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Handbook

Identification and Correction of Typical Design Deficiencies at Municipal Wastewater Treatment Facilities

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HANDBOOK FOR

IDENTIFICATION AND CORRECTION OF TYPICAL DESIGN DEFICIENCIES AT MUNICIPAL WASTEWATER TREATMENT FACILITIES

U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Research and Development
Municipal Environmental Research Laboratory
Cincinnati, Ohio 45268

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communications link between the researcher and the user community.

Since the passage of PL 92-500, the Construction Grants Program has spent several billion dollars in government funds for the design and construction of publicly-owned treatment works (POTWs). As these facilities became operational, it soon was apparent that 40 to 60 percent of all municipal facilities were not meeting the effluent quality for which they were designed.

The Municipal Environmental Research Laboratory Plant Operation and Design Program funded a 3 1/2-year national survey of the factors limiting the performance of POTWs. The survey found that no one factor was limiting the performance at the 103 facilities surveyed, but that an interrelated unique combination of design, O&M, and management deficiencies was involved at each facility. A major conclusion of this survey was that errors in design were severely limiting the operator's ability to achieve maximum performance from the facility.

This handbook represents an effort directed by the Plant Operation and Design Program to identify and suggest corrections for design deficiencies typically found in municipal wastewater treatment facilities. The listing of deficiencies was prepared from discussions with various engineers familiar with design and operation of municipal wastewater treatment facilities. The deficiency listing does not represent all possible design deficiencies, but represents the input from a number of engineers who have observed that these deficiencies hinder operation and/or limit process performance.

Design considerations are presented to prevent the occurrence of the design deficiencies in new facilities. Where feasible, procedures for correcting deficiencies at existing facilities are presented. In development of this document, it became apparent that design deficiencies are best eliminated during the original design of the facility. Correction of design deficiencies at existing facilities is not always cost effective.

Francis T. Mayo
Director
Municipal Environmental Research Laboratory

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CONTENTS

	Page
Foreword	iii
Acknowledgments	v
INTRODUCTION	1
USER GUIDE	2
Report Format	2
Design Deficiencies Matrix	2
Design Consideration Modules for POTWs	3
Procedures for Using Document	4
DESIGN DEFICIENCIES MATRIX	7
1.0 General Plant Design	8
2.0 Preliminary Treatment	19
3.0 Primary Treatment	23
4.0 Air Activated Sludge	25
5.0 Oxygen Activated Sludge	30
6.0 Trickling Filter	31
7.0 Disinfection	33
8.0 Anaerobic Digestion	35
9.0 Aerobic Digestion	37
10.0 Sludge Dewatering	39
11.0 Lagoons	43
12.0 Land Application	45
13.0 Sludge Disposal	48
14.0 Sludge Reduction	50
15.0 Rotating Biological Contactors	53
DESIGN CONSIDERATIONS	54
1.0 General Plant Design	55
1.1 General	55
1.2 Preliminary	103
1.3 Primary	111
1.4 Secondary Treatment	116
1.5 Sludge Handling	125

CONTENTS
(continued)

		Page
	1.6 Sludge Digestion	132
	1.7 Sludge Dewatering	136
	1.8 Sludge Incineration	142
	1.9 Sludge Disposal	144
	1.10 Disinfection	146
	1.11 Lagoons	150
	1.12 Land Application	152
	1.13 Small Package Plants	156
	1.14 Energy Conservation	168
	1.15 Laboratory	169
	1.16 Chemical Handling	172
	1.17 Control Building	175
	1.18 Site Selection	177
2.0	Preliminary Treatment	178
	2.1 Manual Bar Screens	178
	2.2 Mechanical Bar Screens	182
	2.3 Comminutor	183
	2.4 Barminutor	187
	2.5 Macerator	191
	2.6 Manually Cleaned Grit Chambers	193
	2.7 Mechanically Cleaned Grit Chambers	197
	2.8 Aerated Grit Chambers	198
	2.9 Degritter	199
	2.10 Grit Pumps	200
	2.11 Influent Flow Measurement	200
	2.12 Raw Waste Pumping	203
	2.13 In-Line Flow Equalization	207
	2.14 Side-Line Flow Equalization	208
	2.15 General	209
3.0	Primary Treatment	211
	3.1 General	211
	3.2 Primary Clarifier	212
	3.3 Primary Sludge Removal	215
	3.4 Primary Sludge Pumps	219
	3.5 Scum Removal	220
4.0	Air Activated Sludge	222
	4.1 Aeration Basin	222
	4.2 Diffusers	235

CONTENTS
(continued)

		Page
	4.3 Fixed Mechanical Aerators	237
	4.4 Floating Aerators	240
	4.5 Blowers	242
	4.6 Air Distribution System	243
	4.7 D.O. Control and Measurement	244
	4.8 Return Sludge Pumping	246
	4.9 Waste Sludge Pumping	250
	4.10 Secondary Clarification	252
	4.11 Oxidation Ditch	260
5.0	Oxygen Activated Sludge	264
	5.1 Aeration Basin	264
	5.2 Air Compressors	265
	5.3 D.O. Measurement	265
	5.4 D.O. Control	268
	5.5 Pressure Swing Adsorption	268
	5.6 Oxygen Gas Flow Control	269
	5.7 Influent Flow Control	269
	5.8 Sampling and Monitoring	269
6.0	Trickling Filter	270
	6.1 Trickling Filter	270
	6.2 Rock Media	274
	6.3 Plastic Media	275
	6.4 Flow Splitting to Filters	276
	6.5 Distribution of Media	276
	6.6 Flow Recirculation	277
	6.7 Secondary Clarifier	279
	6.8 Sludge Pumping	280
7.0	Disinfection	281
	7.1 General	281
	7.2 Chlorine Contact Chamber	283
	7.3 Chlorinator	286
	7.4 Chlorine Control	288
	7.5 Dechlorinator	288
	7.6 Ozone Contact Vessel	289
	7.7 Ozone Generator	289
	7.8 Ozone Controller	290
	7.9 Safety	290

CONTENTS
(continued)

	Page
8.0 Anaerobic Digestion	292
8.1 General	292
8.2 Single-Stage Digester	294
8.3 Two-Stage Digester	295
8.4 Gas Collection	296
8.5 Gas Measurement	297
8.6 Supernatant Withdrawal	297
8.7 Supernatant Disposal	298
8.8 Heating	298
8.9 Maintenance	299
8.10 Safety	299
8.11 Sludge Withdrawal	300
8.12 Sludge Recirculation	301
8.13 Sludge Feed	301
9.0 Aerobic Digestion	303
9.1 General	303
9.2 Aerobic Digester	306
9.3 Decanting	307
9.4 Clarification	308
9.5 Diffused Aeration	309
9.6 Mechanical Aeration	310
9.7 Sludge Removal	310
10.0 Sludge Dewatering	311
10.1 General	311
10.2 Gravity Thickeners	320
10.3 DAF Thickeners	322
10.4 Vacuum Filters	324
10.5 Centrifuges	330
10.6 Filter Presses	332
10.7 Belt Filters	335
10.8 Sludge Drying Beds	338
10.9 Sludge Transfer	341
10.10 Sludge Conditioning	343
11.0 Lagoons	345
11.1 Facultative Ponds	345
11.2 Aerated Ponds	347
11.3 Aerobic Ponds	349
11.4 Polishing Ponds	350

CONTENTS
(continued)

		Page
	11.5 Anaerobic Ponds	351
	11.6 Baffles	352
	11.7 Recirculation Pumps	353
	11.8 Pond Configuration	353
	11.9 Aerators	354
	11.10 Dikes	355
	11.11 Primary Cell	356
	11.12 General	356
12.0	Land Application	358
	12.1 Overland Flow Slope Design	358
	12.2 Buffer Zone	359
	12.3 Cover Crop	360
	12.4 Hydraulic Acceptance	361
	12.5 Pretreatment	362
	12.6 Storage	365
	12.7 Crop Harvest	367
	12.8 Surface Drainage	368
	12.9 Soil Depth	369
	12.10 Infiltration Beds	370
	12.11 Subsurface Drainage	371
	12.12 Odor Control	372
	12.13 Center Pivot Sprinkler	373
	12.14 Traveling Gun Sprinkler	375
	12.15 Single Set Sprinkler	377
	12.16 Lineal Travel Sprinkler	378
	12.17 Grated Pipe Distribution	380
	12.18 Ridge and Furrow	381
	12.19 Spreading Basins	381
13.0	Sludge Disposal	382
	13.1 General	382
	13.2 Landfill	385
	13.3 Spraying	388
	13.4 Planning	389
14.0	Sludge Reduction	391
	14.1 General	391
	14.2 Multiple Hearth Incineration	395
	14.3 Heat Treatment	399
	14.4 Fluidized Bed	401

CONTENTS
(continued)

		Page
14.5	Flash Drying	404
14.6	Composting	406
14.7	Atomized Spray	407
14.8	Co-Incineration	408
15.0	Rotating Biological Contactors	412
15.1	General	412
15.2	RBC	414
15.3	Secondary Clarification	416

INTRODUCTION

This handbook has been prepared for use by engineers involved in the design and review of designs for POTWs. Its intent is to identify design deficiencies found to limit the performance of POTWs. Design considerations have been developed that will eliminate these deficiencies during the design phases of the project. The document will prove useful to personnel involved in the operation and maintenance of POTWs since procedures are presented, where feasible, for correction of design deficiencies at existing facilities. Use of the handbook will assure that the design incorporates a maximum number of operational conveniences.

Typical design deficiencies found in POTWs are identified and associated methods to correct each of the deficiencies noted are presented. The information is not intended for use as a troubleshooting guide for process-oriented operational problems. Reference should be made to other documents for assistance concerning operational problems.

This handbook describes design deficiencies that contribute to performance and reliability problems, poor safety practices, and/or decreased flexibility of plant process control. The result of such deficiencies may be any combination of increased plant operations and maintenance, cost, and energy requirements. The handbook is intended to provide design engineers with guidance that will make their designs more operable and maintainable at less cost, as well as more flexible in providing adequate performance during times of changing influent characteristics.

USER GUIDE

The organization and format of this handbook have been designed to facilitate the location of information concerning typical design deficiencies found in various wastewater treatment systems and, more specifically, individual unit operations, and to reference the deficiencies noted with related solutions. The document is divided into two main sections:

- Design Deficiencies Matrix.
- Design Consideration and Correction Modules for POTWs.

REPORT FORMAT

Design Deficiencies Matrix

Design deficiencies commonly found in the POTWs are categorized in a matrix format. The 15 categories utilized are listed below:

Number	Category
1.0	General Plant Design
2.0	Preliminary Treatment
3.0	Primary Treatment
4.0	Air Activated Sludge
5.0	Oxygen Activated Sludge
6.0	Trickling Filter
7.0	Disinfection
8.0	Anaerobic Digestion
9.0	Aerobic Digestion
10.0	Sludge Dewatering
11.0	Lagoons
12.0	Land Application
13.0	Sludge Disposal
14.0	Sludge Reduction
15.0	Rotating Biological Contactors

The deficiencies within each category are further grouped according to type and then numerically referenced to unit operations and components specific to the category. The deficiency groups used include:

- Layout, Arrangement, and Placement of Components in Design of Plant.

- Hydraulic Design Considerations.

- Mechanical Design Considerations.

- Electrical/Instrumentation Design Considerations.

- Safety Considerations.

- Environmental Considerations.

Design Consideration Modules for POTWs

The design deficiencies listed in the matrix are discussed in "Design Consideration Modules" in terms of items that should be reviewed by the engineer during design of a new or expansion of an existing wastewater treatment plant. Features of the module format are as follows:

- The design consideration category and applicable unit operation or component are indicated in the upper left-hand corner.

- A treatment plant block flow diagram is presented in the upper right-hand corner for each category. The deficiency category represented by the module is shaded to allow the reader to visually identify the portion of the plant discussed.

- The design deficiencies, including reference number and description, are presented in a column on the left side of the page. The associated design considerations are discussed in a column opposite the deficiency.

- The reference numbers for the deficiencies discussed in each module are summarized at the bottom of the page. This facilitates locating specific deficiencies when referring to the modules.

- The modules are sequentially numbered for cross-referencing with the Design Considerations table of contents on page 54.

Suggested methods to correct the design deficiencies, when already present at an existing wastewater treatment facility, are presented in the document. The correction procedure, where applicable, may include the following items:

- Method.
- Materials.
- Cost.
- Sketch.

PROCEDURES FOR USING DOCUMENT

The format of the document allows the reader the flexibility to obtain information either through the deficiency matrix or the design consideration/correction modules. A POTW operator experiencing a specific problem at his plant should first refer to the deficiency matrix in order to identify the appropriate module(s) that describes methods that can be used to correct the problem. On the other hand, an engineer may wish to proceed directly to the design consideration modules in order to identify those items he should review during design of a specific unit operation or component.

The correct procedure for using the design deficiency matrix is as follows:

1. Select the appropriate design considerations category (i.e., preliminary, primary, activated sludge, etc.) and refer to that section of the matrix at the top of the page.

2. Determine which general deficiency group (i.e., mechanical, hydraulic, safety, etc.) the problem falls under and turn to that portion of the matrix on the left hand side of the page.

3. Identify the applicable unit operation or component under the design considerations category and move down that column until the desired deficiency within that deficiency group is located. (NOTE: If the deficiency is not listed for the applicable unit operation or component, refer to the remainder of the deficiencies within the deficiency group and determine if it is listed under another unit operation.)

4. Use the three digit deficiency reference number to identify the related deficiency/correction module as follows:

   1st Digit -- Category number

   2nd Digit -- Unit operation/component number (i.e., column number)

   3rd Digit -- Deficiency number

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY
Layout, Arrangement, and Placement of Components in Design of Plant	Lack of hoists over larger pieces of equipment.	1						1								
	Lack of spare pumps.	2	1											1		
	Lack of walkways around tanks, limiting operator access.	3			1									2		
	Tall above-ground tanks frequently require operator to climb long stairways.	4												3		
	No provisions for moving equipment and supplies from one building floor to another.	5				1		2								
	Use of a room as a BOD incubator is inconvenient because in-and-out traffic makes it difficult to maintain proper temperature.														1	1
	Lab building air vents are located too close to air conditioning air intakes.															2
	Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	6													2	3

Deficiency Reference Number is: 1.1.4

5. Turn to the digit deficiency reference number identified above by noting the reference numbers at the bottom of the Design Considerations section pages (just on top of the page numbers).

6. Read down the left-hand column to the applicable deficiency reference number.

7. The suggested correction method is described in the opposite right-hand column.

8. Related considerations aimed toward preventing the deficiencies during design are also discussed in the opposite right-hand column.

DESIGN DEFICIENCIES MATRIX

Category		Page
1.0	General Plant Design	8
2.0	Preliminary Treatment	19
3.0	Primary Treatment	23
4.0	Air Activated Sludge	25
5.0	Oxygen Activated Sludge	30
6.0	Trickling Filter	31
7.0	Disinfection	33
8.0	Anaerobic Digestion	35
9.0	Aerobic Digestion	37
10.0	Sludge Dewatering	39
11.0	Lagoons	43
12.0	Land Application	45
13.0	Sludge Disposal	48
14.0	Sludge Reduction	50
15.0	Rotating Biological Contactors	53

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15*	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Layout, Arrangement, and Placement of Components in Design of Plant	Lack of hoists over larger pieces of equipment.	1						1											
	Lack of spare pumps.	2	1											1					
	Lack of walkways around tanks, limiting operator access.	3			1									2					
	Tall above-ground tanks frequently require operator to climb long stairways.	4												3					
	No provisions for moving equipment and supplies from one building floor to another.	5				1		2									1	1	
	Use of a room as a BOD incubator is inconvenient because in-and-out traffic makes it difficult to maintain proper temperature.														1	1			
	Lab building air vents are located too close to air conditioning air intakes.															2		2	
	Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	6													2	3		3	
	Lack of vents in laboratory sink drain lines.															4		4	
	Hoods not provided in labs.															5		5	
	Inadequate flexibility to bypass units.	7												4					
	Inadequate consideration of means to remove equipment for repair or replacement.	8												5					
	Inadequate consideration of scum removal from plant.		2	1	2	2	1							6					
	Inadequate valving for maximum flexibility and proper maintenance.	9									1	1	1	7					
	Inadequate consideration of consequences of rupture disc or shear pin failures.	10			4	3								8					

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Layout, Arrangement, and Placement of Components in Design of Plant	Relative layout of process units and interconnecting *piping not optimized.*	11																	
	Excessive length of chemical feed lines, particularly lime slurry recirculation loops.	12															-		
	Inadequate consideration of the impact of major industrial users.	13																	
	Inadequate communication capabilities between buildings and process areas.	14																6	
	Inadequate laboratory facilities for process control.													9		6		7	
	Insufficient color coding of pipes and valves.	15																	
	Inadequate stand-by equipment.	16												10					
	Lack of sampling taps at pumping stations.	17				4													
	Inadequate process flexibility.	18	3	2	4	5	2	3	1	1	2	2	2						
	Lack of all-weather roads to pump stations.	19	4																1
	Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	20	5	3	5	6	3	4	2	2	3		3						
	Layout of unit processes does not allow for future expansion of plant.	21																	
	Use of covered basins inhibit access to and observation of unit processes.	22		4	6														
	All valves not operable from floor level.	23	6	5	7	7	4	5	3				4						
	Inadequate clearance around equipment for maintenance functions.	24	7	6	8	8	5	6	4		4		5						
	Inadequate view of unit processes from control building.	25																8	

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Layout, Arrangement, and Placement of Components in Design of Plant	Inadequate provisions for draining tanks and sumps.	26	8	7	9	9	6	7			5		6	11			3		
	Inadequate provisions for sampling of individual processes.	27	9	8	10	10	7	8	5		6		7	12					
	Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	28	10	9	11	11	8	9	6	3	7	3	8	13					
	Inadequate scum handling and disposal system.	29	11	10	12		9				8			14					
	Foam sprays not concentrated in basin corners where foam build-up occurs.	30			13		10							15					
	Control panels not easily accessible (i.e., too high off ground or placed in close quarters).	31																9	
Hydraulic Design Considerations	No provision for water tap at top of above-ground package units.	32												16					
	Lack of flexibility to operate POTW at low flow start-up conditions.	33	12	11	14	12		10											
	Floor drain piping system undersized.	34				13	11	11										10	
	Drains from buildings discharge into basins with normally (or periodically) high-water levels, causing drains to back-up.	35						12										11	
	Inadequate number of flow meters throughout the plant.	36																	
	Inadequate consideration of groundwater movement into POTW site through sewer trenches.	37												17					

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION						
Hydraulic Design Considerations	Inadequate consideration of hydraulics during design of a venturi flow meter, resulting in a negative pressure occurring in the meter throat.	38																							
	Inadequate consideration of pumping system design and/or fluid characteristics, resulting in pump cavitation.	39	13																						
	Inadequate location of thrust blocks on pipe lines, particularly where couplings are involved or where automatic valves are located.	40																							
	Use of single-speed pumps where variable-speed units are required.	41	14			14								16											
	Poor hydraulic and solids distribution among identical units operating in parallel.			12	15	15	12	13																	
	POTW design based on average flow and BOD and SS loadings with no recognition of peak conditions.	42																							
	Undersized scum pits.	43	15	13	16	16	13	14																	
	No provisions made to allow periodic cleaning of the influent wet well.		16											19											
	Use of city water rather than plant effluent for use as POTW utility water.	44												20											
	Individual flow measurement not provided for each piece of parallel units.	45		14	17		14	15				4	9												
	Inadequate consideration of possible development of septic conditions in channels and splitter boxes.		17	15	[illegible]	17	15	16			9	5	10	21											
	Lack of floor trenches around pumps to carry water spills to sumps.	46	18			[illegible]											4								
	Insufficient or inflexible sludge return and/or wasting pumping capacity.			16	19	19																			

DEFICIENCY GROUP	DEFICIENCY	1 GENERAL	2 PRELIMINARY	3 PRIMARY	4 SECONDARY	5 SLUDGE HANDLING	6 SLUDGE DIGESTION	7 SLUDGE DEWATERING	8 SLUDGE INCINERATION	9 SLUDGE DISPOSAL	10 DISINFECTION	11 LAGOONS	12 LAND APPLICATION	13 SMALL PACKAGE PLANTS	14 ENERGY CONSERVATION	15 LABORATORY	16 CHEMICAL HANDLING	17 CONTROL BUILDING	18 SITE SELECTION
		1.0 - GENERAL PLANT DESIGN																	
Hydraulic Design Considerations	*Change in baseline conditions at a POTW* between time of design and construction.	47												22					
	Lack of flow metering device on chemical feed lines.	48		17	20	20		17									5		
	Chemical feed line is connected to more than one basin at different elevations, causing line to drain rapidly into lower basin and requiring time to fill header before the higher basin can be fed.	49															6		
Mechanical Design Considerations	Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkways to tilt and mechanical equipment to move out of alignment.	50		18	21	21		18											
	No convenient means provided to feed dry chemicals into top-loading feeders.	51			22	22	16										7		
	Lack of drains on chemical mix tanks.	52			23	23	17										8		
	Laboratory vacuum system has insufficient capacity.															7			
	Lack of seal water drippage drain lines.	53	19			24													
	Excessive grouting cracks.	54																	
	Samplers frequently clog.	55												23					
	Pumps are located above the normal water level, making them difficult to prime.	56	20		24									24					
	Pressure gauges not located on inlet side of *back pressure relief valves, making it* difficult to check and/or adjust the valve.	57															9		
	Chemical feed pumps are too small to allow high dosages of chemicals during emergencies.	58			25	25		19									10		

