential industrial sites and for accepting wastewater from the City of Charleston, projection of flows and waste loads from these potential sources due to "water usage" cannot be developed.

3. <u>Projected Flows and Waste Loads Due to "I/I"</u>

Analytical methods to project future flows and waste loads due to "I/I" with a high degree of certainty do not exist. Therefore, an examination of current conditions and policies relating to the Cleveland Utilities wastewater system is used to develop a subjective estimate of future flows and waste loads due to "I/I".

Cleveland Utilities has conducted organized, full scale efforts to repair and rehabilitate the collector sewer system since 1983 or 1984. The current rehabilitation efforts are described in detail in the engineering report entitled "A Comprehensive Evaluation of the Cleveland Utilities Wastewater Transportation and Treatment Systems". While reduction in flows and waste loads due to "I/I" are not expected to be realized at the Hiwassee River Wastewater Treatment Plant for at least another decade, several factors indicate that the flows and waste loads due to "I/I" should not increase by the year 2015. These factors include the following:

- The 42-inch outfall sewer between the Tinsley Park area and the abandoned Mouse Creek Road Wastewater Treatment Plant receives flows in excess of its capacity due to rainfall events. This outfall is the route for virtually all flows to the Hiwassee River Wastewater Treatment Plant. Any additional flows in the sanitary sewer collector system due to "I/I" cannot reach the Hiwassee River Wastewater Treatment Plant due to the capacity of this 42-inch outfall sewer.

- Cleveland Utilities is planning construction of a peak flow holding structure to capture flows at the upstream end of the 42-inch outfall sewer which transports wastewater flow from the Tinsley Park area to the abandoned Mouse Creek Road Wastewater Treatment Plant and store these peak flows until the flow rate in the outfall decreases below the capacity of the outfall. This structure will eliminate or reduce the occurrence of an overflowing manhole near Tinsley Park and should prevent increased flow rates due to "I/I" in this outfall sewer through the year 2015.

- Cleveland Utilities is committed to continuing the ongoing, full-scale efforts to repair and rehabilitate the existing sanitary collector sewer system. These efforts should result in the prevention of additional flows due to "I/I" from reaching the Hiwassee River Wastewater Treatment Plant through the year 2015.

- All new collector sewer extension construction, the most probable source for additional flows and waste loads due to "I/I", is being inspected by representatives of the Cleveland Utilities Distribution and Collection Department. A crew from the Distribution and Collection Department makes all new service connections to the sanitary collector sewer system. These procedures insure that new sanitary sewers and new connections to the sanitary sewer system are constructed using proper techniques and should prevent additional "I/I" from entering the wastewater transportation system.

- Any future additional flows due to "I/I" will result from rainfall events. The waste load from these flows for the parameters $CBOD_5$, TSS and NH_3-N should be negligible.

Cleveland Utilities' managers report that the existing 54-inch portion of the outfall sewer between the abandoned Mouse Creek Road Wastewater Treatment Plant and the Hiwassee River Wastewater Treatment Plant is a potential source for future additional flows due to "I/I". Difficulties in achieving adequate bedding and making up joints were experienced during the construction of this outfall sewer creating a potential source for future "I/I" related flows. Since the 42-inch upstream portion of this interceptor flows at capacity in response to rainfall events and almost no other sources of flow into the 54-inch portion of the outfall exist, the available excess flow capacity in the 54-inch portion could serve to transport additional "I/I" related flow generated in the 54-inch segment of the outfall sewer. Data currently do not exist to define the existing contribution to "I/I" related flow due to the 54-inch segment of the outfall sewer and this potential source is not considered in this evaluation.

No additional flows or waste loads to the expanded Hiwassee River Wastewater Treatment Plant due to "I/I" are projected for the year 2015.

D. Design Capacity and Life Expectancy of the Expanded Wastewater Treatment Plant

1. Proposed Secondary Treatment Capacity

a. General

The characteristics of the Hiwassee River, the receiving stream for the treated wastewater from the Cleveland Utilities Hiwassee River Wastewater Treatment Plant, dictate that "secondary treatment", as defined by the United States Environmental Protection Agency at 40 CFR 133.102, be accomplished at the existing and expanded Hiwassee River Wastewater Treatment Plant. This regulation requires monthly average effluent $CBOD_5$ concentration values less than or equal to 25 mg/l, monthly average effluent TSS concentration values less than or equal to 30 mg/l and effluent pH values between 6.0 and 9.0. The $ICEAS_{TM}$ variant of the cyclical activated sludge process is currently used at the Hiwassee River Wastewater Treatment Plant to achieve secondary treatment. The characteristics and current performance of this $ICEAS_{TM}$ process are described in detail in the engineering report entitled "A Comprehensive Evaluation of the Cleveland Utilities Wastewater Transportation and Treatment Systems". The Cleveland Utilities staff has expressed a desire to expand the secondary treatment capacity of the Hiwassee River Wastewater Treatment Plant using the $ICEAS_{TM}$ process.

b. Proposed $ICEAS_{TM}$ Reactor Volume

The existing Hiwassee River Wastewater Treatment Plant was placed in service in February, 1988. The existing site of the Hiwassee River Wastewater Treatment Plant was developed to allow expansion of the secondary treatment capacity by doubling the plan area or "footprint" of the four (4) existing $ICEAS_{TM}$ reactor basins. Preliminary calculations during the study presented in the engineering report entitled "A Comprehensive Evaluation of the Cleveland Utilities Wastewater Transportation and Treatment Systems" indicate that current flow and waste loads can be adequately treated if two (2) $ICEAS_{TM}$ reactor basins are added. This expansion to meet current needs will occur approximately ten (10) years after the original Hiwassee River Wastewater Treatment Plant was commissioned under the pretense of meeting Cleveland Utilities' wastewater treatment needs for a 20 year period. Cleveland

Utilities' managers and decision makers have expressed the desire to add the four (4) $ICEAS_{TM}$ reactor basins which the site will accommodate during this expansion to provide capacity for future growth.

The proposed expansion of the Hiwassee River Wastewater Treatment Plant secondary treatment capacity will include four (4) additional $ICEAS_{TM}$ reactor basins having inside plan dimensions of 150 feet by 100 feet, a 10.83 feet bottom water level (BWL) depth and a 14.08 feet top water level (TWL) depth. These overall dimensions are identical to the overall dimensions of each of the four (4) existing $ICEAS_{TM}$ reactor basins. Due to proposed changes to improve hydraulic efficiency in the four (4) new $ICEAS_{TM}$ basins, the volumes of each reactor basin will be slightly different. The volumes of the four (4) existing and four (4) proposed $ICEAS_{TM}$ reactor basins are listed in Table No. D-1. The overall dimensions of one existing and one proposed $ICEAS_{TM}$ reactor basin are depicted on Exhibit Nos. 1 and 2.

Table No. D-1
$ICEAS_{TM}$ Reactor Basin
Volumes at BWL and TWL
Hiwassee River Wastewater Treatment
Plant Expansion
Cleveland Utilities
JRWCO 3193

	Existing Basin Configuration	Proposed Basin Configuration
Total Single Basin Volume @ BWL Including Prereact Zone (Gallons)	1,152,750	1,178,996
Total Single Basin Volume Available Between BWL and TWL (Gallons)	345,931	353,808
Single Basin Prereact Zone Volume @ BWL (Gallons)	160,964	192,395
Percentage of Total Volume Occupied by Pre-react Zone at BWL (%)	13.96	16.32

c. Seasonal Flow and Waste Load Capacity of Proposed $ICEAS_{TM}$ Reactors

The seasonal $CBOD_5$ loading capacities of the expanded $ICEAS_{TM}$ process (i.e., eight $ICEAS_{TM}$ reactor basins as described in Paragraph D.1.b.) are calculated based on the following criteria:

- Maximum hydraulic capacity in a three hour cycle is 29.8 MGD.

- Prereact zone volume is neglected for CBOD loading calculations.

- Food to Microorganism (F:M) Ratio is 0.10.

- Mixed Liquor Volatile Suspended Solids concentration (MLVSS) to MLSS concentration ratio is 0.75.

- Maximum Mixed Liquor Suspended Solids concentration (MLSS) is 3,960 mg/l at BWL. This is the maximum MLSS concentration calculated to provide a 0.10 F:M ratio at the maximum 29.8 MGD hydraulic capacity in a three hour cycle assuming that future influent wastewater $CBOD_5$ concentration is unchanged from present influent wastewater $CBOD_5$ concentration.

The "winter" and "summer" $CBOD_5$ loading capacity of the expanded Hiwassee River Wastewater Treatment Plant is 19,590 Lbs/Day for both seasons.

The seasonal loading capacities of the expanded $ICEAS_{TM}$ process for the parameters flow and TSS are calculated by multiplying the ratio of the seasonal $CBOD_5$ loading capacity to the

Ps B-2

S $\frac{19,590}{11,000} \times 9 = 16$ W $\frac{19,590}{10,500} \times 16 = 29.85$

existing seasonal $CBOD_5$ loading listed in Table No. B-1 by the existing seasonal loadings of flow and TSS listed in Table No. B-1. Calculating the seasonal loading capacities for flow and TSS using this method is predicated on the assumption that the relative values of the wastewater characteristics will remain unchanged when the expanded wastewater treatment plant $CBOD_5$ loading capacity is reached. In the case of seasonal flow loadings, the maximum hydraulic capacity of the expanded $ICEAS_{TM}$ process in a three hour cycle (29.8 MGD) is slightly less than the 30.2 MGD calculated flow capacity and, therefore, is the limiting factor for flow capacity. The calculated seasonal waste load capacity for NH_3-N is based on a kinetic model used successfully to design previous cyclical activated sludge processes.

The calculated seasonal flow and waste load capacities of the expanded Hiwassee River Wastewater Treatment Plant are listed in Table No. D-2.

Table No. D-2
Seasonal Flow and Waste Load
Capacities[1] of Expanded
Hiwassee River Wastewater Treatment Plant
Cleveland Utilities
JRWCO 3193

Parameter	Winter (December-April)	Summer May-November)
Flow	29.8 MGD[2]	16.0 MGD
$CBOD_5$ Loading	19,590 Lbs/Day	19,590 Lbs/Day
TSS Loading	33,580 Lbs/Day	30,275 Lbs/Day
NH_3-N Loading	980 Lbs/Day	2,090 Lbs/Day

Notes:

(1) Capacities listed are calculated to treat 85th percentile flows and waste loads.
(2) Limited by maximum hydraulic capacity of $ICEAS_{TM}$ reactors in a three hour cycle.

2. Hydraulic Capacity of Expanded Wastewater Treatment Plant

The hydraulic capacity of the expanded Hiwassee River Wastewater Treatment Plant is limited by the pumping unit or unit process having the lowest hydraulic capacity. *The hydraulic capacity of a wastewater treatment plant is defined as the maximum discharge rate from any pumping unit or the maximum flow rate which can pass through any unit process structure without overflowing the structure walls or submerging a critical portion of the unit.* The hydraulic capacity for each unit process in the expanded Hiwassee River Wastewater Treatment Plant is listed in Table No. D-3. A hydraulic profile through the expanded Hiwassee River Wastewater Treatment Plant for various wastewater flow conditions is depicted in Exhibit No. 3.

Table No. D-3
Design Hydraulic Capacity of Individual Unit Processes in Expanded Hiwassee River Wastewater Treatment Plant
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Unit Process	Maximum Hydraulic Capacity	Limiting Factor
Screw Pump Lift No. 1	49.0 MGD	Rated Capacity of Three Pumps Operating Simultaneously
Influent Flow Measurement Parshall Flume	33.0 MGD	Flume Submerged and Will Not Provide Accurate Flow Measurement
Screw Pump Lift No. 2	49.0 MGD	Rated Capacity of Three Pumps Operating Simultaneously
Mechanically Cleaned Bar Screens	49.0 MGD	Must Use Self-Cleaning Bar/Filter Type with Three Units in Operation
Grit Removal Process	49.0 MGD	Maximum Pumping Capacity of Screw Pumps(1)
ICEAS$_{TM}$ Process	44.78 MGD	Maximum Capacity in 2 Hour Cycle
Chlorine Contact Chamber	29.85 MGD(2)	Center Baffle Wall Submerged at 50 Year Flood River Level if ICEAS$_{TM}$ is in 2 Hour Cycle
Effluent Flow Measurement Parshall Flume	29.85 MGD(2)	Flume Submerged and Will Not Provide Accurate Flow Measurement at 50 Year Flow River Level if ICEAS$_{TM}$ is in 2 Hour Cycle

Notes:

(1) Each of two grit removal units have 30 MGD rated peak hydraulic capacity.
(2) Maximum capacity of two ICEAS$_{TM}$ reactors in 3 hour cycle.