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Mechanical Design Considerations	No ladders provided in manholes.	59																	
	Lack of air bleed-off valves at high points in pump discharge lines.	60	21	19	26	26	18												
	Lack of *mud* valves *in* tanks.	61	22	20	27		19							25					
	Lack of water supply near field samplers.	62												26					
	Lack of locally-mounted gauges on field instrumentation.	63																	
	Lack of by-passes around solenoid valves.	64																	
	Lack of sumps in dry wells.	65	23											27					
	Lack of driers on *instrument air lines*.	66																	
	Lead-sealed caps on cleanouts in pressure lines periodically blow off.	67																	
	Improper water pressure is supplied to rotameters, causing them to burst.	68															11		
	Inadequate provisions for pressure relief around positive-displacement pumps.	69																	
	Lack of pressure gauges on plant pumps.	70																	
	No mixing provided in scum tank to keep scum mixed during pumping.			21	28			20						23					
	Excess oil from stationary units not contained.	71	24	22	29	27	20	21	7										
	Use of single-pane glass windows.														3	8		12	
	Lack of influent composite sampler.	72	25																
	No positive method of removing scum from center *well of clarifiers*.			23	30			22						29					

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Mechanical Design Considerations	Inadequate consideration of the type of valve or gate used.	73																	
	Design does not emphasize heating energy conservation methods.	74					21								4	9		13	
	Inadequate provisions for manual valve operation during emergency conditions.	75										6							
	Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	76		24	31	23	22							30					
	Lack of flexibility in disinfection systems to permit prechlorination for odor control or return sludge chlorination for control of bulking.		20		32						10			31					
	Lack of wyes, tees, and crosses to facilitate cleaning chemical lines.	77			33			23									12		
	Lack of cathodic protection for steel tanks.	78																	
	Lack of a foam control system.	79			34		23							32					
Electrical/Instrumentation Design Considerations	Absence of electrical outlets on top of treatment units.	80		25	35			24						33					
	Electrical cable trenches have no provisions for drainage.	81																	
	Lab electrical circuits on same circuits as POTW equipment, causing interferences with lab instrumentation.	82														10		14	
	Lack of electrical outlets at field-mounted instrumentation for portable calibration equipment.	83			36														
	Lack of both 110 v and 220 v electrical service in labs.															11		15	

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Electrical/Instrumentation Design Considerations	Drains in electrical manholes are not provided with backflow valves to prevent flooding from plant drain system.	84																	
	Inadequate wiring, schematic, and logic diagrams including terminal and wire numbering in field and on drawings; no standard adhered to.	85																	
	Improper selection of type of timer relays, making fine adjustments difficult.	86																	
	Electrical design does not have a power factor correction.	87																	
	Infrequent use of high efficiency lighting sources.	88																	
	Standby generator undersized to run all essential equipment.	89																	
	Use of open fluorescent lighting in humid areas of POTW.	90						25											
	Placement of motor control centers too close to washdown areas.	91						26						34			13	16	
	Inadequate electrical capacity to permit standby pumps and air blowers to operate in parallel.	92	27	26	37	29	24	27						35					
	Lack of ventilation promotes corrosion of electrical components.	93	28					28	[illegible]		11						14	17	
	High water alarm systems not provided.		29	27	38		25							36			15		
	Electrical control panels located below ground where exposed to flooding.	94												37					2
	Lack of auxiliary power.	95												38					
	Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	96	30	28	39	30	26	29							5				

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	*15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Electrical/Instrumentation Design Considerations	Insufficient use of high-efficiency motors.	97													6				
	Electrical quick-disconnect plugs not provided with submerged pumps to facilitate rapid replacement.	98	31											39					
Safety Considerations	Inadequate plant lighting.	99	32	29	40									40					
	Stairways without non-skid surfaces.	100												41					
	Inadequate handrailing and kick plates.	101												42					
	Inadequate fencing around site.	102												43					
	Use of air headers as guard railing at small package-plant type POTW's.	103			41									44					
	Stairs inclined at too steep an angle.	104												45					
	Guard railing not provided around ground-level tanks.	105												46					
	Guard railing kick-plates bow with change in ambient temperature.	106																	
	Stairways provided with only one handrail.	107												47					
	Valve handles located in unsafe areas.	108																	
	Inadequate consideration of state and OSHA ventilation requirements in confined spaces.	109																	
	Inadequate consideration of noise control.	110												48					
	Inadequate separate access to the influent wet well, screening or comminutor room, and chlorine room.	111																	
	Dangerous chemicals not stored in separate areas.	112												49			16		

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	13
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Safety Considerations	Inadequate security provisions.	113												50					
	Inadequate provisions for vehicle and associated equipment protection.	114																	
	Handrails and grating not secure.	115																	
	Stairs not painted bright colors.	116																	
	Wet floors in some areas (pump rooms and pipe gallerys) are slippery.	117																	
	Electric power cut-off switches not locally mounted at individual pieces of equipment.	118																	
	Ladders in manholes and concrete tanks not secure.	119																	
	Hazardous areas not well defined.	120																	
	Handling facilities not provided for mechanical components over 100 pounds.	121	33	30	42	31	27	30	9				11	51				18	
	Inadequate consideration of OSHA safety requirements.	122	34	31	43	32	28	31	10	4	12	7	12	52					
	Permanent access platforms required for maintenance not provided.	123																	
	Inadequate noise abatement in various plant areas (i.e., blower, pump, and dewatering rooms, etc.).	124			44	33		32											
	Plant located in a flood plain.	125																	3
	Inadequate buffer zone to alleviate problems due to noise, odor, aerosol, fog, etc.	126																	4
	Inadequate consideration of any potential *freezing problems of plant components.*	127	35	32	45			33		5	13		13	53					5
	Inadequate consideration of odor development and control.	128																	6

DEFICIENCY GROUP	DEFICIENCY	1.0 - GENERAL PLANT DESIGN																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		GENERAL	PRELIMINARY	PRIMARY	SECONDARY	SLUDGE HANDLING	SLUDGE DIGESTION	SLUDGE DEWATERING	SLUDGE INCINERATION	SLUDGE DISPOSAL	DISINFECTION	LAGOONS	LAND APPLICATION	SMALL PACKAGE PLANTS	ENERGY CONSERVATION	LABORATORY	CHEMICAL HANDLING	CONTROL BUILDING	SITE SELECTION
Safety Considerations	Interior building surfaces not painted with bright, easily-cleaned paints.	129																	
	Accumulation of rags and debris around plant site due to inadequate disposal facilities	130																	
	Inadequate consideration of local weather conditions and their impact on the accessibility of a plant site.	131								6			14						7
	Inadequate consideration of spill prevention plan.	132												54			17		

DEFICIENCY GROUP	DEFICIENCY	2.0 - PRELIMINARY TREATMENT														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		MANUAL BAR SCREENS	MECHANICAL BAR SCREENS	COMMINUTOR	BARMINUTOR	MACERATOR	MANUAL CLEANED GRIT CHAMBER	MEC. CLEAN GRIT CHAMBER	AERATED GRIT CHAMBER	DEGRITTER	GRIT PUMPS	INFLUENT FLOW MEASUREMENT	RAW WASTE PUMPING	INLINE FLOW EQUALIZATION	SIDELINE FLOW EQUALIZATION	GENERAL
Layout, Arrangement, and Placement of Components in Design Plant	Inadequate selection of the number, size, and type of pumps.												1			
	Lack of additional coarse screen for combined sewers.	1	1													
	Lack of provision to remove floating material.	2	2													
	Surface floating aerators do not allow basin to be dewatered.													1	1	
	Inadequate or lack of facilities to flush solids and grease accumulations from the basin walls.													2	2	
	Lack of facilities for withdrawing floating material and foam.													3	3	
	Inadequate provision for removing scum from wet well.												2			
	No provisions for odor control in wet well.												3			
	Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	3	3	1	1	1	1	1	1	1	1		4			
	No provisions to periodically clean the wet well.												5			
	Comminutors not located downstream of grit removal equipment resulting in excessive wear.			2			2	2	2	2						
	Inadequate consideration of proper disposal of coarse screenings and grit.	4	4				3	3	3	3						
	No bar screens provided for protection of mechanical components.			3	2	2							6			
	Improper spacing of bars on bar screens.	5	5													
	No provision for by-passing flow during maintenance.	6	6	4	3	3	4	4	4	4						

DEFICIENCY GROUP	DEFICIENCY	2.0 - PRELIMINARY TREATMENT														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		MANUAL BAR SCREENS	MECHANICAL BAR SCREENS	COMMINUTOR	BARMINUTOR	MACERATOR	MANUAL CLEAN GRIT CHAMBER	MEC. CLEAN GRIT CHAMBER	AERATED GRIT CHAMBER	DEGRITTER	GRIT PUMPS	INFLUENT FLOW MEASUREMENT	RAW WASTE PUMPING	INLINE FLOW EQUALIZATION	SIDELINE FLOW EQUALIZATION	GENERAL
Layout, Arrangement, and Placement of Components in Design Plant	No rock traps provided.			5	4	4										
	No access to raw wastewater flow for sampling before sidestream addition occurs.															1
	Inadequate consideration of needs for odor control.															2
	Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.						5	5	5	5	2					
	Inadequate velocity through process due to poor flow control.						6	6								
	Inadequate design of pumping station, resulting in frequent cycling of units causing flow surges in downstream processes.												7			
	Measurement control section not compatible with flow measurement device.											1				
	Inadequate design of downstream channel slope and geometry causes back-up in control section.											2				
	Inadequate design of obstructions downstream of control section induces inaccuracies in flow measurement.			6	5	5						3				
	Inadequate design permits grit deposits in control section of flow measurement device.			7	6	6										
	Inadequate consideration of debris in wastewater in selection of float for flow measurement.											4				
Hydraulic Design Considerations	Lack of emergency overflow.												8	4	4	
	Improper velocity in bar screen chamber leading to grit deposition.	7	7													
	Improper flow-through velocity in grit chamber.						7	7	6							
	Difficulty in handling high peak flows.															3
	Short-circuiting in grit chamber.						8	8	7							
	Improperly sized wet wells resulting in long detention times and odor problems, or too short detention time and cycling of pumps.												9			
	Flow meters located such that backwater elevation changes, due to clogging of bar screen, affect accuracy of meter.											5				
	Inadequate consideration of diurnal flow patterns in sizing of flow measurement equipment results in measurement equipment being inaccurate at the high and/or low flow ranges.											6				
	Inadequate approach channel length results in flow measurement inaccuracies.											7				

DEFICIENCY GROUP	DEFICIENCY	2.0 - PRELIMINARY TREATMENT														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		MANUAL BAR SCREENS	MECHANICAL BAR SCREENS	COMMINUTOR	BARIMINUTOR	MACERATOR	MANUAL CLEAN GRIT CHAMBER	MEC. CLEAN GRIT CHAMBER	AERATED GRIT CHAMBER	DEGRITTER	GRIT PUMPS	INFLUENT FLOW MEASUREMENT	RAW WASTE PUMPING	INLINE FLOW EQUALIZATION	SIDELINE FLOW EQUALIZATION	GENERAL
Mechanical Design Considerations	Lack of depth gauges provided on basins that operate at varying levels.													5	5	
	Lack of spare air compressor for bubbler systems.												10			
	Improper bar spacing.				7											
	Weirs and gates are not watertight.															4
	Inability to back-flush influent pumps for cleaning purposes.												11			
	Inadequate consideration of effect of waste material on mechanical reliability.		8	8	8	7		9			3					
Electrical/ Instrumentation Design Considerations	Corrosive and/or explosive gases close to electrical motors and equipment.												12			
	Wet well level float controls may become greasy.												13			
	Inadequate consideration of humidity in influent structure results in inaccuracies to flow sensors.											8				
Safety Considerations	Lack of proper ventilation at lift station.												14			
Environmental Design Considerations	Inadequate consideration of potential freezing.	8	9				9					9				

DEFICIENCY GROUP	DEFICIENCY	3.0 - PRIMARY TREATMENT					
		1	2	3	4	5	
		GENERAL	PRIMARY CLARIFIER	PRIMARY SLUDGE REMOVAL	PRIMARY SLUDGE PUMPS	SCUM REMOVAL	
Layout, Arrangement, and Placement of Components in Design of Plant	Inadequate odor control where excess waste activated sludge is received at primary clarifier.	1					
	Flushing and cleanout connections for sludge line not provided.			1	1		
	Primary sludge pumps located too far away from clarifiers.			2	2		
	Lack of screening and grit removal ahead of primary sedimentation.	2					
	Poor flotation of grease.					1	
	Improper length to width ratios.		1				
	Inadequate provisions for preventing frequent maintenance resulting from stringy material in wastewater.			3	3	2	
	Improper placement of scum removal equipment hinders clarifier performance.					3	
	Inadequate provisions for chain, flight, and sproket repair and replacement.			4			
	Inadequate clarifier depth.		2				
	Improper sizing of increments on time clock results in pumping of unnecessarily thin sludge.				4		
	Design includes a common sludge removal pipe for two or more clarifiers resulting in unequal sludge removal from the clarifiers.		3	5			
	Inadequate provisions for sampling of raw sludge.	3		6			
	Operator is not provided with the capability to observe sludge while pumping.			7	5		
	Inadequate flexibility in sludge pumping system.			8	6		

DEFICIENCY GROUP	DEFICIENCY	3.0 - PRIMARY TREATMENT					
		1	2	3	4	5	
		GENERAL	PRIMARY CLARIFIER	PRIMARY SLUDGE REMOVAL	PRIMARY SLUDGE PUMPS	SCUM REMOVAL	
Layout, Arrangement, and Placement of Components in Design of Plant	Scum is recycled through the plant and not removed from the system.					4	
	Improper materials selection.			9	7		
	Improper selection of scum pumping facilities results in excessive O&M.					5	
Hydraulic Design Considerations	Effluent weir not uniformly level.		4				
	Improper baffling resulting in short-circuiting.		5				
	Short-circuiting causing poor solids removal.		6				
	Septic conditions resulting from overloading.		7				
	No provisions for measuring sludge flow.			10	8		
	Inadequate consideration of impact of waste secondary sludge pumping on clarifier loading.		8				
	Inadequate consideration of impact of various trickling filter recirculation rates and strategies on clarifier loadings.		9				
	Inadequate consideration of clarifier inlet design.		10				
	Inadequate consideration of character of sludge in sizing and layout of sludge lines.			11	9		
Mechanical Design Considerations	Inadequate sizing of torque requirement for sludge removal mechanism.		11				
	Heavy wear on scrapers due to grit.		12				
Environmental Considerations	Inadequate freeze protection.					6	

DEFICIENCY GROUP	DEFICIENCY	4.0 -- AIR ACTIVATED SLUDGE										
		1	2	3	4	5	6	7	8	9	10	11
		AERATION BASIN	DIFFUSERS	FIXED MECHANICAL AERATORS	FLOATING AERATORS	BLOWERS	AIR DISTRIBUTION SYSTEM	D.O. CONTROL AND MEASUREMENT	RETURN SLUDGE PUMPING	WASTE SLUDGE PUMPING	SECONDARY CLARIFICATION	OXIDATION DITCH
Layout, Arrangement, and Placement of Components in *Design of Plant*	Lack of flexibility to operate in different modes (i.e., complete mix, plug flow, contact-stabilization, etc.).	1										
	Aerator spacing not adequately considered.	2		1	1							
	No provision for addition of chemicals to improve settling characteristics.										1	
	Improper type of sludge removal mechanism selected.										2	
	No separate waste sludge pumps.									1		
	Inadequate consideration for alkalinity adjustment.	3										1
	Inadequate foam control.	4										
	Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.	5	1	2	2							2
	Improper clarifier sidewater depth (SWD).										3	
	Inadequate aeration capacity.		2	3	3	1						3
	Inadequate screening of raw wastes causes plugging of aerators and return/waste sludge pumping system.	6	3						1	2		4
	Inadequate access to weirs for sampling and maintenance.										4	
	Inability to adequately measure and adjust air flow rates to control D.O. levels and energy consumption.						1	1				
	Inflexible design does not permit isolation of reactors and changes in flow schemes for maintenance purposes and/or to adjust for changes in waste characteristics.	7							2		5	5
	Inadequate consideration of impact and control of in-plant sidestreams.	8						2	3	3	6	6
	Inadequate provisions for sampling and observation of return and waste activated sludge.								4	4		7
	Inadequate consideration of debris in wastewater.			4	4				5	5		8
	Inability to dewater tanks for repair.	9										
	Improper selection of valves for sludge lines.								6	6		
	Inadequate provision for by-passing aeration basin.	10										9
	Inadequate or no air cleaners provided on blowers.		4			2						

DEFICIENCY GROUP	DEFICIENCY	4.0 -- AIR ACTIVATED SLUDGE										
		1	2	3	4	5	6	7	8	9	10	11
		AERATION BASIN	DIFFUSERS	FIXED MECHANICAL AERATORS	FLOATING AERATORS	BLOWERS	AIR DISTRIBUTION SYSTEM	D.O. CONTROL AND MEASUREMENT	RETURN SLUDGE PUMPING	WASTE SLUDGE PUMPING	SECONDARY CLARIFICATION	OXIDATION DITCH
Hydraulic Design Considerations	Improper return sludge flow splitting.								7			
	Overflow rate (OFR) of clarifiers too high to meet effluent SS requirement limitation.										7	
	No provisions for flow diversion boxes.	11									8	
	Inadequate waste sludge pipe sizing for "slip-stream" wasting.									7		
	Short-circuiting in clarifiers.										9	
	Lack of consideration of inlet-outlet losses.										10	
	Improper or no use of a scale-down factor to convert lab overflow rate (OFR) to design OFR.										11	
	Improper weir placement (i.e., proper weir length, but closely-placed troughs create high localized upward velocities within clarifiers).										12	
	Improper length-to-width ratio.										13	
	Improper sidewater depth (SWD) and baffling cause splashing problems in basin.	12										10
	Inadequate sludge recycle/waste capacity.								8	8		
	Inadequate sludge flow measurement for small plants using air lift pumps.								9	9		
	Inability to control and measure mixed liquor flow distribution to multiple secondary clarifiers.	13										11
	Inability to adjust, measure, and control return/waste sludge flows.								10	10		
	Inability to change placement of return sludge in aeration basin.	14							11			
	Inadequate consideration of impact of changing aeration basin levels on aerator performance.	15		5								12
	Improper installation of flow control walls results in inadequate mixing.											13
Mechanical Design Considerations	Improper air piping material.						2					
	No provisions for removing air diffuser drop pipes from aeration tanks.		5				3					
	Multicompartmental basins do not have reinforced inner walls; therefore, individual tanks cannot be dewatered.	16										
	Air valves not graduated to allow even distribution of air flow to diffusers.		6				4	3				

DEFICIENCY GROUP	DEFICIENCY	4.0 -- AIR ACTIVATED SLUDGE										
		1	2	3	4	5	6	7	8	9	10	11
		AERATION BASIN	DIFFUSERS	FIXED MECHANICAL AERATORS	FLOATING AERATORS	BLOWERS	AIR DISTRIBUTION SYSTEM	D.O. CONTROL AND MEASUREMENT	RETURN SLUDGE PUMPING	WASTE SLUDGE PUMPING	SECONDARY CLARIFICATION	OXIDATION DITCH
Mechanical Design Considerations	Inadequate or no provision for scum removal from secondary clarifiers.										14	
	Inability to drain foam spray system results in freezing problems.	17										
	Supports for air drop pipes cannot be seen when aeration basin is full, making it difficult to reinstall the drop pipes.	18	7				5					
	Long scum lines frequently become clogged.										15	
	Scum will not flow from scum tanks once subnatant is pumped out.										16	
	Sludge lines periodically clog with rags, and no backflush facilities are provided.										17	
	Inability to conveniently dewater scum pits.										18	
	Floating aerators located too close to wall or pontoons not aligned properly, causing pontoons to strike the basin wall when started up.				5							
	Lack of splash shields in front of effluent gates.	19										
	Scum accumulation in flow splitter boxes.								12	11		
	Improper placement of gear box drains causes oil to drain into aeration basin.			6	6							14
	Diffusers plug due to dirty air supply.		8									
	Improper selection of bearings which are not compatible with excessive moisture.											15
	Improper support of aerators results in misalignment and premature bearing failure.											16
Electrical Instrumentation Design Considerations	Amp meters not provided at motor control center so operator cannot tell if proper amperage is being drawn.			7	7							
	Quick disconnect plugs on aerators become wet and short out.	20			8							
	Lack of instrumentation to totalize recycle/waste sludge flows.								13	12		
	No time delay relays provided to limit stress shock to aeration gears when shifting from high speed to low speed.			8	9							
	Improper design of D.O. measuring instrumentation does not allow easy removal of equipment for routine inspection and maintenance.							4				

DEFICIENCY GROUP	DEFICIENCY	4.0 -- AIR ACTIVATED SLUDGE										
		1	2	3	4	5	6	7	8	9	10	11
		AERATION BASIN	DIFFUSERS	FIXED MECHANICAL AERATORS	FLOATING AERATORS	BLOWERS	AIR DISTRIBUTION SYSTEM	D.O. CONTROL AND MEASUREMENT	RETURN SLUDGE PUMPING	WASTE SLUDGE PUMPING	SECONDARY CLARIFICATION	OXIDATION DITCH
Safety Considerations	Spray from surface aerators makes walkways slippery.			9	10							17
	Blower silencers not provided.					3						
Environmental Considerations	Inadequate consideration of freezing problems and effect of cold temperatures on efficiency of biological treatment.	21									19	18

DEFICIENCY GROUP	DEFICIENCY	5.0 - OXYGEN ACTIVATED SLUDGE								
		1	2	3	4	5	6	7	8	
		AERATION BASIN	AIR COMPRESSORS	D.O. MEASUREMENT	D.O. CONTROL	PRESSURE SWING ADSORPTION	OXYGEN GAS FLOW CONTROL	INFLUENT FLOW CONTROL	SAMPLING AND MONITORING	
Layout, Arrangement, and Placement of Components in Design of Plant	Inadequate access for maintenance to anti-foam spray headers in covered tanks.	1								
	Inadequate access to D.O. measuring equipment due to mounting in flanged portholes.			1	1					
Hydraulic Design Considerations	Inadequate forward flow control causing ripples in reactor.							1		
	Overly sensitive instrumentation responding to hydraulic ripples and cycling O_2 gas flow.						1			
Mechanical Design Considerations	Inadequate turndown capability due to selection of rotary compressor.		1			1				
	Inadequate condensate removal in reactor gas sample lines.								1	
Environmental Considerations	Inadequate consideration for freezing of reactor gas sampler lines.								2	

DEFICIENCY GROUP	DEFICIENCY	6.0 TRICKLING FILTER							
		1	2	3	4	5	6	7	8
		TRICKLING FILTER	ROCK MEDIA	PLASTIC MEDIA	FLOW SPLITTING TO FILTERS	DISTRIBUTION OF MEDIA	FLOW RECIRCULATION	SECONDARY CLARIFIER	SLUDGE PUMPING
Mechanical Design Considerations	Improper design and installation of distribution arms cause clogging and rotation problems.	1				1			
	Side wall not high enough to prevent splashing or aerosol drifting.	2							
	Inability to add flocculants to aid settling.							1	
	Lack of flexibility to flood the filter.	3			1	2			
	Lack of flexibility to chlorinate the filter.	4							
	Poor ventilation of filter causes odor problems.	5	1	1	2	3			
	Clogging of distributor orifices caused by inadequate primary treatment.	6				4			
	Inflexibility related to isolation of reactors and changes in flow and/or recirculation strategy.	7			3		1		
	Improper sizing of media.		2						
	Improper selection of media without good weathering properties.		3						
	Inadequate air circulation provided during periods of high flows.		4	2		5			
	Inadequate consideration of overspray on filter walls and resulting fly problems.	8					2		
	Inability to adjust, measure, and control recirculation rate.				4		3		
	Inadequate flow dosing equipment.					6			
	Inability to adjust and control flows to clarifiers.							2	

DEFICIENCY GROUP	DEFICIENCY	6.0 TRICKLING FILTER							
		1	2	3	4	5	6	7	8
		TRICKLING FILTER	ROCK MEDIA	PLASTIC MEDIA	FLOW SPLITTING TO FILTERS	DISTRIBUTION OF MEDIA	FLOW RECIRCULATION	SECONDARY CLARIFIER	SLUDGE PUMPING
Hydraulic Design Considerations	Inadequate sizing of filter unit to meet a more stringent effluent limitations requirement.	9							
	Insufficient flow, particularly during low flow conditions, to rotate the distribution arm.	10			5	7			
	Lack of proper recirculation pumping capacity.						4		1
	Excessive sloughing from filter due to excessive organic loading.	11							
	Recirculation of secondary clarifier effluent is causing high flows through the clarifier, resulting in clarifier solids carry-over.	12					5	3	
	No provision for flushing underdrains.	13							
	Inadequate consideration of clarifier inlet and outlet structures to optimize hydraulic characteristics.							4	
	Inadequate flow to filter causes media plugging.	14	5	3					
	Inadequate consideration of effects of recirculation through primaries on clarifier loadings.						6		
	Inadequate consideration of effects on the sludge blanket of taking recirculation flow from below weirs of clarifier.						7	5	
Environmental Considerations	Inadequate freeze protection.	15				8			
	Ice build-up on filter media.	16	6	4					

DEFICIENCY GROUP	DEFICIENCY	7.0 - DISINFECTION								
		1	2	3	4	5	6	7	8	9
		GENERAL	Cl_2 CONTACT CHAMBER	CHLORINATOR	CHLORINE CONTROL	DECHLORINATOR	OZONE CONTACT VESSEL	OZONE GENERATOR	OZONE CONTROLLER	SAFETY
Layout, Arrangement, and Placement of Components in Design of Plant	Lack of adequate working space behind chlorinators.			1						
	Lack of scum removal facilities.		1							
	Hoist rail does not extend beyond edge of building, making cylinder unloading more difficult.	1								
	No provision for sampling at outfall.	2								
	Inadequate use of concrete coatings, which slough off tank walls and plug pipes and pumps.		2							
	Lack of stand-by *equipment*.			2		1				
	Lack of consideration of upstream NH_3 concentration.	3								
	Improper location of chlorine diffuser.		3							
	Inadequate provision for sump to facilitate solids removal.		4							
Hydraulic Design Considerations	Improper location of utility water suction draws excess solids into system.	4								
	Lack of adequate mixing at Cl_2 addition point.		5							
	Insufficient contact time in outfall.		6							
	Inadequate consideration of possible short-circuiting.		7							
	Inadequate consideration of potential for flooding baffles during high flows.		8							
	Inadequate consideration of present and future flows in equipment sizing.	5	9	3		2	1	1		

DEFICIENCY GROUP	DEFICIENCY	7.0 - DISINFECTION								
		1	2	3	4	5	6	7	8	9
		GENERAL	Cl_2 CONTACT CHAMBER	CHLORINATOR	CHLORINE CONTROL	DECHLORINATOR	OZONE CONTACT VESSEL	OZONE GENERATOR	OZONE CONTROLLER	SAFETY
Electrical/Instrumentation Design Considerations	Inadequate consideration of potential flow ranges during selection of automatic control equipment.				1					
	Inadequate feedback for control of chlorine/ozone feed rate.			4	2			2	1	
	Inadequate consideration of emergency alarms, controls, and ventilation.									1
Safety Considerations	Floor drains from chlorine room are connected to floor drains from other rooms.									2
	Inadequate safety equipment.	6	10	5			2	3		3
Environmental Considerations	Improper temperature control in Cl_2 tank storage area.									4
	Improper selection of construction materials to minimize corrosion.		11							

DEFICIENCY GROUP	DEFICIENCY	8.0 - ANAEROBIC DIGESTION												
		1 GENERAL	2 SINGLE-STAGE DIGESTER	3 TWO-STAGE DIGESTER	4 GAS COLLECTION	5 GAS MEASUREMENT	6 SUPERNATANT WITHDRAWAL	7 SUPERNATANT DISPOSAL	8 HEATING	9 MAINTENANCE	10 SAFETY	11 SLUDGE WITHDRAWAL	12 SLUDGE RECIRCULATION	13 SLUDGE FEED
Layout, Arrangement, and Placement of Components in Design of Plant	No provision for changing supernatant withdrawal point within tank.						1							
	No provision for changing supernatant disposal point within plant.							1						
	Inadequate consideration of the impact of the supernatant sidestream on other unit operations.	1	1	1			2	2						
	Lack of sludge thickening ahead of digester.		2	2										1
	Inadequate location of supernatant withdrawal.		3	3			3							
	Inability to isolate and feed sludge to all digesters.			4										2
	Inadequate number of sludge feed lines hinder operation.													3
	Inadequate provision for sampling.	2	4	5	1		4					1		
	Inadequate flow measurement.													4
	Inadequate insulation of heating pipes.								1					
	Inability to feed chemicals during process upset.		5	6										
	Inadequate mixing.			7										
	Inadequate placement of condensate traps on gas lines.				2									
	Inadequate treatment of digester gas before utilization in plant.	3	6	8	3									
	Inadequate provision for digester cleaning.	4	7	9						1	1			
	Inadequate sizing of heat exchanger.								2					

DEFICIENCY GROUP	DEFICIENCY	8.0 - ANAEROBIC DIGESTION												
		1 GENERAL	2 SINGLE-STAGE DIGESTER	3 TWO-STAGE DIGESTER	4 GAS COLLECTION	5 GAS MEASUREMENT	6 SUPERNATANT WITHDRAWAL	7 SUPERNATANT DISPOSAL	8 HEATING	9 MAINTENANCE	10 SAFETY	11 SLUDGE WITHDRAWAL	12 SLUDGE RECIRCULATION	13 SLUDGE FEED
Hydraulic Design Considerations	Insufficient capacity at peak loads.	5												
	Inadequate sizing of sludge lines prevents passage of concentrated sludge.											2	1	5
	Sludge line from digester to sludge draw-off pump too long, resulting in plugging problems.											3		
Mechanical Design Considerations	Lack of multiple sludge withdrawal and return points.											4	2	
	No provision for cleaning sludge heating lines.	6							3					
	Improper use of water seals on pumps around digester.						5		4			5	3	6
Electrical/Instrumentation Design Considerations	Lack of pH and temperature control facilities.	7												
	Sludge metering system inaccurate or unreliable.											6	4	7
	Individual gas measurement not provided on multiple digesters.					1								
	Inadequate provision for high/low gas pressure alarms.				4						2			
Safety Considerations	Lack of condensate and flame traps in gas lines.				5						3			
Environmental Considerations	Pressure relief valves are exposed to cold weather, resulting in freezing.	8	8	10	6	2					4			

DEFICIENCY GROUP	DEFICIENCY	9.0 - AEROBIC DIGESTION						
		1	2	3	4	5	6	7
		GENERAL	AEROBIC DIGESTER	DECANTING	CLARIFICATION	DIFFUSED AERATION	MECHANICAL AERATION	SLUDGE REMOVAL
Layout, Arrangement, and Placement of Components in Design of Plant	Lack of depth gauges provided on basins that operate at varying liquid depths.	1						
	Lack of thickening ahead of digestion, and no provision for decanting within the digester.	2						
	Inadequate consideration of a decrease in operating efficiency due to the temperature drop in winter.	3						
	Inadequate consideration of denitrification-induced settling problems during decanting.		1	1	1			
	Pressure relief valve not provided in area with high groundwater which prohibits batch operation.	4	2					
	Inadequate supernatant flexibility.			2	2			
	Inadequate air supply.					1	1	
	Inadequate flexibility in aeration equipment prohibits operation of tank unless full.						2	
	Inadequate consideration of diffuser maintenance problems and clogging tendency.					2		
	Inadequate mixing to prevent solids deposition and provide uniform D.O. concentrations.		3			3	3	
	Inadequate consideration of pH control.	5						
	Inadequate freeboard for foam containment and spray control.		4					
	Inadequate ventilation in covered digesters.		5					
	Inadequate structural design in common wall construction, causing structural failure during batch operation.	6	6					
Hydraulic Design Considerations	Lack of flexibility to dewater small above-ground tanks by gravity.	7						
	Inability to visually observe the quality of supernatant being drawn off.			3	3			
	Inadequate consideration of sludge viscosity during pump selection.							1
Mechanical Design Considerations	Inability to draw supernatant off at deep enough level.	8		4				
	Lack of spare supernatant pump for both maintenance purposes and to allow rapid dewatering of basin.			5				
	Provisions provided to add defoamer to aeration basin, but not to aerobic digester.	9						
Environmental Considerations	Inadequate freeze protection.	10	7	6				

DEFICIENCY GROUP	DEFICIENCY	10.0 - SLUDGE DEWATERING PROCESSES									
		1	2	3	4	5	6	7	8	9	10
		GENERAL	GRAVITY THICKENERS	DAF THICKENERS	VACUUM FILTERS	CENTRIFUGES	FILTER PRESSES	BELT FILTER	SLUDGE DRYING BEDS	SLUDGE TRANSFER	SLUDGE CONDITIONING
Layout, Arrangement, and Placement of Components in Design at Plant	Truck loading areas not covered or protected from freezing conditions.	1			1	1	1	1		1	
	Vacuum valves on equipment are inaccessible.				2			2			
	Inability to feed chemicals to both sides of a tank that can be baffled into two separate tanks.	2									1
	Improper conveyor operating angle.									2	
	Excessive cake discharge height results in severe sludge splashing.	3			3		2	3		3	
	Inadequate access provided to sample filtrate/centrate streams.	4			4	2	3	4			
	Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosion rates.	5			5	3	4	5			
	Lack of preliminary treatment prior to a disc-nozzle centrifuge.					4					
	Inadequate drainage system.								1		
	No provisions for cake removal from sand bed.								2		
	Inadequate provisions for proper sludge distribution.								3		
	Inadequate layout of underdrains.								4		
	Improper location of sand bed allows inflow of surface drainage.								5		
	Inadequate consideration of potential flooding of sand bed.								6		
	Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	6			6	5	5	6	7		
	Insufficient provisions for storage of chemicals.	7									2
	Inadequate consideration of storage of dewatered sludge during inclement weather.	8								4	
	Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	9			7	6	6	7		5	
Hydraulic Design Considerations	Sludge feed troughs from chemical condition tank to vacuum filter frequently become clogged.				8						
	Inadequate consideration of cyclic peak demands in common air/water supplies results in competition among multiple units.	10		1							
	Inadequate capability to handle peak loads.	11									
	Design specifies solids loading, but neglects hydraulic loading requirements.		1	2							
	Insufficient effluent recycle capacity.			3							

DEFICIENCY GROUP	DEFICIENCY	10.0 - SLUDGE DEWATERING PROCESSES									
		1	2	3	4	5	6	7	8	9	10
		GENERAL	GRAVITY THICKENERS	DAF THICKENERS	VACUUM FILTERS	CENTRIFUGES	FILTER PRESSES	BELT FILTER	SLUDGE DRYING BEDS	SLUDGE TRANSFER	SLUDGE CONDITIONING
Hydraulic Design Considerations	Short-circuiting of flow through tank causes poor solids removal.		2								
	Feed pumps run on an "on-off" cycle, causing uneven feed to DAF unit.			4							
	Wide variations in feed solids concentrations occur because DAF is fed directly from final clarifier.			5							
Mechanical Design Considerations	Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	12			9	7	7	8		6	
	Top of sludge chute not large enough to accept all the cake that comes off the dewatering equipment, causing some sludge cake to fall on the floor.				10		8	9		7	
	Insufficient conveyor skirt length, resulting in severe splashing.									8	
	No flushing facilities provided for sludge transfer or feed pumps.									9	
Mechanical Design Considerations	No drains provided on elevated sections of conveyor drip pans.									10	
	No provision for dust collection when using powdered conditioning agents.										3
	No provision for chemical addition.		3	6	11	8	9	10			4
	Inadequate scum removal.	13	4								
	Improper cleaning of filter cloth.				12		10	11			
	Improper sidewater depth (SWD).		5	7							
	Improper sand gradation.								8		
	Improper selection of filter media.				13		11	12			
	Inadequate sizing of dewatered sludge conveyor.				14	9	12	13		11	
	Inadequate consideration of potential plugging problems in sludge piping.	14								12	
	Inadequate consideration of corrosive nature of materials to be handled.	15				10					
	Walls dividing sludge drying beds are made of untreated wood and warp rapidly.								9		
	Insufficient number of floor drains around dewatering equipment.	16			15	11	13	14			
	Drain lines from filter vats are too small and become clogged.				16			15			
	Spray water systems exhibit clogging problems.				17		14	16			
	Tank drain lines are located 2" to 3" off the bottom of tanks, making it difficult to dewater them.	17									5
	Chemical feed line and pH probe are located close together, causing erroneous and/or cyclic readings.	18									6

DEFICIENCY GROUP	DEFICIENCY	10.0 - SLUDGE DEWATERING PROCESSES									
		1	2	3	4	5	6	7	8	9	10
		GENERAL	GRAVITY THICKENERS	DAF THICKENERS	VACUUM FILTERS	CENTRIFUGES	FILTER PRESSES	BELT FILTER	SLUDGE DRYING BEDS	SLUDGE TRANSFER	SLUDGE CONDITIONING
Mechanical Design Considerations	Clogging problems in lime piping.	19									7
	Excessive agitation in chemical conditioning tanks causes floc to shear.	20									8
	Poor cake release.				18		15	17			
	Inadequate provisions for vibration control *in sludge piping design.*	21				12					
	Inadequate grit removal results in excess corrosion.					13					
	Inadequate treatment of flushing water results in plugged nozzles.					14					
	Inadequate provisions for cleaning of filtrate/centrate lines.				19	15	16	18			
	Inadequate removal of cake from filter media.				20		17	19			
	Filtrate pumps frequently become air bound.				21			20			
Electrical/ Instrumentation Design Considerations	Lack of moisture removal from instrument air lines results in failure of control equipment	22		8							
	Improper use of needle valves in hydraulic drives, resulting in overheating.				22						
	No provision for remote speed control on sludge pumps, chemical pumps, vacuum filter drive, etc., from a central location.				23	16	18	21			9
Safety Considera- ations	Sludge pumping and dewatering area not properly ventilated.	23									
	Inadequate provisions for lifting equipment for repairs.	24			24	17	19	22			
Environmental Considerations	Inadequate freeze protection.		6	9					10		
	Inadequate consideration of impact of local climate on dewatering rate and size requirements for sand beds.								11		

Deficiency Group	Deficiency	11.0 LAGOONS											
		1	2	3	4	5	6	7	8	9	10	11	12
		FACULTATIVE PONDS	AERATED PONDS	AEROBIC PONDS	POLISHING PONDS	ANAEROBIC C PONDS	BAFFLES (LOCATION)	RECIRCULATION PUMPS	POND CONFIGURATION	AERATORS	DIKES	PRIMARY CELL	GENERAL
Layout, Arrangement, and Placement of Components in Design of Plant	Inability of process to meet effluent requirements in winter.	1	1	1	1	1							
	Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	2	2	2	2	2							
	No provision to vary liquid depth for mosquito control in lagoon.	3	3	3	3	3	1					1	
	Single point entry into pond overloads pond in feed zone.	4	4	4	4	4							
	Pond located too close to residential areas.												1
	Lack of multiple cells for operating flexibility.	5	5	5	5	5			1				
	Dike widths too small for maintenance vehicles.										1		
Mechanical Design Considerations	Control inflexibilities.							1	2				
	Inadequate D.O. control.							2		1			
	Anaerobic conditions due to organic overloading.	6	6	6	6			3	3			2	
	Inadequate sludge storage.								4			3	
	Complete mixing problems.		7					4		2			
Hydraulic Design Considerations	Inability to control and adjust recirculation rate.							5					
	Short circuiting.						2		5				
	Inadequate erosion control measures.						3				2		2
Environmental Considerations	Improper seedling of dikes (long root plants used that eventually damage thew dike).										3		
	No drain pLrovided in lagoon.	7	8	7	7	6							
	Water level gauges not provided.	8	9	8	8	7							3
	Odor problems.								6				
	Rodent problems.										4		
	Improper depth between lagoon bottom and groundwater table.	9	10	9	9	8							
	No groundwater monitoring wells provided.	10	11	10	10	9							4
	Inadequate freeze protection.						4		7	3			
Safety Considerations	No fence or all-weather road provided.												5

DEFICIENCY GROUP	DEFICIENCY	12.0 - LAND APPLICATION SYSTEMS																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		OVERLAND FLOW SLOPE DESIGN	BUFFER ZONE	COVER CROP	HYDRAULIC ACCEPTANCE	PRETREATMENT	STORAGE	CROP HARVEST	SURFACE DRAINAGE	SOIL DEPTH	INFILTRATION BEDS	SUBSURFACE DRAINAGE	ODOR CONTROL	CENTER PIVOT SPRINKLER	TRAVELING GUN SPRINKLER	SINGLE SET SPRINKLER	LINEAL TRAVEL SPRINKLER	GRATED PIPE DISTRIBUTION	RIDGE AND FURROW	SPREADING BASINS
Layout, Arrangement, and Placement of Components in Design of Plant	Spray nozzles plug due to solids in wastewater.					1			1					1	1	1	1			
	Excessive wear on pumps due to sand in wastewater.					2														
	Improper slope construction.	1			1			1	2		1		1		2		2	1	1	1
	Inadequate detention time on slope to achieve desired level of treatment.	2		1									2							
	Inappropriate location of storage facilities for optimum energy utilization.					3	1		3		2	1						2	2	2
	Inappropriate location of land treatment plots.	3																		
	Inadequate soil depth for suitable land treatment.	4			2					1	3	2								
	Inadequate location of service roads.		1						4											
	Inadequate provisions for by-passing flow during maintenance.					4														
	Inadequate consideration for needs of pre-chlorination or pre-aeration.						2						3							
	Inadequate construction of lagoons for maintenance and sludge removal.					5	3				4		4							
	Inadequate protection of equipment for freezing conditions.						4						5	2	3	2	3	3		
	Inadequate storage for local weather and its impact on the functioning of the system.					6	5		5			3								
Hydraulic Design Considerations	Inadequate pumping facilities for control of sedimentation in piping.					7	6						6	3	4	3	4	4	3	3
	Inadequate facilities provided for flushing of lateral lines.													4	5	4	5	5		4
	Inadequate site loading for optimum treatment.	5		2	3			2		2	5									

DEFICIENCY GROUP	DEFICIENCY	12.0 - LAND APPLICATION SYSTEMS 1 OVERLAND FLOW SLOPE DESIGN	2 BUFFER ZONE	3 COVER CROP	4 HYDRAULIC ACCEPTANCE	5 PRETREATMENT	6 STORAGE	7 CROP HARVEST	8 SURFACE DRAINAGE	9 SOIL DEPTH	10 INFILTRATION BEDS	11 SUBSURFACE DRAINAGE	12 ODOR CONTROL	13 CENTER PIVOT SPRINKLER	14 TRAVELING GUN SPRINKLER	15 SINGLE SET SPRINKLER	16 LINEAL TRAVEL SPRINKLER	17 GRATED PIPE DISTRIBUTION	18 RIDGE AND FURROW	19 SPREADING BASINS
Hydraulic Design Considerations	Inadequate sprinkler head design to minimize aerosolization.													5	6	5	6			
	Inadequate shaping of drainage channels for efficient system operation.	6							6											
	Inadequate knowledge of subsurface drainage alternatives to alleviate drainage problems.				4			3				4	7							
Mechanical Design Considerations	Inadequate selection of protective coatings to minimize corrosion.					8								6	7	6	7	6		
	Improper selection of maintenance equipment to minimize soil compaction.	7		3	5			4	7		6									
	Insufficient ventilation of pump houses to minimize corrosion potential.					9														
	Inadequate methods for servicing lagoon aerators.				10	7							8							
	Inadequate design for back-up pumping equipment.				11	8														
Electrical/Instrumentation Design Considerations	Improper selection of electrical contacts and machinery for corrosive environments.					12								7	8	7	8			
	Inadequate construction of underground wiring.					13								8	9	8	9			
	Inadequate protection of electrical hardware from voltage surges.					14								9	10	9	10			
	Inadequate use of data telemetry for efficient operation of the treatment system.				6		9		8		7			10	11	10	11			