The hydraulic capacity of the expanded Hiwassee River Wastewater Treatment Plant with all unit process functioning properly at river levels associated with floods up to the 100-year recurrence interval is 29.85 MGD. The highest daily flow measured during the period from January 1, 1990 through April 30, 1995 is 32.1 MGD. The highest instantaneous peak flow recorded during this period is 34.5 MGD for a one hour duration.

3. Life Expectancy of Expanded Wastewater Treatment Plant

The calculated seasonal flow and waste load capacities for the expanded Hiwassee River Wastewater Treatment Plant are listed for comparison with the existing and projected-for-year-2015 seasonal flows and waste loads in Table No. D-4. A review of the information presented in Table No. D-4 reveals that all flows and waste loads projected for the year 2015 are less than the capacity of the expanded Hiwassee River Wastewater Treatment Plant, with the exception of "peak flow". The value listed as "peak flow loading capacity" represents the value below which all portions of the expanded Hiwassee River Wastewater Treatment Plant will operate normally when the Hiwassee River is at the elevation associated with the 100-year recurrence flood.

The expanded Hiwassee River Wastewater Treatment Plant can accommodate peak flows in excess of the value listed as "loading capacity" without overflows or bypasses occurring including the 34.5 historical instantaneous peak flow; however, the $ICEAS_{TM}$ reactors will be in a two hour cycle and typical removal of $CBOD_5$, TSS and NH_3-N may not occur.

The expanded Hiwassee River Wastewater Treatment Plant should be adequate to treat the flows and waste loads projected through the year 2015 unless a new industry discharging a large volume of process wastewater with high $CBOD_5$, TSS and/or NH_3-N characteristics locates in the Cleveland Utilities service area; an existing industry currently discharging a process wastewater with high $CBOD_5$, TSS and/or NH_3-N increases their discharge substantially; or unforeseen additional flows due to "I/I" enter the Cleveland Utilities sanitary sewer system.

Table No. D-4
Comparison of Flow and Waste Load Capacities of Expanded Hiwassee River Wastewater Treatment Plant with Existing and Projected for Year 2015 Flows and Waste Loads
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

	Winter			Summer		
Parameter	Loading Capacity(1)	1995 Loading(2)	2015 Loading(3)	Loading Capacity(1)	1995 Loading(2)	2015 Loading(3)
Peak Flow (MGD)	29.85(4)	32.1(5)	32.1(5)	29.85(4)	32.1(5)	32.1(5)
Normal Flow (MGD)	29.85(4)	16.0	17.74	16.0	9.0	10.74
$CBOD_5$ Loading (Lbs/Day)	19,590	10,500	13,682	19,590	11,000	14,182
TSS Loading (Lbs/Day)	33,580	18,000	21,761	30,275	17,000	20,761
NH_3-N Loading (Lbs/Day)	980	525	915	2,090	1,120	1,510

NOTES:

(1) Values from Table No. D-2. Capacities listed are calculated to treat 85th percentile flows and waste loads.
(2) Values from Table No. B-1. Values represent existing 85th percentile flows and waste loads.
(3) Highest Values from range presented in Table No. C-5. Values represent projected 85th percentile flows and waste loads. These values do not include any projected flows and waste loads due to increases in water usage by industrial customers.
(4) Hydraulic capacity with all unit processes operating properly at river levels up to 100 year recurrence flood and maximum hydraulic capacity for three hour cycle operation of the $ICEAS_{TM}$ process. Flows in excess of this value can be accommodated without overflowing any structure.
(5) Maximum recorded total daily flow between January 1, 1990 and April 30, 1995.

E. Proposed NPDES Permit Requirements

The Tennessee Department of Environment and Conservation, Division of Water Pollution Control has evaluated the discharge of the flows associated with the seasonal loading capacity for the expanded Hiwassee River Wastewater Treatment Plant and developed "Planning Standards for a Proposed Discharge". Based on these planning standards, the Division of Water Pollution Control indicates an NPDES permit will be issued for the expanded Hiwassee River Wastewater Treatment Plant based on a single 21.6 MGD year-round flow and not seasonal flows. The effluent limitations expected to be included in an NPDES permit for the expanded Hiwassee River Wastewater Treatment Plant are listed in Table No. E-1.

Table No. E-1
Expected NPDES Permit Requirements
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Effluent Characteristics	Monthly Average Conc. (mg/l)	Monthly Average Amount (Lbs/Day)	Weekly Average Conc. (mg/l)	Weekly Average Amount (Lbs/Day)	Daily Maximum Conc. (mg/l)
$CBOD_5$	25	4,504	35	6,305	40
TSS	30	5,404	40	7,206	45
NH_3-N	10	1,801	15	2,702	20
Chlorine Residual					0.2
Dissolved Oxygen	1.0 Instantaneous Minimum				

F. Proposed Wastewater Treatment Plant Unit Processes

1. Screw Pump Lift No. 1

Wastewater enters the existing Hiwassee River Wastewater Treatment Plant via Screw Pump Lift No. 1. Screw Pump Lift No. 1 consists of three (3) 84-inch diameter open-type screw lift pumps with a total lift of approximately 28.5 feet. Each of the three (3) screw pumps has a 16.5 MGD rated capacity. **The three (3) existing screw lift pumps in Screw Pump Lift No. 1 will remain in service.**

The following items of work at Screw Pump Lift No. 1 will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant based on comments from Cleveland Utilities Wastewater Treatment Plant operators.

✓- Repair the "frozen"-open 48-inch sluice gate out of existing Special Manhole RS-2 so this gate can be closed.

✓- Replace the existing leaking and/or inoperative sluice gates at the inlet to each screw lift pump.

- Determine the efficiency of the three (3) pumps. If the existing efficiency is substantially less than the manufacturer's expected efficiency for a new installation, consider re-grouting the pump channels for all three (3) pumps to return pumps to original efficiency.

- Replace the existing mercury float-type level sensors used for sensing level at Screw Pump Lift No. 1 inlet for automatic pump control with a pressure transducer and install an auxiliary transducer. The control protocol for operating the pumps in Screw Lift No. 1 (and concurrently in Screw Lift No. 2) will include a manually selected lead pump operating continuously, a manually selected lag pump starting automatically in response to increased level in the inlet to Screw Pump Lift No. 1 then operating continuously until manually stopped and reset as a lag pump, and the third pump held in reserve and only operable by manually starting the pump. Alternation of lead, lag and reserve pump will be manually controlled.

- Replace all three (3) existing screw lift pump guide plates with stainless steel guide plates.

- Replace the existing Allen-Bradley Model 216 Programmable Logic Controller (PLC) used for control of Screw Pump Lift No. 1 (and Screw Pump Lift No. 2) with an input/output (I/O) port and control the screw pumps on both lifts from the new PLC to be located in the Laboratory/Administration Building.

2. <u>Influent Flow Meter</u>

Flow discharging from Screw Pump Lift No. 1 enters the influent flow meter. The influent flow meter is a Parshall flume with a 36-inch throat. The flume can accurately measure flow rates up to 33.0 MGD. **The existing influent flow meter will remain in service.**

No work is proposed at the influent flow meter during the expansion of the Hiwassee River Wastewater Treatment Plant.

3. <u>Screw Pump Lift No. 2</u>

Flow discharging from the influent flow meter combines with the return flow from the sludge processing facilities and enters the inlet to Screw Pump Lift No. 2. Screw Pump Lift No. 2 consists of three (3) 84-inch diameter open type screw lift pumps with a total lift of approximately 28.5 feet. Each of the three screw pumps has a 16.5 MGD rated capacity. **The three (3) existing screw lift pumps in Screw Pump Lift No. 2 will remain in service.**

The following items of work at Screw Pump Lift No. 2 will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant based on comments from the Cleveland Utilities Wastewater Treatment Plant operators.

- Replace the existing leaking and/or inoperative sluice gates at the inlet to each screw lift pump.
- Determine the efficiency of the three (3) pumps. If the existing efficiency is substantially less than the manufacturer's expected efficiency for a new installation, consider re-grouting the pump channels for all three (3) pumps to return pumps to original efficiency.
- Replace all three (3) existing screw lift pump guide plates with stainless steel guide plates.
- Remove the existing vent pipe in the side of the vault housing the screw lift pump cooling water system and install a vent pipe in the top of the vault.

4. Mechanically and Manually Cleaned Bar Screens

NOTE: **This paragraph includes an evaluation of grinders and three (3) alternative types of mechanically cleaned bar screens to replace the unsatisfactory existing mechanically cleaned bar screens. Cleveland Utilities' staff has selected the self-cleaning bar/filter type mechanically cleaned bar screen alternative for inclusion in the expansion of the Hiwassee River Wastewater Treatment Plant expansion.**

a. General

Flow discharging from Screw Pump Lift No. 2 currently enters the channels leading to two (2) existing arcing type mechanically cleaned bar screens and/or one (1) manually cleaned bar screen.

The two (2) existing mechanically cleaned bar screens and the manually cleaned bar screen are all installed in 4-feet wide by 5-feet deep open channels. The existing mechanically cleaned bar screens are Arcing Bar Screens, Model ABS 01216 manufactured by HFE Process, Inc. The mechanically cleaned screens have

5/8-inch nominal screen openings. The existing manually cleaned bar screen is constructed of 3/8-inch thick by 2-inches deep bars with 1-inch nominal openings and is used only to bypass the mechanically cleaned screens during maintenance.

Two problems related to the existing mechanically cleaned bar screens are reported by the Cleveland Utilities Wastewater Treatment Plant operators. First, operators report that the teeth on the rake mechanism are susceptible to breaking. Second, the existing screens are constructed of stainless steel bars 3/8-inch thick by 2-inches deep connected to a base plate at the bottom of the influent channel to each screen. This arrangement creates an assembly much like a human hand with fingers pointing upward. The bars or "fingers" join at the baseplate, or "knuckles". Since the bars in the screen are long and narrow and are not braced at the top, or "finger-tips"; the bars can spread apart allowing solid materials larger than 5/8-inch to pass through the screen. The large floating particles which pass through the existing screens have contributed to the material accumulating in the inlet distribution channels in the existing $ICEAS_{TM}$ reactor basins. The larger settleable solids which pass through the screens can contribute to clogging of the jet aeration system jets in the existing $ICEAS_{TM}$ reactors.

The two (2) existing mechanically cleaned bar screens will be replaced during the expansion of the Hiwassee River Wastewater Treatment Plant based on comments by the Cleveland Utilities Wastewater Treatment Plant operators regarding the severity of the screens' operational problems.

Grinders and three types of mechanically cleaned bar screens were evaluated as replacements for the existing screens. The screen types evaluated include (1) the cylinder-shaped type; (2) the catenary type; and (3) the self-cleaning bar/filter type. These screens were evaluated for the reuse of the existing reinforced concrete structure, opening size required to achieve an acceptable head loss at a 33 MGD peak flow with one screen out of service, and estimated cost.

b. <u>Grinders</u>

Grinders reduce large solids in the waste stream to smaller uniform particles. These solids remain in the waste stream and are treated in downstream processes as sludge. Grinder units capable of accommodating the 33 MGD peak flow in the existing 48-inch wide channels include a horizontally rotating screen to sweep solids from the flow into a grinder.

In order to reuse the existing screen channels and provide for one (1) screen out of service at 33 MGD peak flow, three 48-inch wide channel grinder units were evaluated.

Hydraulic calculations indicate an overflow condition may exist if grinders are used. When one (1) grinder unit is removed from service while two (2) screw pumps are pumping 33 MGD maximum capacity, the calculated water level upstream from the grinder units is at elevation 713.20 feet above mean sea level (MSL). According to record drawings for the Hiwassee River Wastewater Treatment Plant, the top of the existing screen isolation slide gates located upstream from the existing screens are at elevation 712.57 above MSL, indicating the existing slide gates must be replaced with higher gates to avoid overflow during isolation of a screen. The top of the new slide gates would be level with the top of the screen channel walls at elevation 713.82 above MSL.

Solids passing through the grinder units will settle out of the waste stream in the $ICEAS_{TM}$ reactors. These large, sometimes stringy, non-biological solids may eventually create "sludge banks" within the $ICEAS_{TM}$ reactors due to the lack of mechanical sludge removal equipment in the $ICEAS_{TM}$ reactors.

The use of grinders may create two operational difficulties in the form of hydraulic over-flows and "sludge banks". **This alternative is not further considered.**

c. Cylinder-Shaped Type Mechanically Cleaned Bar Screen

The cylinder-shaped type mechanically cleaned bar screen consists of a cylindrical screen basket with a rotating cleaning rake and a hinged cleaning comb, screenings transport tube with a conveyor auger and spray wash system, a dewatering chamber and discharge chute. As wastewater passes through the screen, solids are retained by the screening basket. When the water level in the upstream side of the screen reaches a determined level due to head loss caused by blinding of the screen, the rotating cleaning rake begins to operate. The rotating cleaning rake contains teeth which pass between the bars of the screen and remove the screened material. When the rake reaches the top of the screen, the screened material drops into the screenings transport tube. The rake then reverses its direction of rotation and passes through the hinged comb. The screenings transport tube transports the screened material through the dewatering chamber to the discharge chute. Dewatered screenings are reported to have a solids content of up to 40 percent when discharged.

In order to reuse the existing screen channels and provide for one (1) screen being out of service at a 33 MGD peak flow, multiple 47-inch diameter cylinder-shaped mechanically cleaned bar screens were evaluated. Each 47-inch screen has an approximate 8.45 MGD capacity. In order to process a peak flow of 33 MGD with one (1) screen out of service, five (5) screens and the construction of two (2) additional 4-feet wide channels will be required. Since the existing screening channels must stay in service during construction and due to the configuration of the existing channels, construction of new channels would be very difficult and expensive. **This alternative is not further considered.**

d. Catenary-Type Mechanically Cleaned Bar Screen

The catenary-type mechanically cleaned bar screen consists of a bar rack constructed of trapezoidal shaped bars, chain with cleaning rakes attached, dead plate and discharge chute. The rake teeth engage the bar rack at the bottom of the channel projecting at least one (1) inch into the bars and move through the bars upwards and forward. The screenings removed from the bar rack by the rakes are conveyed up the dead plate by the rakes and deposited into the discharge chute.

In order to reuse the existing screen channels and provide for one (1) screen out of service at 33 MGD peak flow, multiple 48-inch wide screens were evaluated. The standard bar size for catenary-type screens is 5/8-inch x 5/16-inch x 1 3/4-inch. The minimum allowable opening between bars is 1/2-inch if the existing three (3) channels are to be reused for three (3) catenary-type screens.

Hydraulic calculations listed on Exhibit No. 3 indicate two (2) overflow conditions may exist if catenary-type screens are used.

- When one (1) catenary screen is removed from service while two (2) screw pumps are pumping 33 MGD maximum capacity, the calculated water level upstream from the "clean" catenary-type screens is at elevation 712.79 feet above mean sea level (MSL). According to record drawings for the Hiwassee River Wastewater Treatment Plant, the top of the existing screen isolation slide gates located upstream from the existing screens are at elevation 712.57 above MSL, indicating the existing slide gates must be replaced with higher gates to avoid overflow during isolation of a screen. The top of the new slide gates would be level with the top of the screen channel walls at elevation 713.82 above MSL.

- The apex elevation of Screw Pump Lift No. 2 and the top of the existing screen channel walls are at elevations 713.40 and 713.82 feet above MSL, respectively according to record drawings for the Hiwassee River Wastewater Treatment Plant. Hydraulic calculations indicate these elevations would be exceeded by the water level upstream from the catenary-type bar screens when one (1) catenary screen is out of service and the screens are 30 percent blinded while two (2) screw pumps are pumping at 33 MGD maximum capacity or when all three (3) screens are in service and are 30 percent blinded while three (3) screw pumps operate at 49 MGD maximum capacity.

  Operator attention during high flows would be necessary for catenary-type mechanically cleaned bar screens to prevent overflows under either of the aforementioned circumstances.

e. Self-Cleaning Bar/Filter Type Mechanically Cleaned Screens **(Selected Alternative)**

The self-cleaning bar/filter type mechanically cleaned screen consists of a rotating self-cleaning grid of screen links with screen link pivot shafts and motor operated drive chains on each side of the screen, diversion plates on either side of the screen unit, and a compactor/dewatering unit. Incoming wastewater is funneled into the throat of the screen by the diversion plates and passes through the screening grid. Every third screen link is equipped with a hook that gathers the screenings and transports them to the compactor dewatering unit where the screenings are compressed and transported to the collection point.

The screen is oriented parallel to the wastewater flow which allows wastewater to be filtered on each longitudinal side and along the bottom of the channel. This design creates a larger wetted area per foot of depth than the catenary-type screen. The screen links are 1/8-inch thick creating a grid efficiency, or ratio of wetted opening area to the total wetted area, significantly higher than that of a catenary screen with the same screen opening. This characteristic reduces the head loss associated with the screen.

In order to reuse the existing three (3) screen channels and provide for one (1) screen out of service at 33 MGD peak flow, multiple 24-inch screens were evaluated. The minimum allowable opening between screen links is 1/4-inch if the existing three (3) channels are to be reused for three (3) self-cleaning bar/ filter type mechanically cleaned bar screens. Three 24-inch screens with a 1/4-inch opening are capable of operating at 33 MGD peak flow condition with one screen out of service or at 49 MGD with all screens operating without overflowing the apex of Screw Pump Lift No. 2.

During their evaluation of the self-cleaning bar/filter type mechanically cleaned screen, Cleveland Utilities Wastewater Treatment Plant operations staff determined that they desire the following items incorporated into the screen units.

- **High hydraulic pressure automatic shut-off**
- **Reverse feature on screenings augers**

- **Use of 316 stainless steel for fabrication of <u>all</u> screen unit components**

- **Elimination of brushes to avoid collection of stringy materials.**

f. <u>Preliminary Cost Estimate for Alternative Types of Mechanically Cleaned Bar Screens</u>

In evaluating the cost differences between the alternative mechanically cleaned bar screen types, installation and electrical system construction costs were assumed to be equal for all alternatives and are not included in the preliminary cost estimate. The preliminary cost estimate for the catenary-type bar screen alternative is $140,000 and includes the three (3) screen units, screenings conveyor equipment, and the material and installation for replacing the three (3) upstream slide gates. The preliminary cost estimate for self-cleaning bar/filter type bar screen alternative is $210,000 and includes the three (3) screen units and screening conveyor equipment. Preliminary layouts for the screen types evaluated are depicted on Exhibit No. 4.

g. Advantages and Disadvantages

The advantages and disadvantages of the alternative mechanically clean bar screen types evaluated are listed in Table No. F-1.

5. Grit Removal Units

Flow discharged from the existing mechanically cleaned bar screens enters two identical existing grit removal units. The grit removal units are 18 feet diameter Model 30 Pista® grit chambers with equipment manufactured by Smith and Loveless, Inc. The grit chambers operate on the principle of a forced vortex created by an axial flow propeller in conjunction with gravity to force grit to the chamber floor where the grit is collected for removal in a settling compartment. **The existing two grit removal units will remain in service.**

The following items of work at the existing grit removal units will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant based on comments from the Cleveland Utilities Wastewater Treatment Plant operators.

TABLE NO. F-1
ADVANTAGES AND DISADVANTAGES
ALTERNATIVE MECHANICALLY CLEANED BAR SCREENS
HIWASSEE RIVER WASTEWATER TREATMENT PLANT EXPANSION
CLEVELAND UTILITIES
JRWCO 3193

CATENARY TYPE		SELF-CLEANING BAR/FILTER TYPE	
ADVANTAGES	DISADVANTAGES	ADVANTAGES	DISADVANTAGES
1. Screen and bar rack are extremely heavy and durable. 2. All moving parts are above the screen channel. 3. Lowest cost.	1. Creates higher head loss and greater chance of overflow upstream from screens. 2. Slide gates upstream of the screens must be replaced to allow isolation of a screen out of service during peak flows. 3. Screen has no screenings dewatering capabilities. 4. Smallest opening available is 1/2-inch.	1. No overflows upstream from the screens are expected under any flow conditions. 2. All moving parts are above screen channel. 3. Screen has integral dewatering/compaction unit. 4. Offers 1/4-inch opening.	1. Screen links less durable than bar rack. 2. Highest cost.

SELECTED ALTERNATIVE

- The grit pump discharge piping arrangement will be reviewed during detailed design and any changes necessary to prevent pipe stoppages due to grit settling in pipes and hanging check valves will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant. Installation of flushing water lines on the grit pump discharges will also be reviewed during detailed design.

6. <u>Cyclical Activated Sludge Process</u>

a. <u>General</u>

Flow from the two (2) existing grit removal units discharges into a 42-inch diameter pipe which transports the flow to the center of four basins comprising the existing secondary treatment process.

The existing secondary treatment process at the Hiwassee River Wastewater Treatment Plant is a proprietary variant of the cyclical activated sludge process marketed as $ICEAS_{TM}$ by Austgen-Biojet Wastewater Systems, Inc. (ABJ), a division of Water Pollution Control Corporation. Cleveland Utilities' managers and wastewater treatment plant operators have expressed their desire to use $ICEAS_{TM}$ technology for secondary treatment in the expanded Hiwassee River Wastewater Treatment Plant. Since the $ICEAS_{TM}$ technology is proprietary, purchase of the associated equipment must be through negotiation rather than competitive bidding. The following items of equipment are proposed for inclusion in the scope of work to be negotiated with ABJ.

- Eight (8) pairs of 19.7 feet weir length 304 stainless steel decanters with scum baffles for the proposed four (4) new $ICEAS_{TM}$ reactor basins. These decanter units will incorporate the current Aust-gen-Biojet seal and bearing ring sub-assembly design.

- Four (4) electromechanical decanter actuator units with variable frequency drives incorporating double rotary type limit switches. One drive unit is required for each two pairs of decanters.

- Eight (8) automatically actuated resilient seated butterfly-type air control valves and electric actuators. Four (4) valves will be installed in the air distribution piping for the new $ICEAS_{TM}$ reactor and four (4) valves will be installed in the modified air distribution piping for the existing $ICEAS_{TM}$ reactor.

- A new programmable logic controller (PLC) driven, modem equipped control system for both the new and existing $ICEAS_{TM}$ reactors. The control system will incorporate a central Allen-Bradley 5/40 PLC located in the Laboratory/Administration Building equipped with a "hot backup" module communicating with remote input/output (I/O modules located in the existing and new Blower Buildings. The remote I/O modules will control and monitor all $ICEAS_{TM}$ related motors and devices and will communicate with the PLC via a local area network on Data Highway Plus protocol. All data received and transmitted by the PLC will be transferred to a personal computer based data access and management program for archiving and processing for reports.

- Two (2) new motor control centers (MCC's) for control of the motors associated with the existing and proposed $ICEAS_{TM}$ reactors will be located in the existing and proposed Blower Buildings, respectively.

Negotiations will begin with a written Request for Proposal prepared by J. R. Wauford & Company to ABJ upon instruction from Cleveland Utilities.

b. Existing $ICEAS_{TM}$ System

1) General

The existing $ICEAS_{TM}$ system consists of a four basin reactor. Flow is equally divided into each basin by means of adjustable slide gates and enters each basin continuously. The contents of each basin are aerated, settled and decanted in cycles following a pre-set protocol. The cycle protocols used for operation of the existing $ICEAS_{TM}$ reactor are depicted and described on Exhibit No. 5.

2) Tank Configuration

The configuration of the existing $ICEAS_{TM}$ reactor basins is depicted on Exhibit No. 1. Experience with $ICEAS_{TM}$ and other variants of the cyclical activated sludge process since construction of the $ICEAS_{TM}$ reactor at the Hiwassee River Wastewater

Treatment Plant indicates that certain modifications to the existing $ICEAS_{TM}$ reactor basins may enhance the hydraulic performance and reduce maintenance requirements. The following items of work at the existing $ICEAS_{TM}$ reactor basins will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant.