DEFICIENCY GROUP	DEFICIENCY	12.0 - LAND APPLICATION SYSTEMS																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		OVERLAND FLOW SLOPE DESIGN	BUFFER ZONE	COVER CROP	HYDRAULIC ACCEPTANCE	PRETREATMENT	STORAGE	CROP HARVEST	SURFACE DRAINAGE	SOIL DEPTH	INFILTRATION BEDS	SUBSURFACE DRAINAGE	ODOR CONTROL	CENTER PIVOT SPRINKLER	TRAVELING GUN SPRINKLER	SINGLE SET SPRINKLER	LINEAL TRAVEL SPRINKLER	GRATED PIPE DISTRIBUTION	RIDGE AND FURROW	SPREADING BASINS
Safety Considera- tions	Inadequate posting of signs identifying hazards.		3			15								11	12	11	12			
	Inadequate perimeter fencing for public safety.		2				10													
Environmental Considerations	Inadequate consideration given to soil type and the interaction of soild with sodium in the wastewater.				7					3										
	Plastic laterals installed above-ground are breaking because of cold weather.													12	13	12	13			
	Aerosol drift to neighboring land.		4											13	14	13	14			

DEFICIENCY GROUP	DEFICIENCY	13.0 - SLUDGE DISPOSAL					
		1 GENERAL	2 LANDFILL	3 SPRAYING	4 PLANNING		
Layout, Arrangement, and Placement of Components in Design of Plant	Inadequate selection of disposal vehicle results in inability to maneuver in landfill.		1				
	Inadequate truck tire size for landfill disposal.	1					
	Inadequate consideration of sludge concentration/transportation tradeoffs.	2	2	1	1		
	Inadequate consideration of site geology/topography and climate.	3	3	2	2		
Hydraulic Design Considerations	Inadequate consideration of hydraulic transport reduction due to ion exchange.			3	3		
Mechanical Design Considerations	Inadequate consideration of equipment utility in all weather conditions.	4	4	4	4		
Safety Considerations	Inadequate consideration of gas migration/accumulation.		5				
	Lack of vector control.	5	6	5	5		
Environmental Considerations	Inadequate consideration of nutrients and public health hazards (metals, bacteria) transport in soil/groundwater.	6	7	6	6		
	Inadequate buffer zone at disposal site.	7	8	7	7		
	Lack of odor control/prevention.	8	9	8	8		
	Sludge loading delayed due to lack of truck or container capacity.	9	10		9		

DEFICIENCY GROUP	DEFICIENCY	14.0 -- SLUDGE REDUCTION							
		1	2	3	4	5	6	7	8
		GENERAL	MULTIPLE HEARTH INCINERATION	HEAT TREATMENT	FLUIDIZED BED	FLASH DRYING	COMPOSTING	ATOMIZED SPRAY	CO-INCINERATION WITH MUNICIPAL SOLID WASTE
Layout, Placement, and Arrangement of Components in Plant Design	Inadequate consideration of equipment arrangement in overall process flow.	1							
	Inadequate space for sludge staging and preparation.						1		
	Inadequate sludge storage during maintenance periods.	2	1	1	1	1	2	1	1
Hydraulic Design Considerations	Inadequate consideration of feed solids concentration.		2	2	2	2	3	2	2
	Use of high volumes of city water for air scrubbers instead of plant utility water.	3	3	3	3	3			3
Mechanical Design Considerations	No heat exchanger provided to make use of waste heat.		4	4	4	4			4
	Inadequate consideration of fresh air supply and overall ventilation requirements.	4	5	5	5		4		5
	Improper feed equipment selection.	5	6	6	6	5			6
	Inadequate provisions for reliable auxiliary fuel source.		7		7	6	5		7
	Inadequate consideration of impact of recycle streams on main stream processes.	6	8	7	8	7			8
	Improper selection of materials of construction results in excessive corrosion.	7	9	8	9	8	6		9
	Improper consideration of reliability of mechanical components.	8	10	9	10	9	7	3	10
	Inadequate consideration of back-up equipment requirements.	9	11	10	11				11
	Inadequate consideration of Impact of excess scale and ash on air pollution equipment and ash removal facilities.		12		12			4	12
	Improper selection of equipment drives for service in high-temperature areas.		13		13				13

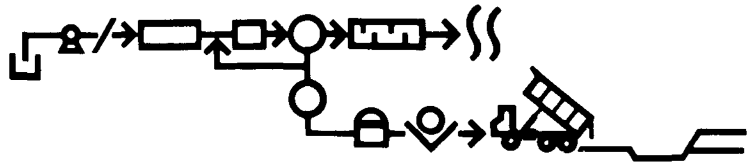
DEFICIENCY GROUP	DEFICIENCY	14.0 -- SLUDGE REDUCTION								
		1	2	3	4	5	6	7	8	
		GENERAL	MULTIPLE HEARTH INCINERATION	HEAT TREATMENT	FLUIDIZED BED	FLASH DRYING	COMPOSTING	ATOMIZED SPRAY	CO-INCINERATION WITH MUNICIPAL SOLID WASTE	
Electrical/Instrumentation Design Considerations	No oxygen analyzing equipment provided to monitor burn.		14		14				14	
	No remote control capability provided for burners to optimize burn.		15		15				15	
	No remote control capability provided for shaft drive to optimize burn.		16						16	
	Improper use of mercury manometers for scrubber water flow measurement causes loss of mercury into system during system surges.		17	11	16	10			17	
	No remote control provided for natural draft and induced draft flow control valves.		18						18	
	Inadequate instrument monitoring of process flows (flue gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	10	19	12	17	11			19	
	No stack sampling ports provided.	11	20						20	
Safety Considerations	Lack of protective insulation on exposed hot piping.	12	21	13	18	12			21	
	Inadequate access to incinerator ash container.		22						22	
Environmental Considerations	Inadequate consideration of ultimate residue disposal.	13	23	14	19		8	5	23	
	Inadequate odor control.		24	15	20	13	9		24	
	Inadequate air pollution control.		25	16	21	14		6	25	

Deficiency Group	Deficiency	15.0 Rotating Biological Contactors										
		1	2	3								
		GENERAL	RBC	SECONDARY CLARIFICATION								
Mechanical Design Considerations	Bearings located below grade and are susceptible to flooding.	1	1									
	Buildings not insulated and facility looses heat in winter causing wastewater temperature to drop.	2	2									
	Primary clarifiers not provided causing settling of dense material in tankage and plugging of media.	3										
	No provision for addition of chemicals to improve settling characteristics.			1								
	No provision for measuring and sampling waste sludge flow.			2								
Hydraulic Design Considerations	Excessive collection system detention times promote incoming septic waste.	4										
	Inadequate confideration of possible development of septic conditions in channels.	5										
	Sidestreams not accounted for in design of RBC units.	6										
	Insufficient tank mixing causes dead spots and solids deposition in RBC tank.		3									
	Improper design of overflow baffles between stages, causes solids deposition.		4									
	Inadequate screening of raw wastes causes plugging of RBC media.	7	5									

DESIGN CONSIDERATIONS

Category		Page
1.0	General Plant Design	55
2.0	Preliminary Treatment	178
3.0	Primary Treatment	211
4.0	Air Activated Sludge	222
5.0	Oxygen Activated Sludge	264
6.0	Trickling Filter	270
7.0	Disinfection	281
8.0	Anaerobic Digestion	292
9.0	Aerobic Digestion	303
10.0	Sludge Dewatering	311
11.0	Lagoons	345
12.0	Land Application	358
13.0	Sludge Disposal	382
14.0	Sludge Reduction	391
15.0	Rotating Biological Contactors	412

Design Considerations



Category: 1.0 General Plant Design

Unit Operation/Component: 1.1 General

DEFICIENCY	CONSIDERATIONS
1.1.1 Lack of hoists over larger pieces of equipment.	<u>New POTW's</u> Architectural and structural designs should include necessary members for hoists over larger pieces of equipment (i.e., pumps, gates, filter presses, etc.) to allow equipment removal for maintenance purposes. <u>Existing POTW's</u> <u>Method</u>: Provide a hoist (pulley, tackle, etc.) to move equipment vertically, and an overhead rail to move equipment horizontally. For small plants, a portable hoist may be appropriate. <u>Materials</u>: A permanent installation may require reinforcing the building superstructure.
1.1.2 Lack of spare pumps.	<u>New POTW's</u> Provide a spare pump(s) at every pumping installation in the plant or as a minimum spare pumps at all major pumping stations (i.e., influent, sludge recycle/waste, intermediate lift, utility water, etc.) and portable pump hook-ups at small pumping stations (i.e., chemical feed, spray water, etc.).

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: If space was provided for future expansion in original design, pour a pad for the pump (if necessary), mount the pump, and install the required piping. Otherwise, it will be necessary to tap into the existing suction header or directly into the wet well. Materials: Concrete for pad (if required), pump, piping, valves.
1.1.3 Lack of walkways around tanks, limiting operator access.	New POTW's Provide adequate walkways and/or stairways to allow operator access to valve handles, gates, instrumentation, etc., and/or to equipment and tank sidewalls for maintenance and clean-up purposes. Existing POTW's Method: Add OSHA-approved walkways constructed of weather-resistant materials. Locate so that operator will have access to tank for sampling, for maintenance of instruments and equipment, for cleaning tank sidewalls, and for turning valve stems. Materials: Galvanized steel or aluminum. Cost: Dependent on length of walkway(s) to be provided, as well as on supporting structure(s) required.

DEFICIENCY	CONSIDERATIONS
1.1.4 Tall, above-ground tanks frequently require operator to climb long stairways.	New and Existing POTW's If space is available, size tanks with adequate width and length to minimize height requirements, and/or construct deep tanks at least partially in ground, or as a minimum provide hoists at the top of stairways to eliminate need for operator to carry equipment up long stairways.
1.1.5 No provisions for moving equipment and supplies from one building floor to another.	New POTW's Provide convenient means of moving equipment and supplies from one building floor to another through use of ramps, hoists, and/or elevators. In below-ground structures such as pump stations, roof hatches with permanent or portable lifting frames can be provided for equipment removal. Care should be taken to ensure that elevators and floor cut-outs for hoists are large enough to allow passage of the largest pieces of equipment anticipated to be used in the building being designed. Existing POTW's Method: Install an elevator or a hoist and overhead rail. If stairways are too narrow to accommodate larger pieces of equipment, add large doorways on appropriate ends of building, or provide floor hatchway in line with hoist rail. Materials: Pulley(s), chain(s), rail(s), wheel(s), doorway(s) for oversized equipment.

DEFICIENCY	CONSIDERATIONS
1.1.6 Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	New POTW's Where louvers are used, they should be an adjustable type, so that they can be closed during cold or wet weather. This is particularly important in buildings such as labs and control rooms which contain people a large percentage of the time. Induced draft ventilation should be considered in lieu of fixed louver systems. Existing POTW's Method: Replace fixed louvers with movable louvers that can be closed in cold weather when not in use. Induced draft louvers should also be considered. Materials: Use same materials as in fixed louvers, or other weather-resistant materials.
1.1.7 Inadequate flexibility to by-pass units.	New POTW's For preliminary treatment units (grit chamber, bar screens, communitors, etc.), provide by-pass channels. For larger multi-unit systems (clarifiers, aeration tanks), tank piping should include necessary valves to allow the stoppage of flow to each tank. For pretreatment units such as equalization, oil and grease removal, odor control, etc., by-pass piping should also be provided. Existing POTW's Method: Design of by-pass structure of piping dependent on individual plant or unit process.

DEFICIENCY	CONSIDERATIONS
1.1.8 Inadequate consideration of means to remove equipment for repair or replacement.	New POTW's Provide doors large enough to permit passage of any vehicles or tools required to remove pieces of equipment from a building, and also large enough to permit passage of equipment itself. Adequate passageways in the building and around the equipment should be provided to allow easy access for both maintenance and removal. A minimum working space of four feet should be provided around all equipment. Existing POTW's Method: Refer to 1.1.1 and 1.1.5.
1.1.9 Inadequate valving for maximum flexibility and proper maintenance.	New and Existing POTW's Piping should be designed with enough valves, long radius elbows, tees, crosses, and clean-outs to provide adequate maintenance and operational flexibility. Sufficient valving should be provided to allow bypassing pieces of equipment for maintenance purposes.
1.1.10 Inadequate consideration of consequences of rupture disc or shear pin failure.	New POTW's When considering rupture discs for piping systems (e.g., on discharge side of a positive displacement pump), specify disc to withstand pressure below the maximum allowable pressure for the piping system. In addition, pipe the blow-off valve (i.e., rupture disc, spring loaded type, etc.) to discharge to a nearby sump so that, in the event of a rupture disc failure, clean-up of sludge or other materials will be minimized.

DEFICIENCY	CONSIDERATIONS
	When specifying shear pins (e.g., for clarifier or thickener mechanisms), also provide a high-torque switch wired to: alarm at a high torque prior to shut down; and to shut down the mechanism at a predetermined torque that is less than the shear pin failure torque.
	<u>Existing POTW's</u> <u>Method</u>: If rupture disc is located inside a building, pipe the blow-off valve to a nearby floor drain, building sump, or wet well. If the disc is located outside, pipe it to the plant drainage system or nearby wet well.
	Install alarms that are energized at a lower torque than that rated for the shear pin; such alarms forewarn the operator of a potential problem.
1.1.11 Relative layout of process units and interconnecting piping not optimized.	<u>New POTW's</u> When laying out process units and interconnecting piping, space the units far enough apart so that maintenance equipment can have access to units. In the case of common-wall tanks (e.g., rectangular clarifiers), provide access at both ends of the battery of tanks to facilitate maintenance.
	Provide sufficient clearance and paved turnaround area for large vehicles (e.g., tank trucks delivering chemicals) to facilitate maneuverability.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: In an existing POTW, it is difficult and costly to change the location of tanks. However, sometimes the function of a tank can be changed if necessary, e.g., an aerobic digester can be converted to an aeration basin by changing valve arrangements. Piping runs can be optimized in order to reduce pumping costs by eliminating unnecessary bends and lengths of pipe.
1.1.12 Excessive length of chemical feed lines, particularly lime slurry recirculation loops.	New POTW's Locate chemical feed equipment as close as possible to point of application. Minimize pipe length and number of bends. In feed lines where settling is possible (especially lime slurry lines), add a clean-out plug at each elbow to facilitate cleaning. In most cases, lime systems should include a continuous recirculation loop with controlled draw-off at the point(s) of application. The recirculation pump should provide a minimum velocity of 5 feet/second in the loop under all flow conditions. Lime pumping should be installed with quick-disconnect pipe joints and flushing connection for ease of maintenance. Automatic line flushing systems should be considered for use with lime systems. Lime piping should be accessible for flushing and clean-out, and should not be installed underground.

DEFICIENCY	CONSIDERATIONS
	Avoid any low points in piping systems. Minimum pipe diameter for lime slurry feed lines should be 1 1/2 to 2 inches. Existing POTW's Method: Increase the pumping capacity in slurry-conveying lines in order to keep solids in suspension. If possible, relocate chemical feed facilities closer to point of application. Materials: Larger impeller in existing pump, or larger pump.
1.1.13 Inadequate consideration of the impact of major industrial users.	New POTW's The impact of industrial users on a POTW can be minimized by implementing the following measures: • Enforce the local sewer ordiinance. If necessary, update an existing ordinance to prohibit the discharge of any wastes that: create a fire or explosion hazard; impair the hydraulic capacity of the sewer system; inhibit biological treatment processes; and/or create a hazard to people, the the sewer system, the treatment process, or the receiving waters. • During the POTW design stages, solicit maximum input from contributing industries regarding total flows, peak flows, waste composition, etc. Encourage industries to conserve water by installing such devices as closed system recirculation

DEFICIENCY	CONSIDERATIONS
	loops and cooling towers. Prohibit industries from diluting their wastes with uncontaminated water.
	Existing POTW's Method: Enforce local sewer ordinances regarding industrial users. Require the industry to meet Federal pretreatment standards for that industry.
1.1.14 Inadequate communication capabilities between buildings and process areas.	New POTW's Provide adequate in-plant communication facilities by specifying an intercom system for each building. Outside speakers for paging personnel should also be provided.
	Existing POTW's Method: Install an intercom system between buildings and an outside paging (i.e., speakers) system.
1.1.15 Insufficient color coding of pipes and valves.	New and Existing POTW's All exposed pipes and valves should be color-coded according to the material carried. The color-coding system can vary from plant-to-plant, but the following is a suggested system: • Potable water — *Dark Blue • Sealing water, wash water, plant effluent — White • Raw wastewater — *Grey • Sludge — *Dark Brown

DEFICIENCY	CONSIDERATIONS	
	• Equipment drains	Orange
	• Sanitary drains	Orange with tags
	• Chemical feed	Aqua
	• Process air, compressed air, blower inlet and outlet	*Dark Green
	• Chlorine	*Light Yellow
	• Scum and grease	Light Green
	• Domestic hot water	Light Blue
	• Oil lines, gas lines	*Brick Red
	• Hoists and trolleys	Safety Yellow
	• Fire protection system, sprinkler piping	Safety Red
	• Steam line	Tan
	• Vents	Ivory
	• Water lines for heating build-ing or diges-ters	Blue, with 6-in. bands spaced 30-in. apart.

*These colors are recommended as standard by WPCF.

DEFICIENCY	CONSIDERATIONS
	Include on each line an arrow indicating the direction of flow. Prepare the surface of the pipe or valve as required by paint supplier.
1.1.16 Inadequate stand-by equipment.	New POTW's Provide stand-by equipment per EPA publication Design Criteria for Mechanical, Electric and Fluid System and Component Reliability (Publication No. EPA-430-99-74-001). Existing POTW's Method: Maintain a complete inventory of spare parts for larger pieces of equipment, such as spare motors and impellers for aerators. Provide a spare pump at pumping stations, a spare chlorinator, and an emergency generator as a stand-by power source. Refer to 1.1.2 and 1.1.95.
1.1.17 Lack of sampling taps at pumping stations.	New POTW's Provide sampling taps on the discharge lines of major pumping stations such as raw wastewater, sludge, and process sidestreams (i.e., filtrates, supernatants, underflows, etc.). Existing POTW's Method: Add a sample tap of appropriate size to the discharge line of a pump, downstream of the check valve. Shut off valve downstream of tap location in order to prevent backflow during installation of tap.

DEFICIENCY	CONSIDERATIONS
	Materials: Sample tap (plug valve) on reducing tee, with two legs of tee same diameter as a pump discharge line, and a third leg of tee same diameter as tap (1 1/2" to 3" for sludge, 1/2" for relatively clear water).
1.1.18 Inadequate process flexibility.	New and Existing POTW's Provide necessary pumps, piping, and valving to ensure each piece of major mechanical equipment or unit operation can be isolated for routine maintenance, repairs, and/or operational changes.
1.1.19 Lack of all-weather roads to pump stations.	New POTW's To ensure year-round, reliable accessibility to pump stations, all-weather access roads (i.e., gravel or paved) should be provided. Existing POTW's Method: Provide an all-weather road to each pump station. Materials/Cost: • Gravel road: $2/sq ft, depending on length of road. • Asphalt road: $4/sq ft, depending on length of road.
1.1.20 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New POTW's High-pressure hose hydrants should be easily accessible throughout a POTW, but not located in vehicle traffic routes. Hydrants should be provided both inside and outside plant buildings.

DEFICIENCY	CONSIDERATIONS
	Sufficient flushing hydrants should be provided to allow clean-up at any location on the plant grounds, particularly around major pieces of equipment. This would include clarifiers, aeration basins, scum pits, bar screens, sludge handling areas, chemical addition facilities, etc.
	If the plant is located in a cold-climate area, outside hydrants should be anti-freeze type.
	Existing POTW's Method: Add flushing hydrants, as needed, throughout the plant, both inside and outside buildings. Outside hydrants should be anti-freeze type if the plant is located in a cold climate area. A minimum hydrant pressure of 50 psi should be provided. An effluent sump and utility water pump can be installed to recycle treated effluent back to the plant flushing hydrants.
1.1.21 Layout of unit processes does not allow for future expansion of plant.	New POTW's During the layout of a new POTW, space should be dedicated for installation of equipment required for future expansion. Such space allocation should be indicated on the site plans and building layouts. Piping as well as tankage arrangements should allow for future expansion needs.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Place new unit processes as close as possible to existing units. Allow for possible differences in elevation when calculating flow distribution and sizing pumps. Consider the use of multi-story structures.
1.1.22 Use of covered basins inhibit access to and observation of unit processes.	New and Existing POTW's Covered basins should only be utilized to prevent freezing problems at POTWs located in areas characterized by several months of below-freezing temperatures. At other locations, the use of in-ground tanks should be considered as an alternative approach. If covered basins are warranted, covers with multiple entrances and observation ports that can be readily removed should be specified.
1.1.23 All valves not operable from floor level.	New and Existing POTW's For safety and convenience reasons, all valves should be easily accessible by POTW operators. Overhead valves should be provided with chain operators, and below grade valves should be equipped with extended valve stems. Wherever possible, valves should be placed within reach of an operator from floor level.
1.1.24 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's For maintenance purposes, provide a minimum of 4-foot clearances around indoor equipment and allow room for truck access around outdoor equipment.

DEFICIENCY	CONSIDERATIONS
1.1.25 Inadequate view of unit processes from control building.	New POTW's The plant control building should be centrally located in order to offer a view of the plant grounds which encompasses as many of the unit operations as possible. Consideration should also be given to an elevated control room located on the second story level of one of the plant buildings. Outside lighting should be adequate to offer night-time view of the units. Existing POTW's Method: Install more process instrumentation to monitor treatment operation. Schedule operations personnel for hourly tours through plant. Provide an observation station on the control building roof.
1.1.26 Inadequate provisions for draining tanks and sumps.	New POTW's A plant drain system should be provided which is low enough to service all tanks and buildings in the plant. All tank and sump bottoms and building floors should be sloped to provide good drainage. Tanks should be equipped with mud (drain) valves and/or pump-out sumps. If possible, tanks should be drained to the plant drain system. Existing POTW's Method: Install mud valves, pump-out sumps, and/or drains in the bottom of wet wells and sumps. For small sumps, the bottom should be grouted to provide a sloped surface that drains to the sump drain.

DEFICIENCY	CONSIDERATIONS
1.1.27 Inadequate provisions for sampling of individual processes.	New POTW's Sampling facilities should be provided throughout the POTW to allow performance evaluations of the individual unit operations. Such facilities would include sample taps at pumping stations, sample ports in tanks, stairways and ladders that allow access to sampling sites. etc. Existing POTW's Method: Refer to 1.1.17.
1.1.28 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New POTW's A crane, monorail or a beam to which a hoist can be attached should be located above all major pieces of equipment. The roof or floor above the equipment should be designed for the lifting load of the hoist. Buildings that contain large pieces of equipment, (i.e., filter presses, vacuum filters, pumps, etc.) should have adequate ceiling heights and floor loading capacities to allow entrance of equipment removal vehicles. The access area around equipment should be adequate for its removal. Access roads and access areas should be provided around all outdoor equipment. Existing POTW's Method: Use portable hoisting frame and hoist with hand truck to move equipment to accessible area. Where feasible, install larger overhead doors to provide increased access into a building.

DEFICIENCY	CONSIDERATIONS
1.1.29 Inadequate scum handling and disposal system.	New POTW's Scum removal facilities should be provided on all tanks (i.e., clarifiers, chlorine contact tanks, wet wells, splitter boxes, etc.) that provide quiescent conditions. A positive scum removal system consisting of sumps and pumps should be provided to transfer the scum from various collection points in the plant to a central holding site. The collected scum should be hauled to a final disposal site or incinerated on-site along with plant sludge, and not allowed to recirculate through the treatment system. Existing POTW's Method: Add skimmer and scum sump to tanks with scum accumulation problems, along with requisite scum pump(s) and level controls. Pipe scum removal equipment so that the scum is removed from the system and not allowed to recirculate through the system.
1.1.30 Foam sprays not concentrated in basin corners where foam build-up occurs.	New POTW's Spray heads should be spaced one foot apart in basin corners to minimize foam build-ups. Foam sprays may also be required in certain open channels, such as aeration basin influent and/or effluent channels. Existing POTW's Method: Install additional spray nozzles (1-foot apart) along spray water header in basin corners. Materials: Non-clog spray nozzles.

DEFICIENCY	CONSIDERATIONS
1.1.31 Control panels not easily accessible (i.e., too high off ground or placed in close quarters).	New POTW's All field-mounted control panels should be conveniently located for operator access. The panel controls should be within easy reach of an operator, and a four-foot working space should be provided around the console. Existing POTW's Method: Relocate panel to a position that is within easy reach of an operator and provides at least 4 feet of clearance around the console.
1.1.32 No provision for water tap at top of above-ground package units.	New POTW's Provide water tap (i.e., hose bib) at top of unit, using plant effluent as utility water source. Existing POTW's Method: Add water tap at top of unit by connecting into the plant utility water system or by using plant effluent as the water source. Materials: Choose piping and valving to be compatible with existing piping materials; a PVC system can be installed as an expedient measure.
1.1.33 Lack of flexibility to operate POTW at low-flow startup conditions.	New POTW's Utilization of parallel flow trains should be considered during conceptual and preliminary engineering design. This would allow use of only the capacity required during initial plant operations. Use of multiple pumps versus single large units is also advantageous for handling initial small influent flows.

DEFICIENCY	CONSIDERATIONS
	<u>Existing POTW's</u> <u>Method</u>: Install lift pumps properly sized to handle initial flows; these can be used as spare or back-up pumps eventually. If necessary, construct partitions in tanks in order to provide proper detention times.
1.1.34 Floor drain piping system undersized.	<u>New POTW's</u> Before sizing the floor drain piping for a building, the flows that will be discharged to the drain system must be identified. This could include relatively large flows such as filtrates, supernatants, pump seal water, etc. While floor drains for lab or administrative buildings may only require 2- or 4-inch piping, sludge dewatering may require 6- or 8-inch drain lines. <u>Existing POTW's</u> <u>Method</u>: Install larger floor drain piping or provide additional piping to reduce the volume of flow discharged to the existing drain piping. Re-pipe certain pieces of equipment to discharge directly to the plant drain sewer rather than to a building drain system.
1.1.35 Drains from buildings discharge into basins with normally (or periodically) high-water levels, causing drains to back-up.	<u>New POTW's</u> Ensure the discharge elevation of the plant drainage system is low enough to always provide adequate gravity flow to the system discharge point. Tanks with varying water levels, such as equalization basins, should not be utilized as drain line discharge points unless anticipated tank high-water levels are still low enough to prevent water backing up into building drains. The plant influent wet well should be considered for use as the discharge point.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install flap valve at the end of the drain line if there is enough head in the drain line to open the valve without back-up of flow. As an alternative solution, re-pipe the drains to a lower basin or wet well in the plant.
1.1.36 Inadequate number of flow meters throughout the plant.	New POTW's As a minimum, provide flow meters to monitor the following streams: • Influent flow. • Recycle sludge flow. • Waste sludge flow. • Flow to sludge conditioning units. • Effluent flow. Various sidestreams (i.e., supernatants, filtrates, centrates, etc.) from other areas of the plant may require flow measurement, depending on the individual POTW, but the above flows should be measured at all plants. Existing POTW's Method: Where required, in-line magnetic flow meters can be installed in existing piping, if appropriate; weir boxes or parshall flumes can be utilized. Materials: Suggested methods of flow measurement in each area are as follows:

DEFICIENCY	CONSIDERATIONS
	• Influent and effluent flows: magnetic flow meter, sonic flow meters, venturi meter, V-notch weir with float. • Sludge flow (recycle, waste, conditioning unit): use closed-pipe flow meters only (magnetic, sonic, venturi).
1.1.37 Inadequate consideration of groundwater movement into POTW site through sewer trenches.	New POTW's Impermeable barriers (i.e., bentonite clay or concrete) should be placed across sewer trenches leading to a POTW site. The barriers should extend between the trench walls and from the bottom of the trench to within one foot of the ground surface. Existing POTW's Method: Install impermeable barriers in the sewer trench. Materials: Concrete or clay.
1.1.38 Inadequate consideration of hydraulics during design of a venturi flow meter, resulting in a negative pressure occurring in the meter throat.	New POTW's Ensure that sufficient line pressure is provided upstream of the venturi meter or a negative pressure will occur in the venturi throat. This will cause air to be drawn into the meter DP cell or out of solution in the wastewater and cause erroneous flow readings. If necessary, a goose-neck venturi can be specified or the DP cell can be located below the venturi in order to ensure a positive throat pressure. Existing POTW's Method: Install a goose-neck venturi meter and move the meter box below the level of the venturi throat.

DEFICIENCY	CONSIDERATIONS
1.1.39 Inadequate consideration of pumping system design and/or fluid characteristics, resulting in pump cavitation.	New POTW's Avoid high suction lifts and specify pumps that have low net positive suction head requirements when designing pumping systems. This is particularly important when the liquid to be pumped has a low vapor pressure. Existing POTW's Method: Replace existing pumps with new pumps having low net positive suction head requirement. Shorten suction line by relocating pump. Increase size of suction piping. Install suction assistant devices (i.e., steam ejectors).
1.1.40 Inadequate location of thrust blocks on pipe lines, particularly where couplings are involved or where automatic valves are located.	New POTW's Thrust blocks should be provided at each point of change in pipe direction. Specify control rods on piping to prevent pipe from pulling out of couplings. Thrust blocks should support automatic valves that will periodically close and cause piping to vibrate. Existing POTW's Method: Install thrust blocks at points where piping changes direction (i.e., pipe bends, control valves, changes in elevation, etc.) for support. Install control rod on piping to prevent pipe from pulling out of the couplings. Set the closing time on automatic control valves slow enough to prevent a sudden thrust at the valve.

DEFICIENCY	CONSIDERATIONS
1.1.41 Use of single-speed pumps where variable speed units are required.	New POTW's Consider the use of variable-speed (or two-speed) pumps at the following locations: • Influent pumping station. • Recycle pumps. • Chemical feed pumps. • Feed pumps to sludge dewatering systems. Existing POTW's Method: Add variable-speed drive to existing pumps where required. Variable-speed pumps should be used at the following locations: • Influent pumping station. • Recycle pumps. • Chemical feed pumps. • Feed pumps to sludge dewatering systems.
1.1.42 POTW design based on average flow and BOD and SS loadings with no recognition of peak conditions.	New POTW's Both maximum and minimum flows and organic loadings should be considered during design of a POTW. It is particularly important that plant pumping stations and piping be adequately sized to handle peak flow rates. Sludge handling equipment should also be sized to handle projected maximum solids loadings. Existing POTW's Method: Install additional pumping capacity as needed to handle peak flows (influent and sludge flows). If feasible, install an equalization basin to dampen peak organic loads.

DEFICIENCY	CONSIDERATIONS
1.1.43 Undersized scum pits.	New POTW's Scum pits should be sized to hold one day of scum production, and should be a minimum size of 4' x 4' x 4'. Existing POTW's Method: Increase the capacity of the scum pump and/or enlarge the scum pit.
1.1.44 Use of city water rather than plant effluent for use as POTW utility water.	New POTW's Plant effluent in lieu of city water should be considered as a source of utility water in order to reduce annual operating costs. An effluent sump, utility water pump, flow control valves, and piping would be required to supply clean-up water throughout the plant. Existing POTW's Method: Install effluent reuse system, consisting of a wet well, recycle pumps, flow control valves and piping. An existing tank such as the chlorine contact chamber or post-aeration basin can be used as a wet well for the recycle system.
1.1.45 Individual flow measurement not provided for each piece of parallel units.	New POTW's Provide individual flow measurement for parallel units. Flow meter (or weir) readings should be totalized so that the entire plant flow is recorded. Existing POTW's Method: Refer to 1.1.36.
1.1.46 Lack of floor trenches around pumps to carry water spills to sumps.	New POTW's Provide floor trenches around pump bases to route water spills to a sump. An alternative approach is to provide a pipe that carries water spills from pumps to a sump. How-

DEFICIENCY	CONSIDERATIONS
	ever, the pipes should not run along the floor (or ground) in areas that would create safety hazards.
	Existing POTW's Method: Provide a drain pipe and route water spills to building sump, or install floor trenches or curbing in concrete floor that carry water to a nearby sump.
1.1.47 Change in baseline conditions at a POTW between time of design and construction.	New POTW's Due to the extensive lag that generally occurs between the time a plant is designed, the Federal construction grants are received, and the plant is actually constructed, it is imperative that future waste loads are considered. This includes projecting municipal and industrial waste flows. It is emphasized that overestimating or underestimating future flows can cause serious operational problems.
	Existing POTW's Method: Refer to 1.1.13.
1.1.48 Lack of flow metering device on chemical feed lines.	New POTW's Provide flow meters on chemical feed lines. The meters should be located near the chemical feed pumps.
	Existing POTW's Method: Install flow meter, such as rotameter, on each chemical line. The meters should be located near chemical feed pumps. Install chemical metering pumps equipped with built-in flow meters.
1.1.49 Chemical feed line is connected to more than one basin at different elevations,	New POTW's When feeding a chemical to more than one tank, use separate feed lines and metering pumps. If feeding chemical through a common header, specify that discharge points in dif-

DEFICIENCY	CONSIDERATIONS
causing line to drain rapidly into lower basin and requiring time to fill header before the higher basin can be fed.	ferent tanks must be at the same elevation. If discharge points must be at different elevations, provide throttle valve at lower basin(s), so that both (all) basins are fed at same rate; also, provide a check valve in the chemical feed lines to prevent the back-flow of chemical from one tank to the other. Existing POTW's Method: Throttle valve to lower basin(s), so that both (all) basins are fed at the same rate; or use spare pump, and arrange valving so that lead pump feeds one basin and spare pump feeds the other. Install a check valve to prevent lines from draining when pump is not operating.
1.1.50 Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkways to tilt and mechanical equipment to move out of alignment.	New POTW's Piping supported by walkways should be placed beneath and run along the middle of the walkways to avoid twisting the unit and any other equipment attached to the walkway. As an alternative, if clarifiers or thickeners are indoors, support piping from building ceilings or walls. Otherwise, support piping from tank walls. Existing POTW's Method: Relocate the piping to hang directly beneath the middle of the walkway to prevent an imbalance of weight hanging under the walkway.
1.1.51 No convenient means provided to feed dry chemicals into top-loading feeders.	New POTW's To avoid this problem: design chemical feed facilities such that the top of the mix tanks are at floor level (i.e., provide a mezzanine); specify mechanical, dry-chemical feeder loading devices; provide a stairway and platform that allows operators to manually feed chemicals to top-loading feeders.

DEFICIENCY	CONSIDERATIONS
	For larger quantities of dry chemicals, use overhead cranes, fork-lift trucks, etc., to load chemicals into feeders. Existing POTW's Method: Install an elevated platform that allows operator access to the top of the chemical feeder. Dry chemical feeder loading device can be manual or mechanical: • Manual: Clamp 50-lb bag onto a plywood plank. Tilt plank over edge of tank, slit bag, and empty bag contents into feeder. • Mechanical: For larger quantities of dry chemicals, use overhead crane, fork-lift trucks, etc., to load chemicals into feeder.
1.1.52 Lack of drains on chemical mix tanks.	New POTW's Provide drain valves in the bottom of all above-ground chemical mix tanks. Ensure that drains allow complete drainage of tanks. Sumps should be provided in the bottom of below-grade tanks. Existing POTW's Method: Add drain valve(s) to the bottom of above-ground chemical mix tank(s). Materials: Drain valves and piping should be compatible with tank material. Cost: Less than $100 per tank, including labor.

DEFICIENCY	CONSIDERATIONS
1.1.53 Lack of seal water drippage drain lines.	New and Existing POTW's Refer to 1.1.46.
1.1.54 Excessive grouting cracks.	New POTW's Specify the use of non-shrink grout for plant construction. Existing POTW's Method: Chip out old grout and replace it with new non-shrink grout.
1.1.55 Samplers frequently clog.	New POTW's Specify that 3/4 inch or larger sample lines be used with wastewater samplers. In addition, clean-out taps should be provided on sample lines. For wastewaters with high solids levels, automatic line flushing systems (air or water) can be used. Existing POTW's Method: Replace existing sampling lines with 3/4-inch lines. Provide means to periodically air or water flush the sample lines.
1.1.56 Pumps are located above the normal water level, making them difficult to prime.	New POTW's Whenever possible, lay out pumping systems such that the pump suction line is flooded. If this is not feasible, specify self-priming pumps. Air bleed-off valves should also be provided at high points in the pump piping system to allow removal of air locks and subsequent priming of the pumps. Existing POTW's Method: Add self-priming feature to existing pumps, or rearrange piping so that suction is flooded.

DEFICIENCY	CONSIDERATIONS
1.1.57 Pressure gauges not located on inlet side of back-pressure relief valves, making it difficult to check and/or adjust the valve.	New and Existing POTW's Install pressure gauges on upstream and downstream side of back pressure valves and on pressure side of relief valves.
1.1.58 Chemical feed pumps are too small to allow high dosages of chemicals during emergencies.	New POTW's Chemical feed pumps should be sized to feed both maximum and minimum dosages. The use of metering pumps with variable stroke adjustment allows a broad pumping capacity range. Multiple pumps should also be specified; this would allow the use of the spare pump during emergency periods when high chemical dosages are required. Existing POTW's Method: Use spare pump; if spare pump not available, use portable pump, or make chemical batches with higher dosages, if possible. If warranted, install larger pumps.
1.1.59 No ladders provided in manholes.	New POTW's All manholes should be equipped with a ladder that is securely anchored to the manhole wall. Existing POTW's Method: Install steel or aluminum ladders in manholes.
1.1.60 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Provide air bleed-off valves at high points in pump discharge lines to allow removal of air-locks and subsequent priming of pumps.
1.1.61 Lack of mud valves in tanks.	New and Existing POTW's Provide mud valves or pump out sumps at low point in tank bottoms. Refer to 1.1.26.

DEFICIENCY	CONSIDERATIONS
1.1.62 Lack of water supply near field samplers.	New and Existing POTW's Provide a hose bib or yard hydrant near samplers for clean-up purposes.
1.1.63 Lack of locally-mounted gauges on field instrumentation.	New and Existing POTW's Provide locally-mounted gauges on all field-mounted flow meters, pH meters, D.O. meters, etc. to allow instantaneous meter readings in the field by POTW operators.
1.1.64 Lack of by-passes around solenoid valves.	New and Existing POTW's Provide by-pass piping around solenoid valves to facilitate cleaning and repair.
1.1.65 Lack of sumps in dry wells.	New POTW's Provide pump-out sumps in all dry wells to allow removal of rainwater clean-up water, etc. Existing POTW's Method: Add sump to each dry well for use with portable pump. Materials: Compatible with existing dry well.
1.1.66 Lack of driers on instrument air lines.	New and Existing POTW's Provide air dryers on instrument air system.
1.1.67 Lead-sealed caps on clean-outs in pressure lines periodically blow off.	New and Existing POTW's Clean-outs on pressure lines should be equipped with clamp-on caps.
1.1.68 Improper water pressure is supplied to rotameters, causing them to burst.	New POTW's Ensure rotameters are rated for the maximum line pressure that will be achieved, particularly if rotameters are used in lines carrying city water since these lines may be under very high pressure.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install pressure-reducing valves in front of rotameters, or install new rotameters with a rated maximum operating pressure that exceeds the line pressure of the water supply system.
1.1.69 Inadequate provisions for pressure relief around positive-displacement pumps.	New POTW's Provide pressure-relief valves or rupture discs in discharge lines from positive-displacement pumps. Existing POTW's Method: Add pressure-relief valve at discharge of each positive-displacement pump. Materials: Rupture discs rated for pressure slightly less than rated pressure of discharge piping system.
1.1.70 Lack of pressure gauges on plant pumps.	New and Existing POTW's Provide pressure gauge on discharge side of all pumps in plant.
1.1.71 Excess oil from stationary units not contained.	New and Existing POTW's Provide drip pans to collect oil drippage from equipment (blowers, pumps, clarifier/thickener mechanisms, aerators, etc.).
1.1.72 Lack of influent composite sampler.	New POTW's Provide an influent composite sampler. In some cases, two influent samplers may be desirable to collect raw wastewater samples and additional samples downstream that include plant side-streams routed back to the head-end of the treatment plant. Existing POTW's Method: Provide refrigerated, heated composite sampler for influent stream.

DEFICIENCY	CONSIDERATIONS
	Materials: Composite sampler, sample pump, piping (3/4 inch or greater).
	Cost: Composite sampler - $4,000.
1.1.73 Inadequate consideration of the type of valve or gate used.	New and Existing POTW's The following items should be kept in mind when specifying valves and gates: • If watertight conditions are required, a sluice gate rather than a slide gate should be used. • Valve material must be compatible with the adjoining piping material and with the liquid to be carried. Specification of a valve type for a particular use should follow these guidelines: • Globe valve: Used for throttling or regulating flow. • Gate valve: Used for stopping flow completely. Valve is used in fully-open or fully-closed position. • Check valve: Used to prevent back flow through equipment, i.e., to prevent fluid from flowing back through a pump. Check valves with obstruction in the flow stream should not be used for raw sewage, sludges, slurries, or fluids containing solids.

DEFICIENCY	CONSIDERATIONS
	• Piping pressure relief valve: Used to relieve excessive pressure, temperature, or vacuum in a piping system, e.g., on the discharge side of positive displacement pumps. Rupture discs, instead of relief valves, should be used when handling fluids containing solids or stringy fibers.
	• Plug valve: Used in wastewater treatment plants for flow shut-off in raw sewage and sludge lines and any other lines carrying stringy matter. Valve should be eccentric type to offer full port opening.
	• Butterfly valve: Used where low head loss, throttling capabilities, small space requirements, drip-tight shut-off, etc., are required.
	• Ball valve: Use in chemical feed lines, where throttling capabilities and tight shut-off are required. Full port openings should be used.
	• Diaphragm valve: Used in lines that carry corrosive fluids, fibrous slurries, sludges, solids in suspension, etc., where material in pipe should not contact any of the operating parts of the valve.
	• Flap valve: Used in POTW's at the effluent end of a pipe to open when there is flow out of the pipe and close to prevent backflow into the pipe when flow ceases. Flap valves are also termed tide gates.

1.1.73

DEFICIENCY	CONSIDERATIONS
	• Float valve: Used to prevent overflow of liquid from a tank, to control flow rate from a tank, and/or to maintain a predetermined level of liquid in a tank (e.g., chemical mix tank). • Mud valve: Used to drain tanks (i.e., clarifiers, aeration tanks, mix tanks, etc.) with a valve operator at the top of the tank. • Tank pressure relief valve: Used as tank groundwater blowoff valve (i.e., lets groundwater enter an empty tank to prevent the tank from floating out of the ground).
1.1.74 Design does not emphasize heating conservation measures.	New POTW's Specify insulation be installed under all roofs and in all walls and thermopane and/or storm windows be used in buildings containing labs and control rooms. Utilize active and/or passive solar designs where possible. Add heat exchangers to incineration systems for energy recovery. Existing POTW's Method: Add insulation wherever possible, especially under building roofs. Add storm windows, or replace existing single-pane windows with thermopane windows. Replace existing heating systems with more efficient units.
1.1.75 Inadequate provisions for manual valve operation during emergency conditions.	New and Existing POTW's All valves with automatic operators should be equipped with manual, auxiliary operators or a piping by-pass with manual-operated valves provided.