- Following evaluation of the results of a dye tracer study, determine if the removal of the short solid baffle wall transverse to the long dimension of the $ICEAS_{TM}$ reactor basins in each basin will increase hydraulic residence time. This wall was originally constructed to minimize mass movement of the sludge blanket towards the decanters during the decanting portion of each cycle. Subsequent experience at other cyclical activated sludge facilities has proven this wall is not needed to control sludge blanket movement. Dye tracer studies at other similar facilities indicate that the wall contributes to hydraulic short circuiting under high flow conditions and the subsequent reduction in average hydraulic residence time.

- Installation of floor-mounted diffused aerators in the selector compartment, referred to by the Cleveland Utilities Wastewater Treatment Plant operators as the "diamond", to completely mix the compartment contents and prevent solids deposition on the compartment floor. The selector has not proven to enhance performance of the $ICEAS_{TM}$ reactor and the floating aspirating-type aerators can not completely mix the selector compartment contents leading to solids deposition and the associated maintenance problems.

- Removal of the inlet distribution channel in each basin and replacement with an inlet flow distribution system which will not trap floating oil and grease. Since aeration and contact with MLVSS cannot occur in the inlet distribution channels, no biological reduction of the trapped oil and grease can occur and the oil and grease layer continues to build up until the layer overtops the channel.

3) <u>Decanters</u>

Each $ICEAS_{TM}$ reactor basin is equipped with two (2) pairs of decanters. Each of the four decanters provides a 19.7 feet weir length. Both pair of decanters in each basin are actuated by an electro-mechanical decanter drive system. The drives, and consequently the speed of the decanters, are controlled by variable frequency variable speed drives.

Variable speed control of the decanter drives is desirable for three reasons:

- The various operating cycle protocols require the decanters to travel through the vertical distance between BWL and TWL at different speeds.

- Retraction of the decanters to the "park" position above TWL following the end of decanting at a faster speed than the decanter travels during decanting is desirable to reduce the time rotating equipment operates during each cycle.

- The decanter weir travels along an arc during decanting. The vertical rate of travel of an object travelling along an arc at a constant speed is not constant. Constant speed decanter drives produce a variable rate of decanting with the lowest rate being at TWL and the highest rate being at BWL. This condition was observed to cause scouring of the sludge blanket and contribute to hydraulic short circuiting at a facility constructed prior to the Hiwassee River Wastewater Treatment Plant. The variable speed controller can be programmed with an algorithm to produce a constant decant rate.

The existing decanters and drives will remain in service. No work associated with the existing decanters and drives is proposed during the expansion of the

Hiwassee River Wastewater Treatment Plant.

4) <u>Aeration System</u>

The existing $ICEAS_{TM}$ reactor is supplied with oxygen and mixing energy by a jet-type aeration system which consists of the following items:

- Three (3) Model 1405-0-0-0-0-0-5-AD centrifugal blowers manufactured by the Lamson Corporation driven by 200 HP electric motors.

- Four (4) electrically actuated 14-inch air control butterfly valves.

- Eight (8) Model MT2DM-58 jet aeration headers manufactured by Mass Transfer Systems, Inc.

- Eight Model FA500 submersible aeration pumps manufactured by Davis-EMU driven by 67 HP electric motors.

A comparison of the jet-type aeration system with two alternate types of aeration systems is presented in Paragraph F.6.c. Regardless of the type of aeration system selected for the expansion of the Hiwassee River Wastewater Treatment Plant, the following items of work relating to the existing $ICEAS_{TM}$ reactor aeration system will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant based on comments from Cleveland Utilities Wastewater Treatment Plant operators.

- Air piping from the existing blowers to the existing $ICEAS_{TM}$ reactor will be modified so that one blower provides air to only one basin during aeration. The current arrangement provides a single air line from all three existing blowers to the $ICEAS_{TM}$ reactor. At any time, two basins are always in aeration. Two blowers are usually operated simultaneously. The two basins in aeration are always at different water levels. The air supply to the two basins is unevenly split with most of the air flowing to the basin with the lowest water level at any given time. This arrangement results in one of the two basins in the aeration portion of a cycle receiving more air than necessary for adequate treatment and one basin receiving less air than necessary for adequate treatment at any given time. This condition may contribute to the "bulking" condition occasionally experienced in the existing $ICEAS_{TM}$ reactor. The modified air piping arrangement will allow each one of the two blowers operating at any time to provide a dedicated air supply to each one of the two $ICEAS_{TM}$ reactor basins in the aeration portion of a cycle at any given time. The third blower will serve as a standby unit.

5) <u>Sludge Wasting System</u>

Sludge is wasted from the existing $ICEAS_{TM}$ reactor through four (4) Model FA80-420.1 submersible pumps manufactured by Davis-EMU. Each pump is driven by a 7.4 HP electric motor. Sludge is wasted from the $ICEAS_{TM}$ reactor basins during the aeration portion of each cycle. Waste sludge flow from all four existing $ICEAS_{TM}$

reactor basins is metered at the existing Waste Sludge Flow Meter located on a common discharge line for all four existing waste sludge pumps. Waste sludge handling facilities are currently being upgraded under a separate project.

The existing waste sludge pumps do not have adequate capacity for the expanded Hiwassee River Wastewater Treatment Plant. The existing waste sludge pumps will be replaced with four (4) new vertically mounted, dry pit, vortex type pumps housed in two new above-ground waste sludge pumping stations located at the north and south ends of the existing $ICEAS_{TM}$ reactors. Wastewater treatment plant operators have expressed the desire to avoid the use of submersible pumps in the expanded wastewater treatment plant where possible. The new waste sludge pumps will have a capacity of 450 GPM at an approximate 50 feet total dynamic head. Each new pump will be driven by a 20 HP electric motor. The layout for the proposed replacement waste sludge pumping stations is depicted on Exhibit No. 7.

The volume of sludge which must be wasted during aeration to achieve required mass sludge wasting rates is highest when sludge is wasted during the aeration portion of each cycle. The existing sludge pump suction configuration allows sludge to be drawn from a single location in each basin. If sludge wasting is attempted during the settling or decanting portion of a cycle, "rat holing" occurs in the sludge blanket after a short pumping duration. During expansion of the Hiwassee River Wastewater Treatment Plant, a suction manifold piping system will be added to each existing $ICEAS_{TM}$ reactor basin to allow waste sludge withdrawal from several locations in each basin. This arrangement will provide operators with the option to waste sludge during the aerating, settling or decanting portions of a cycle without "rat holing" occurring.

6) Control/Electrical System

All functions related to the operation of the existing $ICEAS_{TM}$ reactor are automatically controlled by a Model 217 PLC manufactured by Allen-Bradley Company, Inc.

Due to the improvements in PLC technology since the Hiwassee River Wastewater Treatment Plant was constructed, the existing PLC will be removed and replaced with a new PLC programmed to control both the existing and proposed ICEAS$_{TM}$ reactors as part of the Hiwassee River Wastewater Treatment Plant expansion. The existing motor control center (MCC) provided by Austgen-Biojet will be removed and replaced with a new solid state MCC for all motors controlled by the control/ electrical system furnished by Austgen-Biojet.

c. <u>Evaluation of Alternative Aeration Devices</u>

1) <u>General</u>

Since construction of the Hiwassee River Wastewater Treatment Plant, advances have been made in wastewater aeration device technology which could offer substantial savings in wastewater aeration system life cycle cost. Three (3) types of aeration devices are considered appropriate for the cyclical activated sludge process. These include jet aeration, nonporous "coarse bubble" diffusers and perforated membrane disc "fine bubble" diffusers. Porous "fine bubble" diffusers are not considered appropriate for the cyclical activated sludge process due to their tendency toward fouling by the formation and accretion of a biofilm layer on the diffuser.

The advantages, disadvantages and life cycle costs of aeration systems incorporating each of the three aeration devices considered appropriate for the cyclical activated sludge process are presented for the expanded Hiwassee River Wastewater Treatment Plant.

2) <u>Jet Aeration</u>

The existing ICEAS$_{TM}$ reactor utilizes a jet aeration system for oxygen transfer and mixing energy. The jet aeration system combines liquid pumping with air diffusion. The pumping system recirculates liquid in the reactor basin, ejecting it through a nozzle assembly. The existing jet aerators are configured as longitudinal directional aerators.

The jet aerators and associated piping are of fiberglass reinforced plastic construction.

The existing jet aeration system described in Paragraph F.6.b.4) appears to be adequate for reuse in the expanded Hiwassee River Wastewater Treatment Plant if the air supply configuration is revised as described in Paragraph F.6.b.4). If jet aeration is selected for use in the expanded Hiwassee River Wastewater Treatment Plant, the new $ICEAS_{TM}$ reactor will be equipped with a jet aeration system identical to the existing jet aeration system, except that vertically mounted, dry-pit type aeration pumps will be used instead of the submersible type aeration pumps utilized in the existing system. This change is based on comments from Cleveland Utilities Wastewater Treatment Plant operators.

3) Nonporous Coarse Bubble Diffuser

Nonporous coarse bubble diffuser aeration devices are an established aeration technology with well documented operating characteristics. The nonporous coarse bubble diffuser aeration system evaluated for use in the expanded Hiwassee River Wastewater Treatment Plant is the Sanitaire fixed orifice, stainless steel fixed header system manufactured by Water Pollution Control Corporation. Nonporous coarse bubble diffusers have relatively large openings for air dispersion into the reactor basin resulting in relatively large bubbles. This large opening reduces opportunities for clogging. The coarse bubble diffusers evaluated for the Hiwassee River Wastewater Treatment Plant expansion are attached to six stainless steel longitudinal headers in each reactor basin and one stainless steel transverse header in the prereact zone of each reactor basin. The system evaluated includes 288 diffusers in each reactor basin (including prereact zone), each with 3/4-inch fixed orifices. Mixing is accomplished by the buoyant action of the coarse bubbles rising from the reactor basin floor.

4) Perforated Membrane Disc Diffusers

Membrane diffusers utilize mechanically created preselected patterns of small, individual orifices (perforations) in the membrane to allow passage of air through the material. A new type of perforated diffuser has been introduced within the last decade. It consists of a thin flexible membrane usually made from an elastomer. The patterned orifices in the membrane material are intentionally made during the manufacturing process. Therefore, this new generation of membrane diffusers is referred to as "perforated" membrane diffusers.

Most elastomer membranes are made from ethylenepropylene dimer (EPDM). Although the main ingredient may be EPDM, proprietary additives are usually included to enhance the material characteristics. As a result, it may not always be possible to establish membrane characteristics or physical properties simply by consulting a table in a reference text or handbook.

After the membrane material is produced, air passages are created by punching or cutting minute holes or slits in the membrane. When the air is turned on, the material expands. Each hole acts as a variable aperture opening; the higher the airflow rate, the greater the size of the opening. When the air is turned off, the membrane relaxes down against its support base and a seal is formed between membrane and support in systems where the membrane area conforms to the support. This closing action will reportedly eliminate or at least minimize the backflow of liquid into the diffuser.

Perforated membrane diffusers have been developed over the last 10-15 years in the United States and Europe. The most significant advantage claimed for the perforated membrane diffuser is that its smooth surface and apertures may be more resistant to fouling than are other types of fine bubble diffuser media. Perforated membrane diffusers are constructed as discs and as tubes. Because of their inherent shape, it is difficult to obtain air discharge around the entire circumference of the tubes. Only disc type perforated membrane diffusers are considered for the expanded Hiwassee River Wastewater Treatment Plant.

One of the disadvantages of the perforated membrane diffusers is that elastomer materials can experience physical property changes with time. These changes depend, to varying degrees, on the material used, their shape and dimensions, and environmental conditions. Changes in perforated membrane diffuser properties can affect the backpressure and airflow from blowers supplying air and the oxygen transfer efficiency of the aeration system. EDPM can experience various physical property changes with time when used as wastewater aeration devices.

Conditions that can substantially affect perforated membrane performance and life include hardening or softening of the material; loss of dimensional stability through creep, absorptive and/or extractive exchange with wastewater; and chemical changes resulting from environmental exposure.