DEFICIENCY	CONSIDERATIONS
1.1.76 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New and Existing POTW's Refer to 1.1.26.
1.1.77 Lack of wyes, tees, and crosses to facilitate cleaning of chemical lines.	New POTW's Ensure adequate clean-out taps (i.e., flushing valves) are provided on chemical feed lines to allow removal of pipe blockages. The clean-outs should be installed at wyes, tees, and crosses in the piping. Automatic line flushing systems should be considered for lime systems. Existing POTW's Method: Install flanged fitting with flushing valve. If flushing does not remove blockage, the clean-out flange can be removed in order to rod the pipe.
1.1.78 Lack of cathodic protection for steel tanks.	New and Existing POTW's Provide corrosion protection for steel tanks and pipes by means of auxiliary anodes and/or protective coatings.
1.1.79 Lack of a foam control system.	New and Existing POTW's Foam control systems should be provided for agitated tanks such as aeration basins and aerobic digesters. Foam control systems could consist of spray-water or de-foamer chemical feed systems.
1.1.80 Absence of electrical outlets on top of treatment units.	New and Existing POTW's Provide electrical outlets to service each treatment area including outlets on various pieces of equipment such as clarifiers, aeration basins, thickeners, etc.

DEFICIENCY	CONSIDERATIONS
1.1.81 Electrical cable trenches have no provisions for drainage.	New and Existing POTW's Provide trench drains that discharge to the plant drain system.
1.1.82 Lab electrical circuits on same circuits as POTW equipment, causing interference with lab instrumentation.	New and Existing POTW's Provide an isolation transformer to separate lab electrical circuits from POTW equipment circuits.
1.1.83 Lack of electrical outlets at field-mounted instrumentation for portable calibration equipment.	New and Existing POTW's Electrical outlets (110 v) should be located at field-mounted instrumentation stations. This allows the operator to use portable equipment (without need for batteries) to calibrate field-mounted instrumention or to utilize a temporary instrumentation hook-up while permanent equipment is out of service.
1.1.84 Drains in electrical manholes are not provided with backflow valves to prevent flooding from plant drain system.	New and Existing POTW's Provide backflow valves in all electrical manhole drains.
1.1.85 Inadequate wiring, schematic, and logic diagrams including terminal and wire numbering in field and on drawings; no standard adhered to.	New and Existing POTW's Specify in contract documents that as-built wiring drawings, schematics, and logic diagrams must be prepared by the contractor constructing the treatment plant. Also, wiring in the field must be numbered and wiring identification lists provided at all circuit breaker boxes.

DEFICIENCY	CONSIDERATIONS
1.1.86 Improper selection of type timer relays, making fine adjustments difficult.	New and Existing POTW's Provide timer relays properly graduated for the intended application. For instance, a timer graduated by hours shouldn't be specified if control must be based on minutes.
1.1.87 Electrical design does not have a power factor correction.	New and Existing POTW's Provide power factor correction capacitor for entire plant electrical system or at local high-use motors.
1.1.88 Infrequent use of high efficiency lighting sources.	New and Existing POTW's Specify high efficiency lighting systems such as high pressure sodium or fluorescent units.
1.1.89 Stand-by generator undersized to run all essential equipment.	New and Existing POTW's Stand-by generator capacity should be sufficient to start and operate all lighting, ventilation, controls, instrumentation, and essential process equipment (i.e., aerators, lift pumps, etc.) needed to handle average flows.
1.1.90 Use of open fluorescent lighting in humid areas of POTW.	New and Existing POTW's Cover plant lighting fixtures to keep moisture out, or specify fixtures designed for outdoor use.
1.1.91 Placement of motor control centers too close to wash-down areas.	New POTW's Motor control centers (MCC) should not be placed in rooms with equipment that requires routine wash-down. MCC's should generally be located in separate rooms or buildings. Existing POTW's Method: Construct an enclosure around the motor control center to keep the electrical equipment from getting wet. A curb should also be installed around the enclosure to prevent wash-water flowing into the room from equipment areas.

DEFICIENCY	CONSIDERATIONS
1.1.92 Inadequate electrical capacity to permit stand-by pumps and blowers to operate in parallel.	New and Existing POTW's Electrical systems should be sufficiently sized to allow the simultaneous use of designated operating and stand-by equipment. This is particularly important for pumping and aeration systems.
1.1.93 Lack of ventilation promotes corrosion of electrical components.	New and Existing POTW's Adequate room ventilation must be provided to remove moisture and/or gases such as chlorine or hydrogen sulfide, and to prevent equipment corrosion problems.
1.1.94 Electrical control panels located below ground where exposed to flooding.	New and Existing POTW's All electrical control panels should be located in areas protected from flooding.
1.1.95 Lack of auxiliary power.	New and Existing POTW's All POTWs should include emergency power for major process equipment. This can be accomplished by use of diesel fuel, gasoline, natural gas or digester gas powered generators; or provide dual power feed lines to the plant site. The stand-by power should be automatically activated upon a plant electrical power failure.
1.1.96 Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Provide power factor correction capacitor for the entire plant electrical system.

DEFICIENCY	CONSIDERATIONS
1.1.97 Insufficient use of high-efficiency motors.	New POTW's Specify high-efficiency motors in lieu of standard "off-the-shelf" units. Existing POTW's Method: As motors are replaced, specify high-efficiency motors in lieu of standard "off-the-shelf" units.
1.1.98 Electrical quick-disconnect plugs not provided with submerged pumps to facilitate rapid replacement.	New and Existing POTW's Quick-disconnect electrical plugs should be provided with submerged equipment (pumps, samplers, etc.) to allow rapid replacement with stand-by units when maintenance is required.
1.1.99 Inadequate plant lighting.	New and Existing POTW's Provide sufficient lighting to ensure safe operating conditions are attained in all areas of the plant. This is particularly important around open tanks, aeration basins, below grade tanks and sumps, stairways, etc. Design plant lighting system to conform to "Lighting and Thermal Operation Guidelines" published by the Federal Energy Administration. Refer to 1.1.88.
1.1.100 Stairways without non-skid surfaces.	New POTW's Specify non-skid surfaces for all stairways. Existing POTW's Method: Place non-skid strips on all stairways.
1.1.101 Inadequate handrailing and kick plates.	New POTW's Provide handrailing and kick plates on both sides of all stairways and on all walkways around tanks and equipment. Handrail and kick plates should meet OSHA requirements.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Add handrailing on both sides of all stairways and on all walkways around tanks. Add kick plates at all handrails. Materials: Weather-resistant material such as aluminum, galvanized steel, etc.
1.1.102 Inadequate fencing around site.	New POTW's Provide fencing (a minimum of 8 feet high) around the entire site to make it inaccessible to all unauthorized personnel. Existing POTW's Method: Add fencing (approximately 8 feet high) around entire site to make it inaccessible to all unauthorized personnel. Materials: Chain-link fence constructed of weather-resistant material (aluminum, galvanized steel, etc.) Cost: Approximately $8-10/linear foot.
1.1.103 Use of air headers as guard railing at small package-plant type POTWs.	New POTW's Air headers can become very hot and should not be used as guard railings. Refer to 1.1.101. Existing POTW's Method: Install insulation on air headers that are used as guard railings. Add handrails as described in 1.1.101.
1.1.104 Stairs inclined at too steep an angle.	New and Existing POTW's Design stairways to meet OSHA requirements; specify a maximum incline of 30 degrees.

DEFICIENCY	CONSIDERATIONS
1.1.105 Guard railing not provided around ground-level tanks.	New and Existing POTW's Guard railing or fencing should be provided around all tanks that have open tops at ground-level. Refer to 1.1.101.
1.1.106 Guard railing kick plates bow with change in ambient temperature.	New and Existing POTW's Specify that slotted kick plates be attached to handrail posts with U-bolts to allow for expansion.
1.1.107 Stairways provided with only one handrail.	New and Existing POTW's Refer to 1.1.101.
1.1.108 Valve handles located in unsafe areas.	New and Existing POTW's Locate valves so that they are easily accessible and can be operated safely.
1.1.109 Inadequate consideration of state and OSHA ventilation requirements in confined spaces.	New and Existing POTW's Review OSHA and state regulations concerning design of ventilation systems for wastewater treatment plants and safety requirements for confined space.
1.1.110 Inadequate consideration of noise control.	New POTW's Specifications for mechanical equipment and their associated electric motors should have a noise emission criteria section. Work areas should also be designed to meet OSHA noise criteria. Noise absorbing and/or containing enclosures should be considered only when equipment cannot be designed to meet the work place noise criteria. Existing POTW's Method: All replacement mechanical equipment and their associated T.E.F.C. electrical motor specifications should have a noise emission criteria section.

DEFICIENCY	CONSIDERATIONS
	Work areas should be redesigned to meet OSHA noise criteria. Refer to the Institute on Noise Control Administration for specific equipment and/or building noise abatement corrections. Noise absorbing and/or containing enclosures should be considered only when equipment cannot be designed to meet the work place noise criteria.
1.1.111 Inadequate separate access to the influent wet well, screening or comminutor room, and chlorine room.	New and Existing POTW's For safety reasons, separate access should be provided to all individual process areas. This is particularly true for chlorine storage areas and chlorinator rooms.
1.1.112 Dangerous chemicals not stored in separate areas.	New and Existing POTW's Provide separate, well-ventilated areas for storage of hazardous chemicals. Ensure adequate clean-up facilities are also provided.
1.1.113 Inadequate security provisions.	New and Existing POTW's Provide plant lighting per 1.1.99 and fencing per 1.1.102.
1.1.114 Inadequate provisions for vehicle and associated equipment protection.	New POTW's Specify fenced-in garages to house plant vehicles and maintenance equipment. This provides a secured area to store parts and equipment, and a work area to maintain vehicles. A maintenance shop could be incorporated as part of the vehicle storage complex. Existing POTW's Method: Store vehicles and associated equipment in a fenced area or in a locked garage when not in use.

DEFICIENCY	CONSIDERATIONS
1.1.115 Hand rails and grating not secure.	New POTW's Secure hand rails and grating by anchoring with bolts to concrete or by welding to other metal, as appropriate. Clip and/or bolt grating. Refer to 1.1.106. Existing POTW's Method: Secure hand rails and grating by anchoring with bolts to concrete or by welding to other metal, as appropriate. Place hand rail posts in shoes bolted to the floor rather than on flat anchor plates. Clip and/or bolt grating to concrete.
1.1.116 Stairs not painted bright colors.	New POTW's Indoor or outdoor stairs which require painting should be painted with bright colors for safety reasons. Existing POTW's Method: Indoor or outdoor stairs which require painting should be painted with bright colors for safety reasons. Material: Moisture-resistant paint. Cost: Approximately $0.50 per square foot.
1.1.117 Wet floors in some areas (pump rooms and pipe galleries) are slippery.	New POTW's Specify a non-slip surface for floors in areas that will frequently be wet; this would include pump rooms, sludge handling areas, pipe galleries, etc. Existing POTW's Method: Abrade surface of floor to make rough, or add mats (metal or plastic) to walkways to make walking safer.

DEFICIENCY	CONSIDERATIONS
1.1.118 Electric cut-off switches not locally mounted at individual pieces of equipment.	New and Existing POTW's Locally-mounted power cut-off switches that override power switches at motor control centers should be provided at (within view of) individual pieces of equipment. This prevents a piece of equipment being activated while it is being serviced by an operator.
1.1.119 Ladders in manholes and concrete tanks not secure.	New and Existing POTW's Specify galvanized steel (not plastic) rungs for tanks and manholes. The ladders should also be brightly painted. Refer to 1.1.59.
1.1.120 Hazardous areas not well defined.	New and Existing POTW's Hazardous areas should be well defined via use of signs and bright colors (safety paints) and also be restricted by means of fencing or separate access (e.g., chlorine room).
1.1.121 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Provide portable or fixed hoist systems to move large pieces of equipment. Refer to 1.1.1 and 1.1.28.
1.1.122 Inadequate consideration of OSHA safety requirements.	New POTW's Refer to OSHA safety requirements during design of POTW. Existing POTW's Method: Conduct OSHA survey of entire plant; make required changes where necessary.
1.1.123 Permanent access platforms required for	New and Existing POTW's Provide permanent access platforms for all equipment mounted on large

DEFICIENCY	CONSIDERATIONS
maintenance not provided.	tanks (e.g., fixed aerators, clarifier mechanisms) and for all equipment which is otherwise inaccessible (e.g., elevated motors, valves, mixers, etc.).
1.1.124 Inadequate noise abatement in various plant areas (i.e., blower, pump, and dewatering rooms, etc.).	New POTW's Consider noise abatement measures in areas which house mechanical equipment such as blowers, pumps, centrifuges, etc. Refer to 1.1.110. Existing POTW's Method: Provide noise abatement measures per 1.1.110. Conduct noise survey of entire plant to identify problem areas. Install vibration attenuating mounts on motors and equipment. Install flexible coupling between equipment and pipes and conduit. Install vibration alternating pipe hangers. If above procedures fail to reduce work area noise levels to acceptable levels, install noise attenuating enclosures. As a last resort, issue personnel protective hearing equipment.
1.1.125 Plant located in a flood plain.	New and Existing POTW's Provide dikes and berms as required to protect the plant from a 100-year flood.
1.1.126 Inadequate buffer zone to alleviate problems due to noise, odor, aerosol, fog, etc.	New and Existing POTW's Locate plant in a relatively remote area. Provide a visual buffer zone by planting trees around the plant site. Cover tanks if appropriate to minimize fogging on adjacent highways. Landscape area to facilitate mowing and grooming activities. Refer to 1.1.10 and 1.1.124 for noise abatement procedures.

DEFICIENCY	CONSIDERATIONS
1.1.127 Inadequate consideration of any potential freezing problems of plant components.	New POTW's Specify in-ground tanks in cold climate areas. Specify splash guards around fixed aerators to decrease freezing during winter months. Cover tanks if required. Provide insulation and/or heat tracing of exposed pipes and valves. Refer to 1.1.22. Existing POTW's Method: Add splash guards around fixed aerators to decrease freezing during winter months. Routinely check surfaces of exposed tanks for ice formation that interferes with functioning of mechanisms such as fixed aerators, clarifier mechanisms, etc. Cover tanks if required. Provide insulation and/or heat tracing of exposed pipes and valves.
1.1.128 Inadequate consideration of odor development and control.	New and Existing POTW's Principal sources of odors in POTWs include: septic raw wastewater; industrial waste discharges; unwashed grit; scum; organically overloaded biological treatment processes; flue gas from incinerators without after burners; and sludge handling facilities. Preventative odor control measures that can be taken include: the use of submerged inlets; proper process design loadings; covered tanks with gas treatment systems such as activated carbon adsorbers; air or oxygen additions to in-plant wastewater transmission troughs; combustion of off-gases at proper temperatures; addition of chemicals such as chlorine, hydrogen peroxide, ozone, and lime to tanks, wet wells, sewer lines, etc; and providing facilities such as closed dumpsters, ample yard hydrants, floor drains, etc., that encourage good housekeeping practices.

DEFICIENCY	CONSIDERATIONS
1.1.129 Interior building surfaces not painted with bright, easily-cleaned paints.	New POTW's Paint interior building surfaces with bright, easily-cleaned paints. Rubber-based paints are superior to water-based paints for concrete surfaces, since they are easily cleaned and more resistant to corrosive gases. Existing POTW's Method: At next scheduled repainting, paint all interior surfaces of the plant, especially surfaces from the floor level to five feet above the floor, with a gloss or semi-gloss paint in a light or bright color.
1.1.130 Accumulation of rags and debris around plant site due to inadequate disposal facilities.	New and Existing POTW's Provide covered trash cans or dumpsters at various places throughout the plant (i.e., bar screens, grit chambers, maintenance shops, sludge handling areas, pumping stations, etc.) and make rag and debris clean-up a part of the regular housekeeping routine.
1.1.131 Inadequate consideration of local weather conditions and their impact on the accessibility of a plant site.	New and Existing POTW's During the site selection process, consideration must be given to area climatic conditions Areas that are characterized by heavy rainfall will require all-paved roads, consideration of impact of local flooding problems on plant accessibility, provisions for adequate drainage, etc. POTWs should not be located at a remote site in areas that experience heavy snow fall. Local snow removal capabilities and emergency snow routes should be identified. Refer to 1.1.19.

DEFICIENCY	CONSIDERATIONS
1.1.132 Inadequate consideration of spill prevention plan.	<u>New POTW's</u> In order to prevent spills of oil and/or hazardous materials from contaminating surface or groundwaters, the following measures should be taken. • Provide dikes, berms, retaining walls, etc., around above-ground storage tanks with sufficient capacity to retain the entire contents of the largest tank. • Removal of the contents of the diked area must be by positive means, such as a manually-operated valve or pump, after an inspection of the material has determined where it should be directed. • Plant drainage systems from undiked areas should flow, if possible, into ponds, lagoons, or catchment basins if there is a possibility that runoff could come in contact with oil or hazardous chemicals. <u>Existing POTW's</u> <u>Method</u>: Prepare a Spill Prevention Control and Countermeasure (SPCC) Plan and Pollution Intervention Prevention Plan (PIPP) for the facility, and follow through with implementation of spill containment measures proposed therein. This could include constructing dikes around chemical storage tanks, routing stormwater runoff from potentially-contaminated areas to the plant drain system, providing proper on-site clean-up materials, etc.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.2 Preliminary	
1.2.1 Lack of spare pumps.	New and Existing POTW's Refer to 1.1.2.
1.2.2 Inadequate consideration of scum removal from plant.	New POTW's Some type of scum removal mechanism, such as a rotating scum trough, should be provided to remove scum from the influent wet well. The material removed should be pumped to the sludge handling facilities at the plant, and not recycled back through the plant. Existing POTW's Method: Scum should be taken out of the plant system and not allowed, for example, to drain to the influent pump station.
1.2.3 Inadequate process flexibility.	New POTW's Provide necessary piping and valving to ensure major pieces of mechanical equipment, such as bar screens, grit chambers, lift pumps, and comminutors, can be isolated for maintenance and repairs. Existing POTW's Method: Add by-pass lines around mechanical equipment (bar screen, comminutor, grit chamber, etc.) for servicing during repair. The following provisions should be made where applicable to enhance the controllability of preliminary treatment equipment:

DEFICIENCY	CONSIDERATIONS
	• Influent Pumping Station - Racks or screens to protect pumps from abrasive material and objects that can plug the suction lines. - Pump speed controllers and wet well level controllers set to minimize the number of pump starts and stops. - Influent flow meter. • Bar Screen - Mechanical cleaner adjusted so that screen face is cleaned often enough to prevent back-up of flow in influent channel. • Velocity-Controlled Chain-and-Flight Grit Chamber - Scrapers set to operate at low speed to minimize collection of organic matter along with grit. - Bucket elevator set to operate at a rate fast enough to remove the grit collected. • Aerated Grit Chamber - Adjustable air flow set low enough to allow grit to settle, but high enough to prevent organic material from being removed with the grit.
1.2.4 Lack of all-weather roads to pump stations.	New and Existing POTW's Refer to 1.1.19.

DEFICIENCY	CONSIDERATIONS
1.2.5 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Hose bibs should be provided at wet wells, bar screens, grit chambers, comminutors, clarifiers, and pump stations.
1.2.6 All valves not operable from floor level.	New and Existing POTW's Overhead valves should be provided with chain operators, and valves below grade should be provided with extended stems.
1.2.7 Inadequate clearance around equipment for maintenance functions.	New POTW's Provide a minimum of 4 feet around indoor equipment, such as pumps, and allow truck access for outdoor equipment such as screens, comminutors, grit screw conveyors, etc. Existing POTW's Method: Where possible, relocate equipment to a more accessible position.
1.2.8 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Wet well designs should consider dual compartments to allow continued operation during cleanout or maintenance periods, and should have bottom drain valves or pump-out sumps. Sumps should have sloped bottoms to facilitate dewatering.
1.2.9 Inadequate provisions for sampling of individual processes.	New POTW's Provide facilities for an influent sampling station. This would include an automatic composite sampler, electrical outlet, hose bib, and a sampling tap (or a submersible sampling pump). Existing POTW's Method: Provide a composite sampler per 1.1.72 for influent flow.

DEFICIENCY	CONSIDERATIONS
1.2.10 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.2.11 Inadequate scum handling and disposal system.	New and Existing POTW's Provisions should be made to remove scum from the influent wet well and aerated grit chambers. This could include skimmer underflow baffles, a scum trough, scum pits, and pumps, etc. Refer to 1.1.29.
1.2.12 Lack of flexibility to operate POTW at low flow start-up conditions.	New POTW's Refer to 1.1.33. Existing POTW's Method: Refer to 1.1.33. Where required, partitions may have to be installed to narrow channels in order to obtain proper liquid velocities.
1.2.13 Inadequate consideration of pumping system design and/or fluid characteristics, resulting in pump cavitation.	New and Existing POTW's Refer to 1.1.39.
1.2.14 Use of single-speed pumps where variable-speed units are required.	New and Existing POTW's Dual-speed or variable-speed pumps should be considered for use at POTW influent lift stations in order to provide the necessary pumping capacities and desired efficiencies to handle both minimum and maximum flows.
1.2.15 Undersized scum pits.	New and Existing POTW's Refer to 1.1.43.