Absorption by the membrane of various constituents, including oils, can result in softening of the membrane with volumetric changes and subsequent dimensional changes. Membrane creep, which may be influenced by these factors, will reduce oxygen transfer efficiency in some cases. It may also be accompanied by a reduction in back pressure on the blower supplying air to lower than the original value after cleaning. This reduction is not recoverable by known maintenance procedures.

In order to determine if the wastewater treated by the expanded Hiwassee River Wastewater Treatment Plant will affect perforated membrane diffuser properties, a pilot study is being undertaken in the existing $ICEAS_{TM}$ reactor. The pilot study includes a pre-installation analysis and characterization of the perforated membrane disc diffuser and a post installation analysis by a common independent laboratory to determine any changes in the membrane properties. This pilot study will continue for a six month minimum period and for as long as possible prior to the necessity to select an aeration system alternative.

The major manufacturers of perforated membrane disc diffusers are:

- Sanitaire, Division of Water Pollution Control Corporation,
- Aeration Engineering Resources Corporation (Aircor),
- Eimco Process Equipment Company, and
- Envirex

Due to the possible differences in EPDM materials caused by proprietary additives, only those manufacturers who conduct a pilot study in the existing ICEAS$_{TM}$ reactor will be considered. Sanitaire has completed a pilot study. Aircor and Eimco have pilot studies underway. Envirex declined to perform a pilot study.

Due to the relative lack of operating history available for perforated membrane discs used in cyclical activated sludge systems, visits to existing cyclical activated sludge facilities with at least one year's operating experience should provide valuable information. Known installations include:

- Phillipsburg, New Jersey
  3.5 MGD Municipal Wastewater Treatment Plant
  Eimco diffusers
- Marshalltown, Iowa
  Sanitaire diffusers
- Holbaek, Denmark
  Sanitaire diffusers

The perforated membrane disc aeration system evaluated for the Hiwassee River Wastewater Treatment Plant expansion includes a full basin floor coverage grid layout incorporating 2470 discs having a 9-inch diameter in each basin. Mixing is accomplished by the buoyant action of the fine bubbles rising from the reactor basin floor. Some manufacturers provide discs with diameters other than 9-inches. If these discs are selected, the total number required will vary from the number used in this evaluation.

Cleveland Utilities will require that a replacement technology warranty be provided by the supplier of perforated membrane discs against the failure of the devices to perform adequately over a minimum life in the event perforated membrane discs are the selected aeration device alternative.

5) <u>Life Cycle Cost Analysis</u>

A life cycle cost analysis using the present worth method was performed for each of the three aeration systems evaluated in order to compare the relative capital and operational costs associated with each alternative. The present worth method utilized indicates the funds required in 1995 to pay all unique costs necessary to install and operate each alternative for a 20 year period. Future operating and maintenance costs are assumed to be invested at a constant rate of return. Costs which are common to each alternative are not included in the analysis; therefore, the present worth values calculated do not represent actual total present worth costs for each alternative but do represent actual present worth cost differences for each alternative.

The assumptions used for this life cycle cost are listed in Appendix A.

The results of this life cycle cost analysis are listed in Table No. F-2.

Table No. F-2
Summary of Life Cycle Cost Analysis
Aeration System Alternatives
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

	Jet System	Non-Porous Coarse Bubble System	Perforated Membrane Disc System
Capital Costs in 1995 Dollars	$1,355,000	$1,152,000	$ 832,500
First Year's Power Cost in 1995 Dollars	$ 405,196	$ 362,806	$ 216,037
Material Replacement Costs in 1995 Dollars	$ 0	$ 0	$ 98,800 in years 5, 10 & 15
Present Worth	$5,497,515	$4,861,142	$3,229,129

6) <u>Advantages and Disadvantages of Various Aeration Devices Evaluated</u>

Advantages and disadvantages of the three aeration devices are listed in Table No. F-3.

Note: Following the initial review of aeration device alternatives, Cleveland

TABLE NO. F-3
ADVANTAGES AND DISADVA
ALTERNATIVE AERATION S
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JET SYSTEM		COARSE BUBBLE SYST	
ADVANTAGES	DISADVANTAGES	ADVANTAGES	DI
1. Existing system; operators are familiar with operation. 2. Established technology for cyclical activated sludge systems. 3. Allows mixing without aeration which is necessary for biological total nitrogen removal and biological phosphorous removal.	1. Pumps required for mixing; requires most mechanical equipment; has highest maintenance requirements. 2. Highest life cycle cost.	1. Established technology for cyclical activated sludge systems. 2. Diffuser system is all stainless steel construction. 3. Blowers provide aeration and mixing. 4. Life cycle cost lower than jet system.	1. Lo tr ci 2. Li hi fo sy

Following the initial review of aeration device alternatives, Cleveland Utilities management elected not to consider further the jet system alternative.

Utilities management elected not to consider further the jet system alternative.

d. Proposed $ICEAS_{TM}$ System

1) General

The proposed $ICEAS_{TM}$ system will consist of a four basin reactor. Flow will be equally divided into each basin at a central flow division structure by means of bottom opening weir gates and will enter each basin continuously. The contents of each basin will be aerated, settled and decanted in cycles synchronized with the four basins in the existing $ICEAS_{TM}$ reactor following a pre-set protocol. The cycle protocols for the existing and proposed $ICEAS_{TM}$ reactors in the expanded Hiwassee River Wastewater Treatment Plant are depicted and described on Exhibit No. 6.

2) Tank Configuration

The configuration of the proposed $ICEAS_{TM}$ reactor basins is depicted on Exhibit No. 2. This configuration incorporates characteristics developed through experience with other successfully operating cyclical activated sludge systems.

3) Decanters

Each proposed $ICEAS_{TM}$ reactor basin will be equipped with decanters and drives identical to the decanters and drives included in the existing $ICEAS_{TM}$ reactor described in Paragraph F.6.b.3) with the following exceptions:

- the current Austgen-Biojet scum baffle design will be provided;
- the current Austgen-Biojet seal and bearing ring sub-assembly will be provided.

4) Aeration System

The proposed $ICEAS_{TM}$ reactor will be supplied with oxygen by the selected aeration system alternative described in Paragraph F.6.c.

The air supply piping from the proposed blowers will be configured to allow one blower to supply air to only one basin during the aeration portion of each cycle, thereby assuring positive control of the oxygen/air volume provided to each basin throughout the aeration cycle.

5) <u>Sludge Wasting System</u>

One waste sludge pump will be provided for each new $ICEAS_{TM}$ reactor basin. The new waste sludge pumps will each have a capacity of 450 GPM at an approximate 50 feet total dynamic head. This capacity will allow adequate mass sludge wasting at the ultimate expanded wastewater treatment plant capacity for MLSS concentrations down to 1,500 mg/l. The new waste sludge pumps will be the vertically mounted, dry-pit, vortex type and be driven by 20 HP electric motors. The two waste sludge pumps for the two northernmost proposed $ICEAS_{TM}$ reactor basins will be housed in a below ground structure located at the center of the northern end of the proposed $ICEAS_{TM}$ reactor. The two waste sludge pumps for the two southernmost proposed $ICEAS_{TM}$ reactor basins will be housed likewise at the southern end of the proposed $ICEAS_{TM}$ reactor. The layout for the proposed waste sludge pumping stations is depicted on Exhibit No. 7.

Suction piping for each new waste sludge pump will be designed to allow sludge withdrawal from multiple locations in each new $ICEAS_{TM}$ reactor basin. This arrangement should allow sludge wasting to occur during aerating, settling or decanting portions of each cycle.

The discharge piping from each new waste sludge pump will be routed to the proposed Sludge Metering and Sampling Structure. This proposed structure is depicted on Exhibit No. 7A. During detailed design, installation of an on-line sludge concentration sensor will be evaluated as a means to more accurately control the mass of sludge wasted each day. The arrangement of the proposed discharge piping will be evaluated during detailed design to determine if sludge transfer between the new $ICEAS_{TM}$ reactor basins can be accomplished.

6) <u>Control/Electrical System</u>

All electric motors associated with the existing and proposed $ICEAS_{TM}$ reactors will be automatically controlled through a new PLC based control system. Primary system components will be manufactured by Allen-Bradley Company, Inc. The new PLC based control system will incorporate the following features:

- Two Allen Bradley Model 5/40 PLC's connected to provide a "hot backup" and located in the Laboratory/Administration Building. One spare Model 5/40 PLC will be provided.

- I/O modules located in the existing and proposed Blower Buildings. The I/O module in the existing Blower Building will replace the existing Allen Bradley Model 217 PLC. These I/O modules will be connected to the new Model 5/40 PLC system via redundant Allen-Bradley Remote I/O Links™.

- Panel Mate Power Series 4000 electronic operator interfaces manufactured by the Eaton Corporation will be provided with the PLC and at each I/O module. These interfaces will include color graphics and touch screen control on a 14-inch CRT and will communicate with each other over a Data Highway Plus protocol local area network. One spare Panel Mate interface unit will be provided.

- Capability to transfer data to the wastewater treatment plant SCADA system.

The new electrical system provided with the $ICEAS_{TM}$ control system will include new motor control centers, featuring solid state starters, for all motors controlled by the $ICEAS_{TM}$ control system. The motor control centers will be located in the existing and proposed Blower Buildings and will include "hand-off-automatic" (H-O-A) switches for each motor to allow bypass of the PLC based automatic control system.

7. <u>Disinfection</u>

a. <u>General</u>

Disinfection of treated effluent from the existing $ICEAS_{TM}$ reactor at the Hiwassee River Wastewater Treatment Plant is accomplished by chlorination. In order to meet current and proposed NPDES Permit effluent total residual chlorine concentration limitations, dechlorination is included in the disinfection process following a contact time after chlorination adequate to achieve required fecal coliform destruction. Dechlorination is currently accomplished with sulfur dioxide addition.

The United States Environmental Protection Agency has recently started investigative studies and opened a public forum regarding the use of chlorine as a wastewater disinfectant. Initial reactions to these efforts indicate that chlorine could be banned as a wastewater disinfectant at some time in the future. Due to the national and international political implications of a ban of chlorine as a wastewater disinfectant, an estimate of the outcome of these efforts cannot be made with any degree of certainty. Due to this consideration, Cleveland Utilities Water Division management requested that disinfection by ultraviolet radiation be considered as an alternative to disinfection using chlorine and sulfur dioxide.

Hydraulic limitations of the existing 54-inch outfall to the Hiwassee River at the 100 year recurrence flood river level dictate separate disinfection facilities for the existing and proposed $ICEAS_{TM}$ reactors regardless of the disinfection alternative selected. Flow rates and durations during decanting from each $ICEAS_{TM}$ reactor will define the hydraulic loading to the selected disinfection process. The expected hydraulic loadings and durations to the individual disinfection unit serving either the existing or proposed $ICEAS_{TM}$ reactor, regardless of the disinfection alternative selected, are listed in Table No. F-4.

Table No. F-4
Hydraulic Loadings and Durations to Individual Disinfection Units
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

$ICEAS_{TM}$ Cycle Protocol	Flow Rate Into Disinfection Units (GPM)	Range of Durations of Flow Rates (Minutes)
4 Hours(1)	7,775	10.6 to 60.0 beginning every 60 minutes
3 Hours(2)	10,366	34.1 to 43.0 beginning every 45 minutes
2 Hours	15,550	Expected to occur only under exceptional circumstances

Notes: (1) 4 hour cycle is expected to occur approximately 98.6 percent of the time.
(2) 3 hour cycle is expected to occur approximately 1.4 percent of the time.

Estimated durations of these flows are based on the statistical distribution of flow data for the period from January 1990 through December 1992.

b. Existing Disinfection Facilities

The existing chlorination/dechlorination disinfection facilities consist of the following:

- Two (2) 2,000 pounds per day (PPD) chlorinators manufactured by Capital Controls Company, Inc.
- One (1) 8,000 PPD chlorinator manufactured by Capital Controls Company, Inc.
- One (1) 500 PPD sulfonator manufactured by Wallace and Tiernan and one (1) 1,000 PPD auxiliary sulfonator manufactured by Capital Controls Company, Inc. The sulfonator was placed in service in January 1995.
- Scales for eight (8) ton cylinders of chlorine.
- Scales for four (4) ton cylinders of sulfur dioxide.
- Storage area for twelve (12) ton cylinders of chlorine and/or sulfur dioxide.