DEFICIENCY	CONSIDERATIONS
1.2.16 No provisions made to allow periodic cleaning of the influent wet well.	New POTW's The wet well design should include dual compartments to allow continued operation during maintenance periods, and should have a bottom drain valve or a pump-out sump. Existing POTW's Method: Construct partitions in the wet well that will compartmentalize it; the individual compartments can be dewatered when required for cleaning purposes.
1.2.17 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New POTW's Design channels for a flow velocity of 2 ft/sec at design flow. Provide means to clean out channels and splitter boxes (i.e., to remove settled solids and/or scum). Provide the flexibility to aerate channels carrying raw wastewater. Existing POTW's Method: Inject air along the channel or in the splitter boxes to maintain aerobic conditions. The channels or splitter boxes could also be partitioned off to reduce their volume and, therefore, increase flow-thru velocities and the time wastewater or sludge is allowed to remain in them.
1.2.18 Lack of floor trenches around pumps to carry water spills to sumps.	New and Existing POTW's Refer to 1.1.46.
1.2.19 Lack of seal water drippage drain lines.	New POTW's Refer to 1.1.53. Existing POTW's Method: Refer to 1.1.46

DEFICIENCY	CONSIDERATIONS
1.2.20 Pumps are located above the normal water level, making them difficult to prime.	New and Existing POTW's Refer to 1.1.56.
1.2.21 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Refer to 1.1.60.
1.2.22 Lack of mud valves in tanks.	New and Existing POTW's Refer to 1.1.61 and 1.2.8.
1.2.23 Lack of sumps in dry wells.	New and Existing POTW's Refer to 1.1.65.
1.2.24 Excess oil from stationary units not contained.	New POTW's Refer to 1.1.71. Existing POTW's Method: Provide drip pans to collect lubrication oil which drips from pumps and similar equipment. The drip pans can be emptied into a waste oil collection tank. The waste oil can then be reprocessed by a waste oil reprocessor. Materials: Metal or plastic drip pans large enough to have to be emptied only once every day or two. A covered 55-gallon drum or similar container for waste oil storage. The drum should be located away from storm drains and in an area where it will not be affected by traffic (vehicular or personnel) or by weather. Cost: Less than $100.

DEFICIENCY	CONSIDERATIONS
1.2.25 Lack of influent composite sampler.	New and Existing POTW's Refer to 1.1.72.
1.2.26 Lack of flexibility in disinfection systems to permit prechlorination for odor control or return sludge chlorination for control of bulking.	New and Existing POTW's Provide facilities necessary to allow prechlorination of raw wastewater to prevent odor problems at the front-end of a POTW. This would include extra chlorinator capacity over that required for just effluent disinfection, rotameters to control the flow of chlorine solution to the influent wet well, a diffuser in the wet well, wet well ventilation fans, and required piping.
1.2.27 Inadequate electrical capacity to permit stand-by pumps and air blowers to operate in parallel.	New POTW's Electrical systems should be sized to permit stand-by pumping equipment to operate in parallel with normally operating equipment. This may be periodically required during high influent flow periods. Existing POTW's Method: Refer to 1.1.92.
1.2.28 Lack of ventilation promotes corrosion of electrical components.	New POTW's Provide adequate ventilation in bar screen, comminutor, and pumping rooms to prevent corrosion of electrical components; in addition, specify sealed electrical components. Existing POTW's Method: Install ventilation fans and associated duct work to continually vent enclosed areas that have high humidity or corrosive gases (i.e., chlorine, hydrogen peroxide, hydrogen sulfide, etc.) present. The fans should provide a room air change rate of two times per hour. Provide NEMA-4 boxes for electrical components.

DEFICIENCY	CONSIDERATIONS
1.2.29 High water alarm systems not provided.	New and Existing POTW's Specify high-level alarm systems in wet wells, scum sumps, flow channels, chemical mix tanks, and similar unit operations. Alarms should signal at the main control panel as well as outside alarm horns to indicate to the operator the area of the plant having problems.
1.2.30 Motors oversized for future growth which never materialized, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.2.31 Electrical quick-disconnect plugs not provided with submerged pumps to facilitate rapid replacement.	New and Existing POTW's Refer to 1.1.98.
1.2.32 Inadequate plant lighting.	New and Existing POTW's Provide adequate lighting around unit operations located outside (i.e., wet wells, grit chambers, bar screens, etc.). Refer to 1.1.99.
1.2.33 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.
1.2.34 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.

DEFICIENCY	CONSIDERATIONS
1.2.35 Inadequate consideration of any potential freezing problems of plant components induced by wind and/or cold temperatures.	New and Existing POTW's In cold weather climates, consideration should be given to placing preliminary unit operations such as bar screens, comminutors, and grit chambers inside a protective structure. Provisions to cover wet wells and splitter boxes should also be made. Refer to 1.1.127.

Unit Operation/Component: 1.3 Primary

1.3.1 Inadequate consideration of scum removal from plant.	New and Existing POTW's Provide proper scum removal mechanism, such as chain-and-flight collector or return sludge flight collector, for rectangular tanks, and transverse rotating helical wiper attached to a shaft for circular tanks. Pumps should be designed to transport the scum to the solids handling facilities. Scum should not be recycled back through the plant.
1.3.2 Inadequate process flexibility.	New and Existing POTW's Refer to 1.1.18.
1.3.3 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Hose bibs should be provided at primary clarifiers, scum troughs, sumps, and pumping stations. Refer to 1.1.20.
1.3.4 Use of covered basins inhibit access to and observation of unit processes.	New and Existing POTW's Refer to 1.1.22.

DEFICIENCY	CONSIDERATIONS
1.3.5 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.3.6 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Refer to 1.1.24.
1.3.7 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.3.8 Inadequate provisions for sampling of individual processes.	New POTW's Provide safe and convenient access to primary clarifier effluent for sample collection. Existing POTW's Method: Provide sampling taps (per 1.1.17) on discharge end of primary sludge pumps.
1.3.9 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.3.10 Inadequate scum handling and disposal system.	New and Existing POTW's Refer to 1.1.29.
1.3.11 Lack of flexibility to operate POTW at low flow start-up conditions.	New and Existing POTW's Refer to 1.1.33.

DEFICIENCY	CONSIDERATIONS
1.3.12 Poor hydraulic and solids distribution among identical units operating in parallel.	New and Existing POTW's Provide a flow splitter box in front of primary clarifiers. For equal distribution, flow must have free fall over weirs.
1.3.13 Undersized scum pits.	New and Existing POTW's Refer to 1.1.43 and 1.2.15.
1.3.14 Individual flow measurement not provided for each of parallel units.	New and Existing POTW's Provide means, such as weirs, to measure the flow to individual units (i.e., primary clarifiers) that operate in parallel in order to allow adjustment of an equal flow rate to each unit. Refer to 1.1.36, 1.1.45, and 1.3.14.
1.3.15 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.3.16 Insufficient or inflexible sludge return and/or wasting pumping capacity.	New POTW's Design pumping systems to include spare pumps for increased flexibility. Provide variable speed drives on sludge pumps or install multiple pumps so that additional pumps can be operated to increase system capacity when required. Existing POTW's Method: Add auxiliary sludge pumping and piping or increase the impeller and/or motor size of the existing sludge pumps.
1.3.17 Lack of flow metering devices on chemical feed lines.	New and Existing POTW's Refer to 1.1.48.

DEFICIENCY	CONSIDERATIONS
1.3.18 Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkways to tilt and mechanical equipment to move out of alignment.	New and Existing POTW's Refer to 1.1.50.
1.3.19 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Refer to 1.1.60.
1.3.20 Lack of mud valves in tanks.	New and Existing POTW's Refer to 1.1.61 and 1.2.22.
1.3.21 No mixing provided in scum tank to keep scum mixed during pumping.	New and Existing POTW's Mixers should be installed in scum pits receiving large quantities of scum to keep a crust from forming in the pit, and the scum from coning during pumping. Scum pit bottoms should also be sloped.
1.3.22 Excess oil from stationary units not contained.	New POTW's Refer to 1.1.71. Existing POTW's Method: Refer to 1.2.24.
1.3.23 No positive method of removing scum from center well of clarifiers.	New and Existing POTW's Provide yard hydrants near clarifiers to allow operators to periodically clean out center wells. If the wastewater contains high concentrations of oil and grease: • Provide additional scum slots in center well wall. • Specify that a center well skimmer is to be provided by the clarifier supplier.

DEFICIENCY	CONSIDERATIONS
	• Consider a spray water system that forces scum through the slots in the center well wall.
1.3.24 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New POTW's Refer to 1.1.76. Existing POTW's Method: Refer to 1.1.26.
1.3.25 Absence of electrical outlets on top of treatment units.	New and Existing POTW's Refer to 1.1.80.
1.3.26 Inadequate electrical capacity to permit stand-by pumps and air blowers to operate in parallel.	New and Existing POTW's Refer to 1.1.92.
1.3.27 High water alarm systems not provided.	New and Existing POTW's Refer to 1.2.29.
1.3.28 Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.3.29 Inadequate plant lighting.	New and Existing POTW's Provide lighting around open tanks such as primary clarifiers. Refer to 1.1.99.
1.3.30 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.

DEFICIENCY	CONSIDERATIONS
1.3.31 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.
1.3.32 Inadequate consideration of any potential freezing problems of plant components.	New POTW's Refer to 1.1.127. Existing POTW's Method: If routine break-up of ice on clarifier is insufficient to ensure proper functioning of clarifier mechanism, add covers to primary clarifiers.

Unit Operation/Component: 1.4 Secondary Treatment

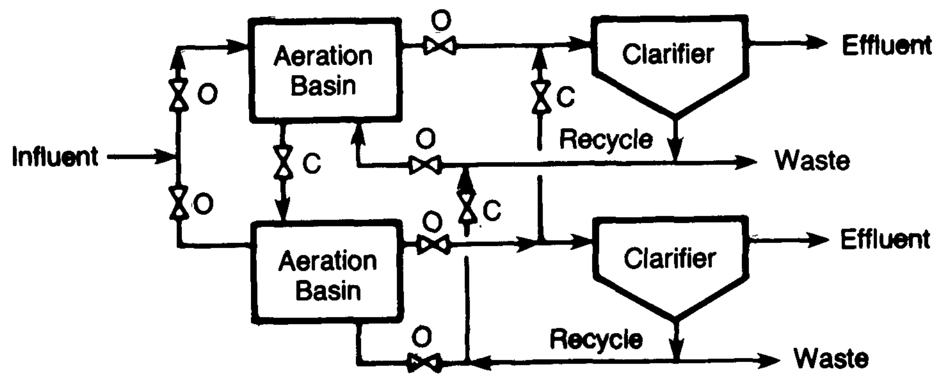
DEFICIENCY	CONSIDERATIONS
1.4.1 Lack of walkways around tanks, limiting operator access.	New POTW's Provide adequate walkways to allow maximum operator access to valves, tank sidewalls, gates, troughs, etc. Existing POTW's Method: Refer to 1.1.3.
1.4.2 Inadequate consideration of scum removal from plant.	New and Existing POTW's Provide proper scum removal mechanism, such as chain-and-flight collector or return sludge flight collector, for rectangular tanks, and transverse rotating helical wiper attached to a shaft for circular tanks. Pumps should be designed to transport the scum to the solids handling facilities. Ensure the scum is removed from the plant and not merely recycled back into the treatment system.

DEFICIENCY	CONSIDERATIONS
1.4.3 Inadequate consideration of consequences of rupture disc or shear pin failures.	New and Existing POTW's Refer to 1.1.10.
1.4.4 Inadequate process flexibility.	New POTW's Refer to 1.1.18. Existing POTW's Method: If plant layout warrants, install piping and valving so that multiple aeration basins can be operated in the complete mix mode, the plug flow mode, or the contact-stabilization mode (see sketches). In addition: • Add piping necesssary to isolate aeration basins, trickling filters, and clarifiers. • Install variable-speed aerators and/or blowers in aeration basin(s). • Install variable-speed sludge pumps for return and waste sludge flow. • Provide for recirculation of filter effluent at trickling filter plants. • Provide chemical feed system (capable of feeding at varying rates), if necessary, to improve settling characteristics. Materials: Valving and piping should be compatible with existing piping.

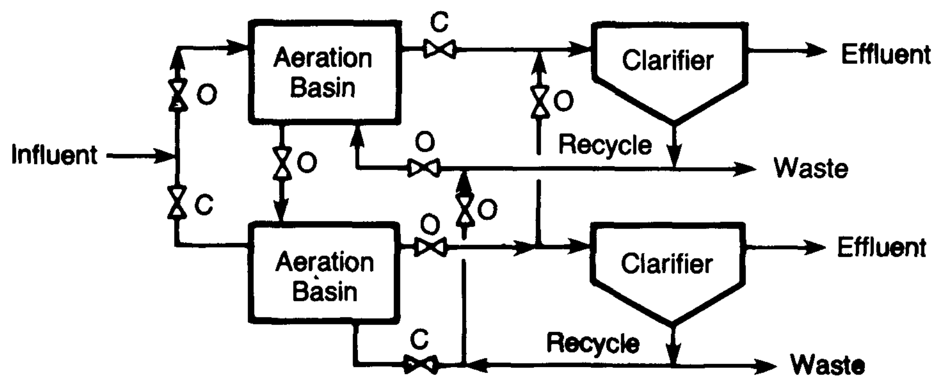
DEFICIENCY | CONSIDERATIONS

Sketch: Activated sludge modes.

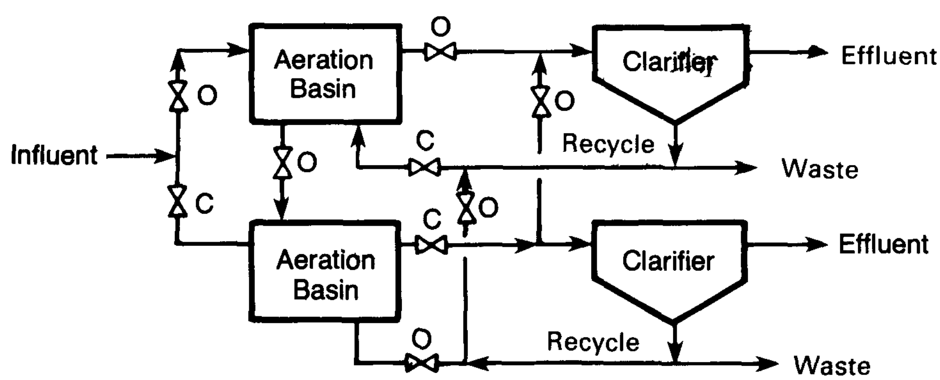
- Complete Mix



- Plug Flow



- Contact Stabilization



DEFICIENCY	CONSIDERATIONS
1.4.5 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Yard hydrants should be available for cleaning effluent weirs on tanks, scum troughs in clarifiers, tank sidewalls, and splitter boxes.
1.4.6 Use of covered basins inhibit access to and observation of unit processes.	New POTW's Refer to 1.1.22. Existing POTW's Method: Remove the covers from the basins unless the advantages of observation and access are outweighed by the freeze protection provided by the covers. Refer to 1.1.22.
1.4.7 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.4.8 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Refer to 1.1.24.
1.4.9 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26 and 1.2.22.
1.4.10 Inadequate provisions for sampling of individual processes.	New POTW's Provide sample taps on recycle/waste pump discharge lines. Existing POTW's Method: Provide D.O. probes for aeration basins, sampling taps on discharge side of sludge recycle/waste pumps, and flow measurement for sludge recycle stream and sludge waste stream.

DEFICIENCY	CONSIDERATIONS
1.4.11 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.4.12 Inadequate scum handling and disposal system.	New and Existing POTW's Refer to 1.1.29.
1.4.13 Foam sprays not concentrated in basin corners where foam buildup occurs.	New and Existing POTW's Refer to 1.1.30.
1.4.14 Lack of flexibility to operate POTW at low flow start-up conditions.	New and Existing POTW's Provide parallel secondary treatment trains and the piping flexibility needed to remove some of the units from service when flow is low.
1.4.15 Poor hydraulic and solids distribution among identical units operating in parallel.	New POTW's Provide a flow splitter box upstream of both aeration basins and clarifiers. For equal distribution, flow must have free fall over weirs. Existing POTW's Method: Provide a splitter box, if required, to divide flow and solids evenly among aeration basins and secondary clarifiers. If necessary, add valving to return sludge lines so that sludge recycle from a given clarifier will not be restricted to one particular aeration basin.
1.4.16 Undersized scum pits.	New POTW's Scum pits should be sized to accommodate one-day scum storage and be a minimum size of 4' x 4' x 4'.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 1.1.43.
1.4.17 Individual flow measurement not provided for each piece of parallel units.	New and Existing POTW's Provide means, such as weirs, to measure the flow to individual units, such as aeration basins and clarifiers that operate in parallel in order to allow adjustment of an equal flow rate to each unit. Refer to 1.1.45.
1.4.18 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.4.19 Insufficient or inflexible sludge return and/or wasting pumping capacity.	New and Existing POTW's Refer to 1.3.16.
1.4.20 Lack of flow metering device on chemical feed lines.	New and Existing POTW's Provide flow meters, such as rotameters, on chemical feed lines to allow accurate determination of chemical feed rates.
1.4.21 Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkways to tilt and mechanical equipment to move out of alignment.	New and Existing POTW's Refer to 1.1.50
1.4.22 No convenient means provided to feed dry chemicals into top-loading feeders.	New and Existing POTW's Refer to 1.1.51.
1.4.23 Lack of drains on chemical mix tanks.	New POTW's Refer to 1.1.52.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Add drain valves(s) to the bottom of above-ground chemical mix tank(s). Materials: Drain valves and piping should be compatible with tank material. Cost: Less than $100 per tank, including labor.
1.4.24 Pumps are located above the normal water level, making them difficult to prime.	New and Existing POTW's Refer to 1.1.56.
1.4.25 Chemical feed pumps are too small to allow high dosages of chemicals during emergencies.	New and Existing POTW's Refer to 1.1.58.
1.4.26 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Refer to 1.1.60.
1.4.27 Lack of mud valves in tanks.	New and Existing POTW's Refer to 1.1.61 and 1.2.8.
1.4.28 No mixing provided in scum tanks to keep scum mixed during pumping.	New and Existing POTW's Refer to 1.3.21.
1.4.29 Excess oil from stationary units not contained.	New POTW's Refer to 1.1.71. Existing POTW's Method: Refer to 1.2.24.

DEFICIENCY	CONSIDERATIONS
1.4.30 No positive method of removing scum from center well of clarifiers.	New and Existing POTW's Refer to 1.3.23.
1.4.31 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New and Existing POTW's Refer to 1.1.26.
1.4.32 Lack of flexibility in disinfection systems to permit prechlorination for odor nontrol or return sludge chlorination for control of bulking.	New and Existing POTW's Provide facilities necessary to allow chlorination of return activated sludge to alleviate bulking problems. A chlorine addition line should be tapped into the sludge return line. Additional chlorinator capacity above that required for effluent disinfection and a rotameter to control the chlorine solution feed rate would be required.
1.4.33 Lack of wyes, tees, and crosses to facilitate cleaning chemical lines.	New and Existing POTW's Refer to 1.1.77.
1.4.34 Lack of a foam control system.	New and Existing POTW's Refer to 1.1.79.
1.4.35 Absence of electrical outlets on top of treatment units.	New and Existing POTW's Electrical outlets should be provided at all sluice gate locations on aeration tanks to operate portable gate cranks and at the center well on all clarifiers for power tools. Refer to 1.1.80.
1.4.36 Lack of electrical outlets at field-mounted instrumentation for portable calibration equipment.	New and Existing POTW's Electrical outlets should be provided at pH and D.O. monitoring stations to allow calibration of the equipment with portable equipment or for temporary hook-up of equipment. Refer to 1.1.83.

DEFICIENCY	CONSIDERATIONS
1.4.37 Inadequate electrical capacity to permit stand-by pumps and air blowers to operate in parallel.	New and Existing POTW's Refer to 1.1.92.
1.4.38 High water alarm systems not provided.	New and Existing POTW's Refer to 1.2.29.
1.4.39 Motors over-sized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.4.40 Inadequate plant lighting.	New and Existing POTW's Provide lighting around aeration tanks, clarifiers, walkways and stairways. Refer to 1.1.99.
1.4.41 Use of air headers as guard railing at small package-plant type POTWs.	New and Existing POTW's Refer to 1.1.103.
1.4.42 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.
1.4.43 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.
1.4.44 Inadequate noise abatement in various plant areas (i.e., blower, pump and dewatering rooms, etc.).	New POTW's Aeration blowers should be specified with noise reduction accessories such as inlet and outlet silencers and sound enclosures.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Provide noise abatement measures per 1.1.124.
1.4.45 Inadequate consideration of potential freezing problem of plant components.	New POTW's Refer to 1.1.127. Existing POTW's Method: Provide splash guards around fixed aerators to decrease freezing during winter months. Cover aeration basins/trickling filters and/or clarifiers, if necessary. Provide insulation and/or heat tracing of exposed pipes and valves.