- One (1) chlorine contact chamber with approximate 303 feet - 8 inches by 15 feet outside dimensions and a center longitudinal baffle wall bisecting the chamber along its length. Water depth at the 15,550 GPM (22.39 MGD) maximum possible decanting flow rate will be approximately 7.6 feet.

Existing equipment provides two auxiliary chlorinators, but no auxiliary sulfonator for operation under current conditions.

Chlorine is currently added to the wastewater as a hypochlorite solution. No special mixing of hypochlorite solution with wastewater flow is currently provided at the hypochlorite solution injection point. The average chlorine dosage during the period from January 1990 through December 1992 is 3.22 mg/l. The sulfur dioxide dechlorination system has been in operation since January 1995. Wastewater treatment plant operators report sulfur dioxide usage is approximately two-thirds the chlorine usage.

The existing chlorine contact chamber is divided longitudinally into two compartments, each having 303 feet - 8 inches by 7 feet - 6 inches approximate dimensions. These dimensions yield a 40.5:1 length to width ratio. Tennessee Department of Environment & Conservation, Division of Water Pollution Control "Design Criteria for Sewage Works" recommend a minimum 30:1 length to width ratio. Either compartment may be taken out of service by means of inlet and outlet sluice gates without affecting flow through the other compartment. Each compartment is fitted with three (3) sets of over and under baffles to protect against hydraulic short circuiting. The top (i.e. "under") baffles collect floating solids and the bottom (i.e. "over") baffles make cleaning the dewatered chlorine contact chamber difficult. The large length to width ratio of the chlorine contact chamber compartments make these baffles unnecessary. The removal of these baffles will be incorporated into the expansion of the Hiwassee River Wastewater Treatment Plant if disinfection by means of chlorination and dechlorination is continued.

c. Chlorination/Dechlorination Alternative

Flow from the existing $ICEAS_{TM}$ reactor basins will continue to discharge from the reactor basins through the existing 36-inch diameter decanter effluent lines into the existing 48-inch diameter headers and into existing Manhole E-1 if chlorination/dechlorination is the selected process for disinfection at the expanded Hiwassee River Wastewater Treatment Plant. Chlorine will continue to be injected into the wastewater in Manhole E-1. Flow will continue through the existing 48-inch line from existing Manhole E-1 into the inlet of the existing chlorine contact chamber. The chlorinated wastewater will normally split and flow through both compartments in the chlorine contact chamber. Sulfur dioxide solution will continue to be added to achieve dechlorination at the inlet to the Effluent Flow Meter structure by means of a static diffuser.

Projected chlorine and sulfur dioxide usage for the years 1995 through 2015 are listed in Table No. F-5.

These projected usages are based on a 3.32 mg/l chlorine dosage, a 2.22 mg/l sulfur dioxide dosage and a projected uniform annual increase in flow between the years 1995 and 2015. The assumed chlorine dosage is the average dosage during the period from January 1990 through December 1992. The assumed sulfur dioxide dosage is two-thirds the average chlorine dosage and is based on two months experience with sulfonation. The flows in year 1995 are taken from Table No. B-1. The flows projected in year 2015 are taken from Table No. D-2. The projected cost for chlorine and sulfur dioxide in the year 1995 is approximately $50,000. The projected uninflated cost for chlorine and sulfur dioxide in the year 2015 is approximately $78,000.

Table No. F-5
Projected Chlorine and Sulfur Dioxide Usage
From Year 1995 Through Year 2015
Cleveland Utilities
JRWCO 3193

Year	Wastewater Treatment Plant Influent Flow(1) (MGD)	Chlorine Usage (Lbs/Day)	Sulfur Dioxide Usage (Lbs/Day)
1995	11.92	330	221
1996	12.26	339	227
1997	12.59	349	233
1998	12.93	358	239
1999	13.26	367	246
2000	13.60	376	252
2001	13.93	386	258
2002	14.27	395	264
2003	14.60	404	270
2004	14.94	414	277
2005	15.28	423	283
2006	15.61	432	289
2007	15.95	442	295
2008	16.28	451	301
2009	16.62	460	308
2010	16.95	469	314
2011	17.29	479	320
2012	17.62	478	326
2013	17.96	497	332
2014	18.29	506	338
2015	18.63	516	345

Notes: (1) Flow is weighted average of projected 85th percentile winter and summer seasonal flows.

Maximum chlorination and sulfonation rates are determined by decanter flow rates. The maximum decanter flow rate listed in Table No. F-4 is 15,550 GPM. This decanter flow rate will require chlorination and sulfonation capacities of 620 pounds per day and 414 pounds per day respectively to provide the chlorine and sulfur dioxide dosages used to derive the usages listed in Table No. F-5.

If chlorination/dechlorination is selected as the method for disinfection in the expanded Hiwassee River Wastewater Treatment Plant, the following items of work will be incorporated into the expanded plant.

- The two (2) existing 2,000 PPD chlorinators will be reused. One chlorinator will be dedicated to disinfection of decanted flow from the existing $ICEAS_{TM}$ reactor and one chlorinator will be dedicated to disinfection of decanted flow from the proposed $ICEAS_{TM}$ reactor.
- The one (1) existing 8,000 PPD chlorinator will be reused as an auxiliary chlorinator for both $ICEAS_{TM}$ reactors.
- The one (1) existing 1,000 PPD sulfonator will be reused and dedicated for dechlor-

ination of the decanted flow from the existing $ICEAS_{TM}$ reactor.

- One (1) new 500 PPD sulfonator will be added for dechlorination of the decanted flow from the proposed $ICEAS_{TM}$ reactor. The existing auxiliary Capital Controls sulfonator will serve as an auxiliary unit for both $ICEAS_{TM}$ reactors.
- Two (2) new chlorine induction units will be provided for chlorine injection to improve the efficiency of chlorination at the point of injection into the wastewater flow. One unit will be installed in existing Manhole E-1 to inject chlorine into the decanted flow from the existing $ICEAS_{TM}$ reactor and one unit will be installed to inject chlorine into the decanted flow from the proposed $ICEAS_{TM}$ reactor. Chlorine induction units can inject chlorine gas into wastewater without the use of solution water. During detailed design use of chlorine gas rather than hypochlorite solution will be evaluated to reduce the demand on the effluent water reuse system.

- The over and under baffles in the existing chlorine contact chamber will be removed.
- Repair or replace the leaking sluice gates at the inlet to the existing chlorine contact chamber.
- Construct a weir wall at the outlet from the existing chlorine contact chamber.
- A new chlorine contact chamber similar to the existing chlorine contact chamber, but without the over-and-under baffles, will be constructed with the new $ICEAS_{TM}$ reactor.

- During detailed design, the appropriate building codes officials will be interviewed to determine if the requirements of the 1988 edition of the Uniform Fire Code and the 1991 edition of the Standard Fire Prevention Code (SBCCI) related to chlorine gas storage facilities must be incorporated into the Hiwassee River Wastewater Treatment Plant expansion. These requirements could require a gas treatment and containment system for accidental releases of chlorine gas.

d. Ultraviolet Disinfection Alternative

Ultraviolet light is an established bactericide and virucide. It is a physical disinfection agent and does not produce any toxic residuals. Although certain chemical compounds may be altered by ultraviolet radiation, energy levels used for disinfection of wastewater are too low for this to be a cause for concern.

Advantages of disinfection using ultraviolet light are its simplicity, lack of impact on the environment and aquatic life, and minimal space requirements. The likelihood of producing harmful chemicals in the wastewater is negligible. Required contact times are very short, on the order of seconds rather than minutes. The equipment is simple to operate and maintain.

Disadvantages of disinfection using ultraviolet light include fouling of the quartz lamps which must be dealt with on a regular basis. Fouling is normally corrected by mechanical, sonic, or chemical cleaning. Also high suspended solids concentrations, color, turbidity, and soluble organic matter in the wastewater can react with or absorb the ultraviolet radiation reducing the disinfection performance.

The feasibility of disinfection of the treated effluent from the expanded Hiwassee River Wastewater Treatment Plant using ultraviolet light was investigated in detail with Trojan Technologies, Inc., a leading manufacturer of ultraviolet disinfection technology. The conclusion reached based on the findings of the investigation is that the use of ultraviolet light for disinfection at the expanded Hiwassee River Wastewater Treatment Plant is not feasible. Information gathered during the investigation supporting this conclusion include the following.

- The cost of the two (2) ultraviolet disinfection units necessary to disinfect the decanted flow from the existing and proposed $ICEAS_{TM}$ reactors is approximately $660,000. This cost does not include the cost of modifications to the existing chlorine contact chamber or construction of a new disinfection structure at the proposed $ICEAS_{TM}$ reactor.

- Ultraviolet lamps are designed to be cycled on and off a maximum of four times per day. Operation of an ICEAS$_{TM}$ reactor in the four hour cycle mode would require the ultraviolet lamps be cycled on and off 24 times per day. Annual lamp replacement costs for two (2) ultraviolet disinfection units due to premature failure caused by the excessive on-off cycling is estimated between $42,000 and $84,000. The lamps can be placed in a low power or "idle" mode when decanting is not occurring to avoid the 24 on-off cycles.
- Estimated annual power cost for two (2) ultraviolet disinfection units is approximately $87,000. Approximately 46 percent of the time the units would be on in the "idle" mode and no flow would be discharging from the ICEAS$_{TM}$ reactors.
- Trojan Technologies, Inc. declined to pursue the project unless an equalization basin is constructed prior to the disinfection units.

8. <u>Effluent Flow Meter</u>

Flow discharged from the existing $ICEAS_{TM}$ reactor enters the existing effluent flow meter. The existing effluent flow meter is a Parshall flume with a 36-inch throat. The flume can accurately measure flow rates up to 33.0 MGD. **The existing effluent flow meter will remain in service.** No work is proposed at the existing effluent flow meter during expansion of the Hiwassee River Wastewater Treatment Plant.

A new effluent flow meter will be constructed as part of the expanded Hiwassee River Wastewater Treatment Plant. Flow discharged from the proposed $ICEAS_{TM}$ reactor will enter the new effluent flow meter. The new effluent flow meter will include a 36-inch Parshall flume configured similar to the existing effluent flow meter structure. Individual flows from the existing and proposed effluent flow meters will be indicated, then added together for totalized effluent flow from the expanded Hiwassee River Wastewater Treatment Plant.

A new effluent sampling station will be designed to collect effluent wastewater samples from the combined discharges of the existing and proposed $ICEAS_{TM}$ reactors.

9. <u>Effluent Water Reuse System</u>

The capacity of the existing effluent water reuse system will be evaluated during detailed design relative to the recycled effluent water needs of the expanded Hiwassee River Wastewater Treatment Plant and the new Sludge Handling Facilities currently under construction. If these needs exceed the capacity of the existing effluent water reuse system, the system will be upgraded during the expansion of the Hiwassee River Wastewater Treatment Plant to meet required needs.

G. <u>Proposed Wastewater Treatment Plant Control and Monitoring System</u>

Control of electric motor driven devices at the Hiwassee River Wastewater Treatment Plant is currently accomplished by the existing PLC based control system for motors related to the $ICEAS_{TM}$ process and at local manual control stations for all other motors. Monitoring of various wastewater treatment plant devices, process instruments and flows at the Hiwassee River Wastewater Treatment Plant is currently accomplished by means of indicator lights, totalizers, indicators, recorders and alarm annunciators in a conventional vertical monitoring panel, along with a modified personal computer driven SCADA system utilizing Control View version 4.01 software. Cleveland Utilities management desires to continue this control protocol, i.e. automatic control of the devices associated with the $ICEAS_{TM}$ reactors and local manual control of non-$ICEAS_{TM}$ related devices, and to revise the monitoring protocol by eliminating the monitoring panel and its associated devices and monitoring all wastewater treatment plant functions using a personal computer based SCADA system variant incorporating monitoring functions but no control functions.

The "monitoring only" SCADA system will be based on Realflex Version 4.0 software produced by B.J. Software Systems and will incorporate the following:

- Provide capability to change time inputs for automatically controlled variable time based functions throughout the wastewater treatment plant.

- Produce time versus concentration value charts for data supplied by continuous reading dissolved oxygen meters located in each $ICEAS_{TM}$ basin.

- Produce time versus flow value charts for data supplied by the influent and two effluent flow meters.

- Provide run status and run time for all electric motors.

- Provide an alarm function which will override any other software function when an alarm indicator produces a signal signifying an activity identified as an alarm occurs.

- Provide totalization and indication of all metered flows within the wastewater treatment plant including influent, effluent and waste sludge.

- Interface with data generated at the new Sludge Handling Facilities.

- Interface with data generated by the $ICEAS_{TM}$ PLC based control system.

- Provide raw data to remote monitoring locations with access security. This capacity will be provided by transferring all data collected on the Realflex software at the wastewater treatment plant to the existing Realflex software located at the existing water treatment plant via telephone or radio telemetry using B.J. Scan software. Data from the wastewater treatment plant may then be retrieved from the Realflex software running at the water treatment plant using Remflex remote data retrieval software. This format assures that no conflict will develop due to different local area network protocols such as Simex, Modbus and Data Highway Plus, used within the Cleveland Utilities SCADA system.

H. Proposed Electrical Work

Primary electrical service and the auxiliary generator for the existing wastewater treatment plant will remain in the existing condition. Additional primary electric service for the electric motor driven devices associated with the proposed additions to the Hiwassee River Wastewater Treatment Plant will be provided as a separate underground primary duct bank extending from the existing power company primary pole and switch to a proposed 1000 KVA 12,470-277/480 volt, 3 phase, 4 wire pad mounted transformer to be located on the east end of the proposed Blower Building. Auxiliary power for the electric motor driven devices associated with the additions to the Hiwassee River Wastewater Treatment Plant which require auxiliary power auxiliary power will be provided by a 60 KW engine generator set located adjacent to the proposed additional primary transformer. This proposed electrical power service arrangement provides for separate primary and auxiliary electric power services for each of the two $ICEAS_{TM}$ reactors.

Determination of which electric motor driven devices being added to the Hiwassee River Wastewater Treatment Plant require auxiliary power is based on guidance found in Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability - Technical Bulletin, PB-277 588 published by the United States Environmental Protection Agency for Reliability Classification III.

One-line diagrams indicating proposed modifications to the existing electrical system are depicted on Exhibit No. 10. One line diagrams indicating the proposed new electric service are depicted on Exhibit No. 11.

I. Site Development

The proposed site layout for the expanded Hiwassee River Wastewater Treatment Plant is depicted on Exhibit No. 8. Upon approval of this proposed layout by Cleveland Utilities management, a geotechnical investigation will be undertaken.

Prior to development of a final site plan and at the request of the Cleveland Utilities Water Department management, a landscape architect will be consulted and an estimated cost for landscaping the expanded Hiwassee River Wastewater Treatment Plant will be provided to Cleveland Utilities.

J. Support Buildings

1. Laboratory/Administration Building

The existing Laboratory/Administration Building will be expanded to add two new offices and a new office/cleaning supply storage room. Further discussion with Cleveland Utilities Wastewater Treatment Plant operators is necessary to develop the proposed additional floor plan.

2. Maintenance Building

No work is proposed at the existing Maintenance Building during the expansion of the Hiwassee River Wastewater Treatment Plant.

3. Blower Buildings

No work is proposed at the existing Blower Building during the expansion of the Hiwassee River Wastewater Treatment Plant.

A new Blower Building similar to the existing Blower Building will be constructed to house the blowers providing oxygen to the new $ICEAS_{TM}$ reactor, and controls and the motor control center related to the proposed $ICEAS_{TM}$ reactor as part of the expansion of the Hiwassee River Wastewater Treatment Plant.

4. <u>Chlorine Building</u>

No work is proposed at the existing Chlorine Building as part of the expansion of the Hiwassee River Wastewater Treatment Plant.

5. <u>Generator Building</u>

No work is proposed at the existing Generator Building.

K. Management of Oil and Grease Problem

An abnormally dense accumulation of oil and grease in the inlet flow distribution channels of the existing $ICEAS_{TM}$ reactor basins currently causes operation and maintenance problems. Discharge of the contents of grease traps from restaurants by septic tank haulers is the suspected source of this oil and grease.

After discussions with Cleveland Utilities managers concerning various alternatives to protect the Hiwassee River Wastewater Treatment Plant from the detrimental effects of the substantial oil and grease loads generated by the grease trap wastes, Cleveland Utilities has elected to institute a program to prohibit discharge of grease trap wastes at the Hiwassee River Wastewater Treatment Plant. As part of this program, Cleveland Utilities is assisting grease generators with locating alternative disposal methods.

L. Corrosion Problems

The existing Hiwassee River Wastewater Treatment Plant is located near a paper mill and a chlorine manufacturing facility. Both of these industries discharge acidic air emissions. Existing carbon steel supports, fasteners, and electrical enclosures at the Hiwassee River Wastewater Treatment Plant have experienced severe corrosion.

In order to prevent severe corrosion of these items in the expanded Hiwassee River Wastewater Treatment Plant, all steel supports, fasteners and electrical enclosures will be constructed of 304 or 316 stainless steel. Solder joints will not be allowed on any piping. All above ground electrical conduit shall be PVC coated.

PRELIMINARY PROJECT
COST ESTIMATE

JRWCO 3193
March 1995
Rev. Dec. 1995

Preliminary Project Cost Estimate
Hiwassee River Wastewater Treatment Plant Expansion
Cleveland Utilities
JRWCO 3193

Estimated Construction Cost

Item	Estimated Cost	Total Cost
Sitework/Structure Excavation	$307,304	
Demolition	30,562	
Grout Screw Pumps	30,000	
Dewatering	12,574	
Paving/Curbs/Walks	54,163	
Fence and Grassing	5,985	
Structure/Building Concrete	2,688,522	
Masonry	47,329	
Structural Steel/Miscellaneous Metals	223,275	
Rough Carpentry	8,370	
Roofing/Waterproofing/Caulking	45,084	
Doors/Frames/Hardware	27,013	
Painting	75,410	
Miscellaneous Specialties	1,927	
Process Equipment	2,623,194	
Instrumentation	329,085	
Yard Piping/Process Piping	1,710,702	
Plumbing/HVAC	32,000	
Electrical	750,000	
Permits/Gross Receipt Tax	29,901	
Subtotal		$9,032,400
Contingencies		900,000
TOTAL ESTIMATED CONSTRUCTION COST		**$9,932,400**

Estimated Development Costs

Engineering:

Preparation of Design Memorandum, Specifications, Construction Drawings and Contract Documents	$403,000	
Assistance with Bidding and Award of the Construction Contract	12,000	

Estimated Development Cost (Continued)

Item	Estimated Cost	Total Cost
General Engineering During Construction	110,000	
Resident Construction Observation	160,000	
		$685,000
Construction Manager's Fee		310,070
TOTAL ESTIMATED DEVELOPMENT COSTS		**$995,070**
TOTAL PRELIMINARY PROJECT BUDGET		**$10,927,470**
		SAY $11,000,000

Note:

The Estimated Construction Cost was developed by Brasfield & Gorrie General Contractor, Inc. as construction manager for the Hiwassee River Wastewater Treatment Plant Expansion project. The cost estimate includes the following exclusions.

1. Lab Testing
2. Engineer/Owner Trailer
3. Mass and/or Trench Rock Excavation
4. Stone for Wall Backfill
5. Elastomeric or Cement Based Waterproofing
6. Dampproofing or Water Repellant Coatings
7. Thoroseal Coatings
8. Cranes and Hoist
9. Owner's Protective Insurance
10. Flood Insurance
11. MBE/WBE Cost

APPENDIX A

ASSUMPTIONS USED IN AERATION SYSTEM LIFE CYCLE COST ANALYSIS

General Assumptions

1. Existing jet aeration system in existing $ICEAS_{TM}$ reactor is adequate for reuse in existing $ICEAS_{TM}$ reactor.

2. Existing jet aeration system will be replaced with coarse bubble aeration system or with perforated membrane aeration system if either of these alternatives are selected.

3. Existing blowers can be reused for existing jet aeration system in existing $ICEAS_{TM}$ reactor basins.

4. New blowers required for coarse bubble aeration system or for perforated membrane aeration system in existing $ICEAS_{TM}$ reactor will fit in existing Blower Building.

5. Existing air piping from existing Blower Building to existing $ICEAS_{TM}$ reactor is adequate for all aeration system alternatives in existing $ICEAS_{TM}$ reactor basins.

6. Air piping between new Blower Building and new $ICEAS_{TM}$ reactor basins will be same size, configuration and cost for all aeration system alternatives.

7. New Blower Building will be same size and cost for all aeration system alternatives.

8. Jet aeration system in new $ICEAS_{TM}$ reactor basins will utilize vertical, dry-pit type aeration pumps housed in reinforced concrete stations of same size as used at Union City Wastewater Treatment Plant (85 C.Y. concrete).

9. No special air filtration system is required for perforated membrane aeration system.

10. Dissolved oxygen monitoring system will be same for all aeration system alternatives.

11. Costs associated with electrical systems are identical for new blowers for all aeration system alternatives.

12. Labor costs associated with installing all aeration system alternatives are identical.

13. Life of all aeration system alternatives is 20 years.

14. Interest rate or "present worth" discount rate is 8%.

15. Current electric power cost is $0.048 per KWH. Cost will inflate at 0.5% per year.

16. Perforated membrane discs must be replaced every five years. Current replacement costs will be inflated at 3% per year.

17. "Summer" is defined as the period from May 1 through November 30 (213 Days). Winter is defined as the period from December 1 through April 30 (152 Days).

Assumptions for Oxygen Transfer Calculations

Actual Oxygen Required (Summer)	=	21,200 Lbs/Day
Actual Oxygen Required (Winter)	=	14,000 Lbs/Day
Diffuser Submergence	=	10.8 Feet
Process Elevation	=	707 Feet Above MSL
Air Temperature	=	100°F (Summer), 0°F (Winter)
Wastewater Temperature	=	24°C (Summer), 8°C (Winter)
Minimum Process Dissolved Oxygen Concentration	=	2.0 mg/l
Alpha	=	0.45 for Jet System
	=	0.55 for Coarse Bubble System
	=	0.36 for Perforated Membrane System
Beta	=	0.95
Submerged Oxygen Saturation Concentration	=	10.05 mg/l for Jet System
	=	9.85 mg/l for Coarse Bubble System
	=	10.25 mg/l for Perforated Membrane System
Standard Clean Water Oxygen Transfer Efficiency at 10 Feet Submergence	=	15% for Jet System
	=	7.5% for Coarse Bubble System
	=	20% for Perforated Membrane System @ 2 SCFM/Diffuser
Theta	=	1.024
Tau	=	0.93
Omega	=	0.97

Assumptions Specific to Jet System

Reuse existing jet aeration system; reuse existing aeration pumps; reuse existing blowers by throttling inlet; and add new jet aeration system to match existing for new ICEAS$_{TM}$ reactor including jet diffusers, blowers and aeration pumps but use vertically mounted, dry-pit type aeration pumps.

Construction Costs:

a.	New Jet Diffuser System for 4 New Basins (Match Existing)	=	$ 500,000
b.	New Vertically Mounted, Dry Pit Type Aeration Pumps For 4 New Basins (8 Pumps Required @ $50,000/Each)	=	$ 400,000
c.	Electrical Work for 8 New Aeration Pumps (10% of Pump Cost)	=	$ 40,000
d.	Pumping Station Structures for Dry Pit Type Aeration Pumps (4 Required)	=	$ 255,000
e.	Three New Centrifugal Blowers	=	$ 160,000
	Total Construction Cost	**=**	**$1,355,000**

First Year's Power Costs:

a. Two Existing Blowers Throttled for Summer Operation, Operating 213 Days at Summer BHP

$$(2) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{176 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$ \ 68,519/\text{First Year}$$

b. Two New Blowers Operating 213 Days at Summer BHP

$$(2) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{159 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$ \ 61,901/\text{First Year}$$

c. Two Existing Blowers Throttled for Winter Operation, Operating 152 Days at Winter BHP

$$(2) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{185 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 51,397/\text{First Year}$$

d. Two New Blowers Operating 152 Days at Winter BHP

$$(2) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{167 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 46,396/\text{First Year}$$

e. Four Existing Aeration Pumps Operating 365 Days

$$(4) \times (365 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{67 \text{ BHP} \times 0.7457}{0.90} \times (\$0.048/\text{KWH}) = \$\ 93,369/\text{First Year}$$

f. Four New Aeration Pumps Operating 365 Days

$$(4) \times (365 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{60 \text{ BHP} \times 0.7457}{0.90} \times (\$0.048/\text{KWH}) = \$\ 83,614/\text{First Year}$$

TOTAL FIRST YEAR'S POWER COST = $ 405,196

Assumptions Specific to Coarse Bubble Aeration System

Remove existing blowers and replace with three new blowers, remove existing jet aeration system and replace with coarse bubble aeration system, and add new coarse bubble system for new $ICEAS_{TM}$ reactor including blowers and diffusers.

Construction Costs:

a.	Remove Existing Blowers and Modify Blower Building Piping for New Blowers	= $ 4,500
b.	Remove Existing Jet Aeration System and Aeration Pumps	= $ 7,500
c.	Six New Blowers	= $390,000
d.	New Coarse Bubble Diffuser System for Eight (8) Basins	= $750,000
	TOTAL CONSTRUCTION COST	**= $1,152,000**

<u>First Year's Power Costs</u>:

a. Four New Blowers Operating
213 Days at Summer BHP

$$(4) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{269 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 209{,}450/\text{First Year}$$

b. Four New Blowers Operating
152 Days at Winter BHP

$$(4) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{276 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 153{,}356/\text{First Year}$$

TOTAL FIRST YEAR'S POWER COST = $ 362,806

Assumptions Specific to Perforated Membrane Aeration System

Remove existing blowers and replace with three new blowers, remove existing jet aeration system and replace with perforated membrane aeration system and add new perforated membrane aeration system for new ICEAS$_{TM}$ reactor including blowers and diffusers.

Construction Costs

a.	Remove Existing Jet Aeration System and Aeration Pumps	= $ 7,500
b.	Six New Blowers	= $ 300,000
c.	New Perforated Membrane Diffuser System for Eight (8) Basins	= $ 525,000
	TOTAL CONSTRUCTION COST	**= $ 832,500**

First Year's Power Costs:

a. Four New Blowers Operating
213 Days at Summer BHP

$$(4) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{159 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 123{,}801/\text{First Year}$$

b. Four New Blowers Operating
152 Days at Winter BHP

$$(4) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{166 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 92{,}236/\text{First Year}$$

TOTAL FIRST YEAR'S POWER COST = $ 216,037

Special Material Replacement Cost:

a. Replacement of All Perforated
Membrane Discs in Years 5, 10 and 15

19,760 Membrane Discs x $5.00/Disc = $ 98,800

**TOTAL MATERIAL REPLACEMENT COST
IN YEARS 5, 10 AND 15 = $ 98,800**

First Year's Power Costs:

a. Two Existing Blowers Throttled for Summer Operation, Operating 213 Days at Summer BHP

$$(2) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{196 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 76{,}305/\text{First Year}$$

b. Two New Blowers Operating 213 Days at Summer BHP

$$(2) \times (213 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{136 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 52{,}946/\text{First Year}$$

c. Two Existing Blowers Throttled for Winter Operation, Operating 152 Days at Winter BHP

$$(2) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{164 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 45{,}562/\text{First Year}$$

d. Two New Blowers Operating 152 Days at Winter BHP

$$(2) \times (152 \text{ Days}) \times (24 \text{ Hrs/Day}) \times \frac{138 \text{ BHP} \times 0.7457}{0.94} \times (\$0.048/\text{KWH}) = \$\ 38{,}339/\text{First Year}$$

TOTAL FIRST YEAR'S POWER COST = $ 213,152

Special Material Replacement Cost:

a. Replacement of All Perforated Membrane Discs in Years 5, 10 and 15

15,320 Membrane Discs x $5.00/Disc = $ 76,600

TOTAL MATERIAL REPLACEMENT COST IN YEARS 5, 10 AND 15 = $ 76,700

EXHIBITS

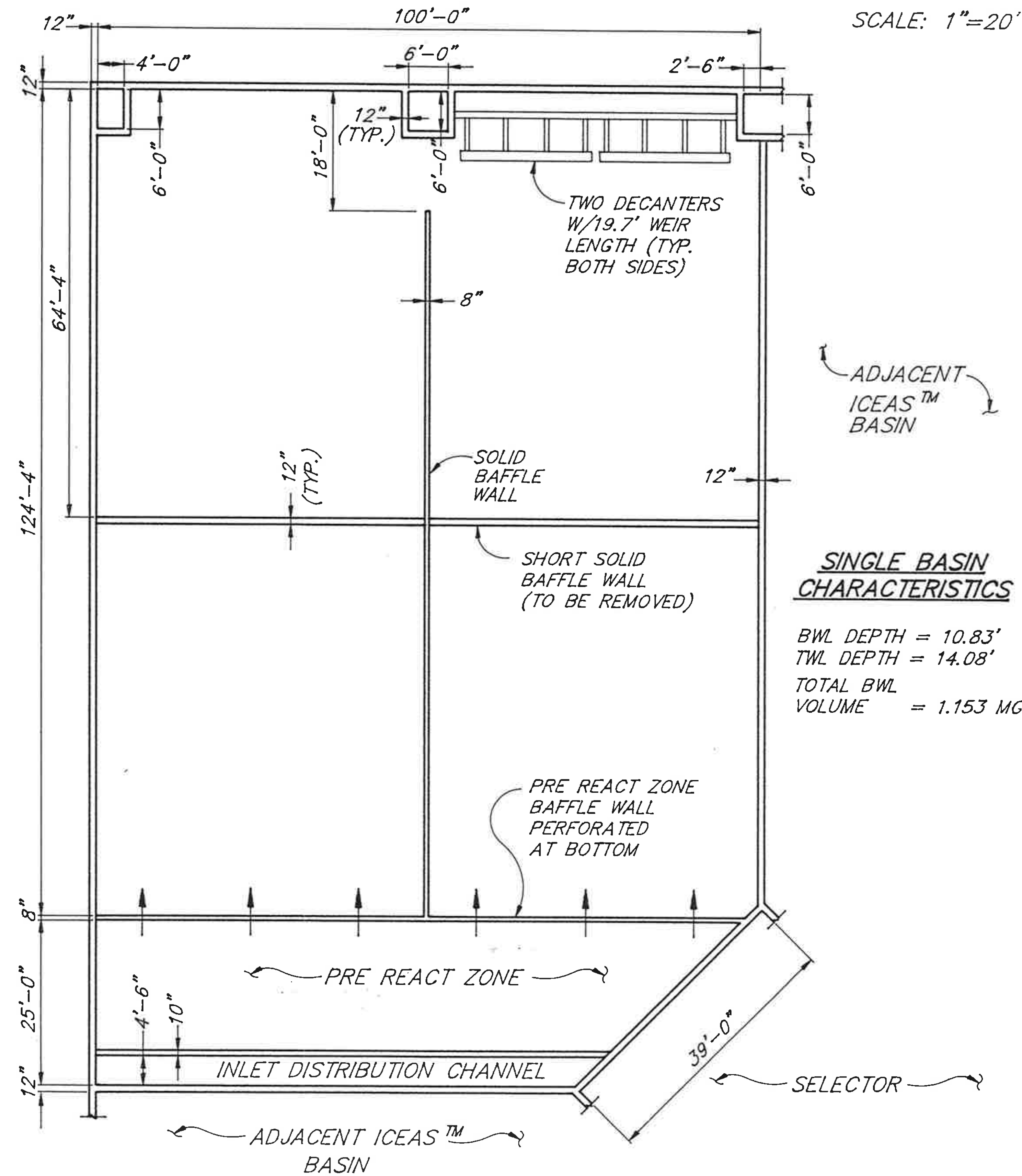

EXHIBIT NO. 1

EXISTING ICEAS™ REACTOR BASIN LAYOUT

(4 EXISTING)

DESIGN MEMORANDUM

HIWASSEE RIVER WASTEWATER TREATMENT PLANT EXPANSION

CLEVELAND UTILITIES

JRWCO 3193

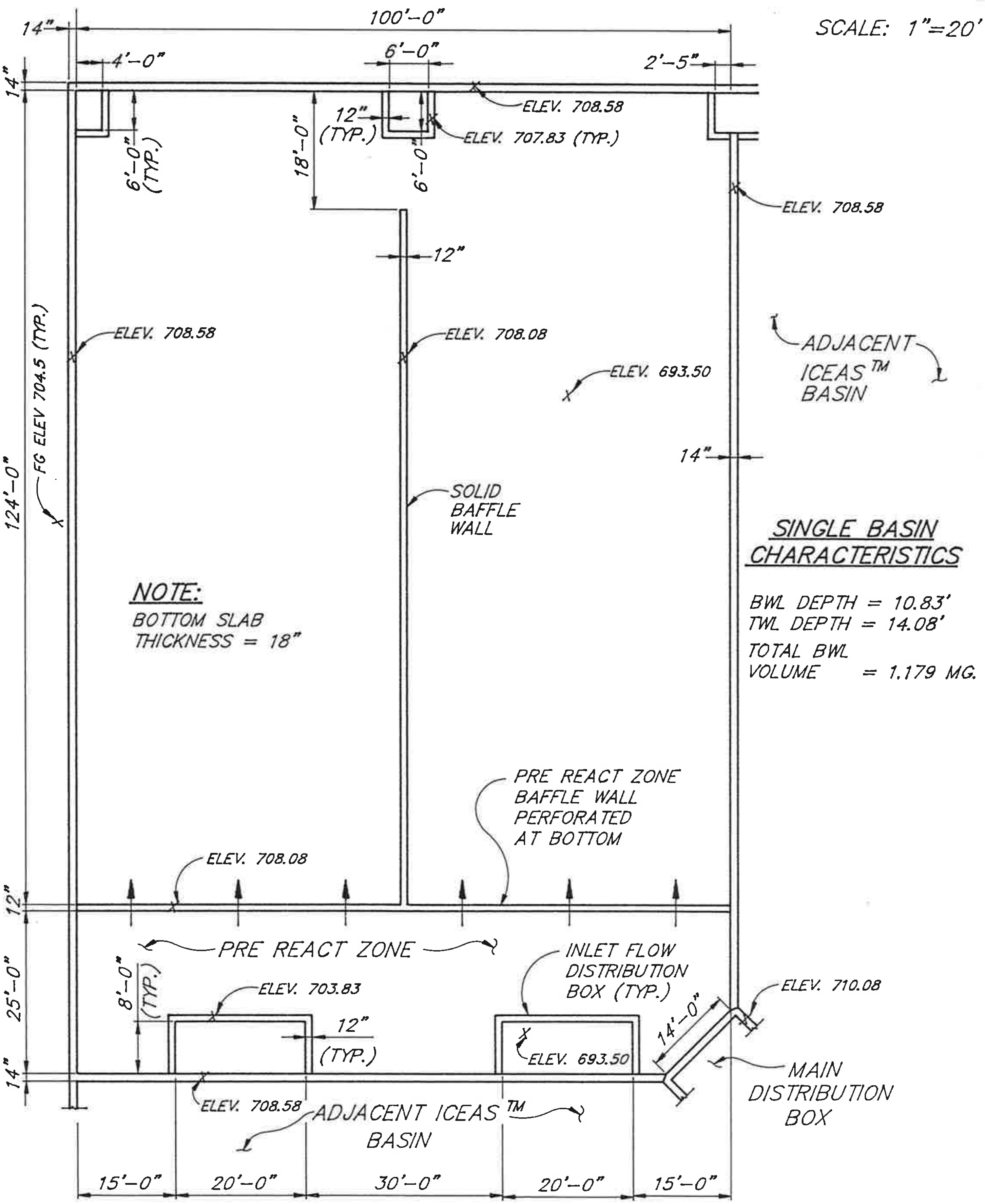

EXHIBIT NO. 2

PROPOSED ICEAS™ REACTOR BASIN LAYOUT

(4 PROPOSED)

DESIGN MEMORANDUM

HIWASSEE RIVER WASTEWATER TREATMENT PLANT EXPANSION

CLEVELAND UTILITIES

REV. 4-28-95

JRWCO 3193