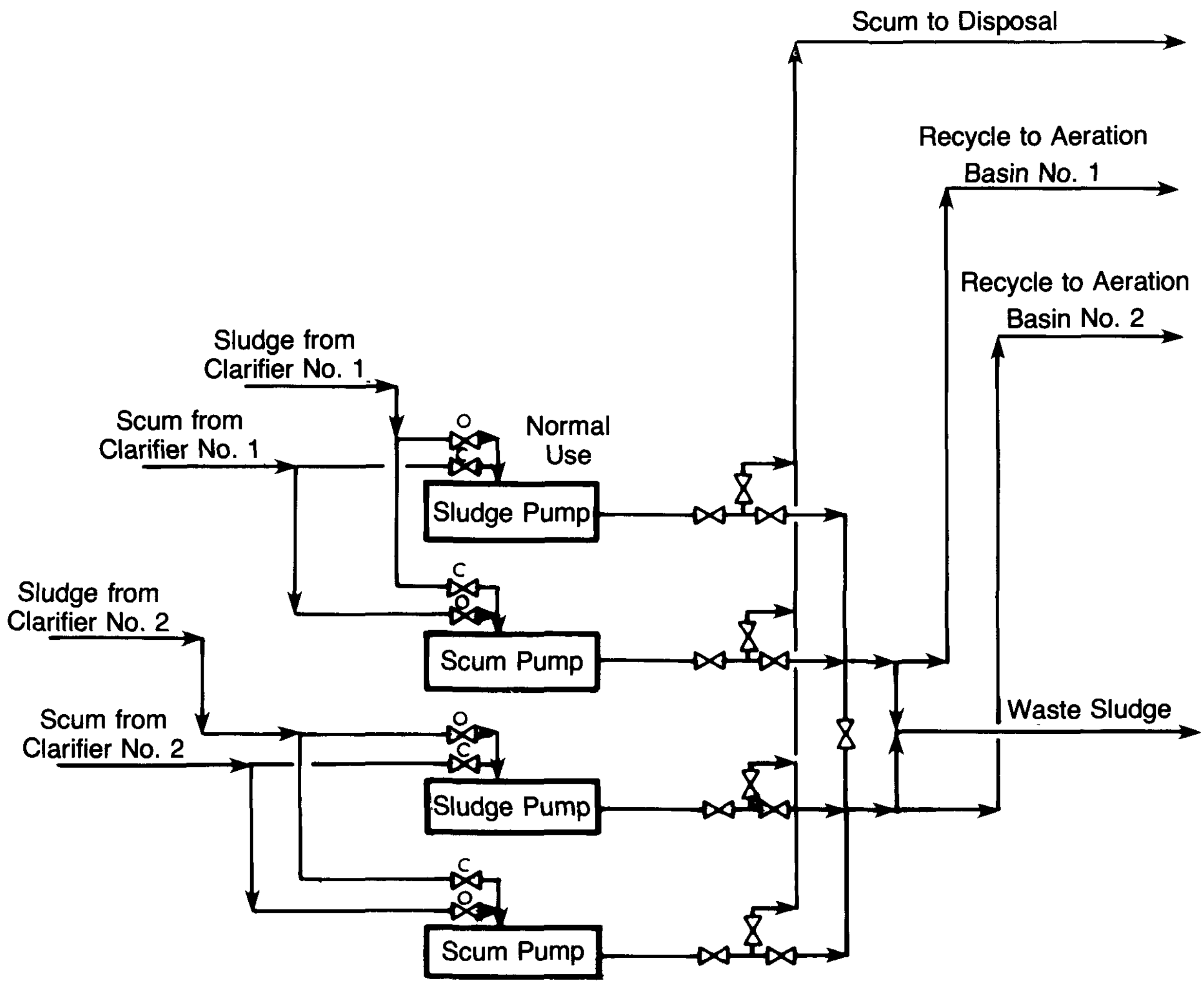
Unit Operation/Component: 1.5 Sludge Handling

DEFICIENCY	CONSIDERATIONS
1.5.1 No provisions for moving equipment and supplies from one building floor to another.	New POTW's Provide adequate means of moving equipment and supplies from one building floor to another through the use of ramps, hoists, and/or elevators. Care should be taken to assure that elevators and floor cutouts for hoists are large enough to allow passage of the largest pieces of equipment in use, or anticipated to be used, in the building being designed. Existing POTW's Method: Refer to 1.1.5.
1.5.2 Inadequate consideration of scum removal from plant.	New and Existing POTW's Refer to 1.4.2.

DEFICIENCY	CONSIDERATIONS
1.5.3 Inadequate consideration of consequences of rupture disc or shear pin failures.	New and Existing POTW's Refer to 1.1.10.
1.5.4 Lack of sampling taps at pumping stations.	New and Existing POTW's Provide sampling taps in the discharge lines from sludge pumping stations. Refer to 1.1.17.
1.5.5 Inadequate process flexibility.	New POTW's Refer to 1.1.18. Existing POTW's Method: Add piping and valving so that each thickener, sludge pump, and sludge holding tank can be isolated for routine maintenance and needed repairs. In the case where the sludge pumps and the scum pumps are similar models, provide valving and piping (as shown in the sketch) to allow the scum pumps to be used as sludge pumps whenever the sludge pumps have to be serviced. If only sludge pumps are available, provide valving and piping to allow the sludge pumps to serve any of the clarifiers. Provide valving at both the suction and discharge sides of the pump so that the pump can be removed for repairs. Materials: Piping and valving to be compatible with existing piping.

DEFICIENCY CONSIDERATIONS

Sketch:



DEFICIENCY	CONSIDERATIONS
1.5.6 Insufficient number and poor placement of high-pressure hose hydrants throughout the plant.	New and Existing POTW's Provide hose bibs near all sludge handling equipment such as pumps, thickeners, dewatering units, etc.
1.5.7 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.5.8 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Refer to 1.1.24.
1.5.9 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.5.10 Inadequate provisions for sampling of individual processes.	New and Existing POTW's Sample taps should be provided on the piping connecting unit processes and on sludge pump discharge lines. Refer to 1.1.17 and 1.1.27.
1.5.11 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.5.12 Lack of flexibility to operate POTW at low flow start-up conditions.	New and Existing POTW's Provide dual systems and stand-by equipment (i.e., pumps) to allow operation of single units during low-flow periods. In addition, rather than operating sludge handling facilities on a continuous basis, operate them only when sufficient quantity of sludge is available.

DEFICIENCY	CONSIDERATIONS
1.5.13 Floor drain piping system undersized.	<u>New and Existing POTW's</u> Floor drain piping for sludge handling facilities should be specified at 6-inch diameter minimum. Refer to 1.1.34.
1.5.14 Use of single-speed pumps where variable-speed units are required.	<u>New POTW's</u> Specify sludge pumps that are two-speed or variable-speed drive units. <u>Existing POTW's</u> <u>Method</u>: Add variable-speed device to existing pumps or a pump recycle line with a flow control valve (FCV) that operates according to the liquid level in the wet well (i.e., as the level increases, the FCV closes and vice versa).
1.5.15 Poor hydraulic and solids distribution among identical units operating in parallel.	<u>New and Existing POTW's</u> Refer to 1.3.12 and 1.4.15.
1.5.16 Undersized scum pits.	<u>New and Existing POTW's</u> Refer to 1.1.43 and 1.4.16.
1.5.17 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	<u>New and Existing POTW's</u> Refer to 1.2.17.
1.5.18 Lack of floor trenches around pumps to carry water spills to sumps.	<u>New and Existing POTW's</u> Refer to 1.1.46.
1.5.19 Insufficient or inflexible sludge return and/or wasting pumping capacity.	<u>New and Existing POTW's</u> Refer to 1.3.16.

DEFICIENCY	CONSIDERATIONS
1.5.20 Lack of flow metering device on chemical feed lines.	New and Existing POTW's Refer to 1.1.48.
1.5.21 Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkway to tilt and mechanical equipment to move out of alignment.	New and Existing POTW's Refer to 1.1.50.
1.5.22 No convenient means provided to feed dry chemical into top-loading feeders.	New and Existing POTW's Refer to 1.1.51.
1.5.23 Lack of drains on chemical mix tanks.	New POTW's Refer to 1.1.52. Existing POTW's Method: Add drain valve(s) to the bottom of above-ground chemical mix tank(s). Materials: Drain valves and piping should be compatible with tank material. Cost: Less than $100 per tank, including labor.
1.5.24 Lack of seal water drippage drain lines.	New and Existing POTW's Pipe pump drain lip to sump or floor drain. Refer to 1.1.46.
1.5.25 Chemical feed pumps are too small to allow high dosages of chemicals during emergencies.	New and Existing POTW's Refer to 1.1.58.

DEFICIENCY	CONSIDERATIONS
1.5.26 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Refer to 1.1.60.
1.5.27 Excess oil from stationary units not contained.	New and Existing POTW's Refer to 1.1.71.
1.5.28 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New and Existing POTW's Refer to 1.1.26.
1.5.29 Inadequate electrical capacity to permit standby pumps and air blowers to operate in parallel.	New and Existing POTW's Refer to 1.1.92.
1.5.30 Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.5.31 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.1, 1.1.28, and 1.1.121.
1.5.32 Inadequate consideration of OSHA requirements.	New and Existing POTW's Refer to 1.1.122.
1.5.33 Inadequate noise abatement in various plant areas (i.e., blower, pumps, and dewatering rooms, etc.).	New POTW's Refer to 1.1.110 and 1.1.124.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: 1. Install silencers for T.E.F.C. electric motor air inlets. 2. Install vibration damping motor and pump mountings. 3. Replace existing pumps and motors with ones that meet a lower noise level specification. 4. Enclose electric motors and pumps with noise attenuating enclosure if above procedures do not reduce work place noise level sufficiently. 5. Install vibration attenuating pipe supports or hangers, and/or flexible couplings between pumps and piping system. 6. As a last resort, issue personal hearing protective equipment.

Unit Operation/Component: 1.6 Sludge Digestion

1.6.1 Inadequate consideration of scum removal from plant.	New POTW's Scum troughs, telescopic valves, swing valves, or draw-off ports should be provided to remove scum from aerobic and anaerobic digesters. The collected scum should be removed from the plant and not recycled back through it. Existing POTW's Method: Refer to 1.2.2.
1.6.2 Inadequate process flexibility.	New POTW's Refer to 1.1.18.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Add piping and valving to isolate each digester (aerobic or anaerobic) during maintenance. Materials: Piping and valving to be compatible with existing piping.
1.6.3 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Provide yard hydrants near sludge digesters and flushing connections to digester piping.
1.6.4 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.6.5 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Refer to 1.1.24.
1.6.6 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.6.7 Inadequate provisions for sampling of individual processes.	New POTW's Provisions should be made to allow sampling of the digester influent and effluent flows. Sample taps should be installed on piping connecting unit processes and on sludge pump discharge lines. Existing POTW's Method: Provide sampling taps at discharge of sludge transfer pumps. Provide sampling taps at multiple levels in anaerobic digester.
1.6.8 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.

DEFICIENCY	CONSIDERATIONS
1.6.9 Inadequate scum handling and disposal system.	New and Existing POTW's Scum collected from digesters should be transported to the sludge handling area and removed from the plant, not recycled back through the plant. Refer to 1.2.2.
1.6.10 Foam sprays not concentrated in basin corners where foam build-up occurs.	New and Existing POTW's Refer to 1.1.30.
1.6.11 Floor drain system undersized.	New and Existing POTW's All drain piping in the digester area should be a minimum of 6 inches in diameter. Refer to 1.1.34.
1.6.12 Poor hydraulic and solids distribution among identical units operating in parallel.	New and Existing POTW's Provide a flow splitter box upstream of digester units. Provisions to allow stopping of the flow to each unit must also be provided. For equal distribution, flow must have free fall over the weirs.
1.6.13 Undersized scum pits.	New and Existing POTW's Refer to 1.1.43.
1.6.14 Individual flow measurement not provided for each piece of parallel units.	New and Existing POTW's Provide means such as weirs to measure the flow to individual units, such as digesters, that operate in parallel in order to allow adjustment of an equal flow rate to each unit. Refer to 1.1.45.
1.6.15 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.6.16 No convenient means provided to feed dry chemicals into top-loading feeders.	New and Existing POTW's Refer to 1.1.51.

DEFICIENCY	CONSIDERATIONS
1.6.17 Lack of drains on chemical mix tanks.	New POTW's Refer to 1.1.52. Existing POTW's Method: Add drain valve(s) to the bottom of above-ground chemical mix tank(s). Materials: Drain valves and piping should be compatible with tank material. Cost: Less than $100 per tank, including labor.
1.6.18 Lack of air bleed-off valves at high points in pump discharge lines.	New and Existing POTW's Refer to 1.1.60.
1.6.19 Lack of mud valves in tanks.	New and Existing POTW's Refer to 1.1.61.
1.6.20 Excess oil from stationary units not contained.	New and Existing POTW's Refer to 1.1.71.
1.6.21 Design does not emphasize heating conservation measures.	New and Existing POTW's Off-gases (i.e., methane) from anaerobic digestion units should be used as a fuel source for plant heating systems (i.e., buildings and digesters) and fuel-driven engines and generators.
1.6.22 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New and Existing POTW's Refer to 1.1.26.
1.6.23 Lack of a foam control system.	New and Existing POTW's Refer to 1.1.79.

DEFICIENCY	CONSIDERATIONS
1.6.24 Inadequate electrical capacity to permit standby pumps and air blowers to operate in parallel.	New and Existing POTW's Refer to 1.1.92.
1.6.25 High water alarm systems not provided.	New and Existing POTW's Refer to 1.2.29.
1.6.26 Motors over-sized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.6.27 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.
1.6.28 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.

Unit Operation/Component: 1.7 Sludge Dewatering

1.7.1 Lack of hoists over larger pieces of equipment.	New and Existing POTW's Refer to 1.1.1.
1.7.2 No provisions for moving equipment and supplies from one building floor to another.	New and Existing POTW's An overhead crane or monorail should be provided over each piece of dewatering equipment. Refer to 1.1.5.
1.7.3 Inadequate process flexibility.	New POTW's Refer to 1.1.18.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Provide piping and valving necessary to isolate dual units. If warranted, install additional dewatering equipment of the same type as existing equipment.
1.7.4 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Provide a hose bib at each piece of dewatering equipment. Provide floor drains around and under dewatering equipment.
1.7.5 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.7.6 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Ensure ample room (4-ft minimum) is provided around sludge dewatering equipment to allow access by operators and equipment. Provide ample overhead clearances as well.
1.7.7 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.7.8 Inadequate provisions for sampling of individual processes.	New POTW's Provide sample taps in sludge lines to allow determination of feed solids concentrations to sludge dewatering equipment. Existing POTW's Method: Provide sampling tap in sludge feed line to measure solids concentration in feed.

DEFICIENCY	CONSIDERATIONS
	Provide for process sampling as follows: • Centrifugation - Provide sampling taps in centrate discharge line to measure turbidity or suspended solids of centrate. • Vacuum and Pressure Filtration Provide sampling taps in filtrate discharge line to measure filtrate suspended solids. • Sludge Drying Beds - Provide access to allow operator to measure sludge dryness at several locations in the bed as well as underflow from the bed.
1.7.9 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.7.10 Lack of flexibility to operate POTW at low flow, start-up conditions.	New and Existing POTW's Refer to 1.5.12.
1.7.11 Floor drain piping system undersized.	New and Existing POTW's All drain piping in sludge dewatering areas should be a minimum of 6 inches in diameter. Refer to 1.1.34.
1.7.12 Drains from buildings discharge into basins with normally (or periodically) high-water levels, causing drains to back-up.	New and Existing POTW's Refer to 1.1.35.

DEFICIENCY	CONSIDERATIONS
1.7.13 Poor hydraulic and solids distribution among identical units operating in parallel.	New and Existing POTW's Specifv feed tanks for sludge dewatering equipment be mixed to prevent solids settling and ensure equal solids distribution to dewatering equipment.
1.7.14 Undersized scum pits.	New and Existing POTW's Refer to 1.1.43.
1.7.15 Individual flow measurement not provided for each piece of parallel units.	New and Existing POTW's Provide flow measuring (and adjustment) equipment to allow determination of flows to sludge dewatering equipment, especially units such as vacuum filters that operate continuously. Refer to 1.6.14.
1.7.16 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.7.17 Lack of flow metering device on chemical feed lines.	New and Existing POTW's Refer to 1.1.48.
1.7.18 Piping which hangs under outside edge of walkways in clarifiers and thickeners causes the walkways to tilt and mechanical equipment to move out of alignment.	New and Existing POTW's Refer to 1.1.50.
1.7.19 Chemical feed pumps are too small to allow high dosages of chemicals during emergencies.	New and Existing POTW's Refer to 1.1.58.

DEFICIENCY	CONSIDERATIONS
1.7.20 No mixing provided in scum tank to keep scum mixed during pumping.	New and Existing POTW's Refer to 1.3.21.
1.7.21 Excess oil from stationary units not contained.	New POTW's Refer to 1.1.71. Existing POTW's Method: Refer to 1.2.24.
1.7.22 No positive method of removing scum from center well of clarifiers.	New and Existing POTW's Refer to 1.3.23.
1.7.23 Lack of wyes, tees, and crosses to facilitate cleaning of chemical lines.	New and Existing POTW's Refer to 1.1.77.
1.7.24 Absence of electrical outlets on top of treatment units.	New and Existing POTW's Provide electrical outlets on top of thickeners and nearby dewatering equipment.
1.7.25 Use of open fluorescent lighting in humid areas (i.e., dewatering building) of POTW.	New and Existing POTW's Refer to 1.1.90.
1.7.26 Placement of motor control centers too close to washdown areas.	New POTW's Since sludge dewatering areas are subject to washdown, motor controls should be housed in separate rooms. Existing POTW's Method: Refer to 1.1.91.

DEFICIENCY	CONSIDERATIONS
1.7.27 Inadequate electrical capacity to permit standby pumps and air blowers to operate in parallel.	New and Existing POTW's Refer to 1.1.92.
1.7.28 Lack of ventilation promotes corrosion of electrical components.	New POTW's Adequate ventilation must be provided to remove moisture and control humidity levels to prevent instrumentation corrosion problems. Existing POTW's Method: Refer to 1.2.28.
1.7.29 Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.
1.7.30 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.
1.7.31 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.
1.7.32 Inadequate noise abatement in various plant areas (i.e., blower, pump, and dewatering rooms, etc.).	New POTW's Refer to 1.1.124. Existing POTW's Method: The following steps are recommended: 1. Conduct noise survey to identify problem areas.

DEFICIENCY	CONSIDERATIONS
	2. Install vibration-attenuating mounts on motors and equipment. 3. Install flexible couplings between equipment and piping, i.e., fluid and electrical or vibration-attenuating pipe hangers. 4. Install air inlet and exhaust silencers on compressors and vacuum pumps. 5. If above procedures fail to reduce work area noise levels to acceptable levels, install noise-attenuating enclosures. 6. As a last resort, issue personnel hearing protective equipment.
1.7.33 Inadequate consideration of any potential freezing problems of plant components.	New and Existing POTW's Trucks and dumpsters which receive dewatered sludge cake should be housed inside to prevent the cake from freezing to the unit and making it difficult to remove.

Unit Operation/Component: 1.8 Sludge Incineration

1.8.1 Inadequate process flexibility.	New POTW's Provide variable speed control on incinerator feed conveyors. Provide an alternate means to dispose of sludge, such as a landfill, if the incinerator is taken out of service.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Provide multiple incineration units sized such that if one unit is taken out of service, the remaining units can handle the entire sludge feed; or provide a landfill so that sludge can be disposed of when the incinerator system is shut down for repairs.
1.8.2 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Provide hose bibs at each floor level in the incinerator building. Refer to 1.1.20.
1.8.3 All valves not operable from floor level.	New and Existing POTW's Refer to 1.1.23.
1.8.4 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's Refer to 1.7.6.
1.8.5 Inadequate provisions for sampling of individual processes.	New POTW's Provide sample ports in the incinerator. Existing POTW's Method: Provide facilities (sample taps, instrumentation, etc.) to perform the following tests for multiple hearth or fluidized bed incineration systems: • Measurement of sludge feed solids concentration. • Measurement of excess air flow. • Measurement of oxygen, carbon dioxide, and carbon monoxide in the stack gases.

DEFICIENCY	CONSIDERATIONS
1.8.6 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	<u>New and Existing POTW's</u> Refer to 1.1.28.
1.8.7 Excess oil from stationery units not contained.	<u>New and Existing POTW's</u> Refer to 1.1.71 and 1.2.24.
1.8.8 Lack of ventilation promotes corrosion of electrical components.	<u>New and Existing POTW's</u> Refer to 1.2.28 and 1.7.28.
1.8.9 Handling facilities not provided for mechanical components over 100 pounds.	<u>New and Existing POTW's</u> Refer to 1.1.121.
1.8.10 Inadequate consideration of OSHA safety requirements.	<u>New and Existing POTW's</u> Refer to 1.1.122.

Unit Operation/Component: 1.9 Sludge Disposal

1.9.1 Inadequate process flexibility.	<u>New POTW's</u> Provide an alternate disposal mode to the primary method utilized. Alternatives could include landfilling, storage lagoon, composting, etc. <u>Existing POTW's</u> <u>Method</u>: The following are suggestions to increase the process flexibility of the sludge disposal method currently used at a given plant. • Add piping and valving to isolate each unit in the sludge disposal system (for maintenance purposes).

DEFICIENCY	CONSIDERATIONS
	• Provide adequate capacity to store sludge or dewatered cake prior to transporting to landfill. • Provide an alternative disposal mode to the primary method utilized. Alternatives could include landfilling, storage lagoon, composting, and incineration.
1.9.2 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Provide utility water hydrants near all sludge handling areas.
1.9.3 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28 and 1.7.9.
1.9.4 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.
1.9.5 Inadequate consideration of any potential freezing problems of plant components.	New and Existing POTW's Refer to 1.7.33.
1.9.6 Inadequate consideration of local weather conditions and their impact on the accessibility of a plant site.	New and Existing POTW's Temporary sludge storage facilities (or extra capacity in on-line units) should be provided to hold sludge during wet-weather conditions when landfilling or land application are the primary sludge disposal methods utilized by a POTW.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.10 Disinfection	
1.10.1 Inadequate valving for maximum flexibility and proper maintenance.	New POTW's Each chlorinator should be valved so that it can be taken out of service without shutting down the entire system. Existing POTW's Method: Add piping and valving to isolate each chlorinator/ozonator and each contact tank during maintenance. If necessary, add provisions for chlorination for odor control and/or bulking control per 1.10.2. Materials: Piping and valving to be compatible with existing piping.
1.10.2 Inadequate process flexibility.	New POTW's Process piping should be designed to allow application of chlorine solutions to various points in the POTW. Each chlorine solution feed point should be provided with a separate feed line, and each feed line should have flow measuring and control devices. Refer to 1.2.26 and 1.4.32. Existing POTW's Method: The following applies to both chlorination and ozonation systems: • Provide duplicate contact chambers and chlorine/ozone addition systems, as well as piping and valving necessary to isolate a contact chamber and/or chlorinator/ozonator for maintenance purposes.

DEFICIENCY	CONSIDERATIONS
	• Provide valving and piping per 1.10.10 to facilitate prechlorination/pre-ozonation for odor control, control of filter flies, control of bulking by return sludge chlorination/ozonation, etc.
1.10.3 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	New and Existing POTW's Utility water hydrants should be provided near chlorine contact chambers and hose bibs near chlorination rooms.
1.10.4 Inadequate clearance around equipment for maintenance functions.	New and Existing POTW's A minimum clearance of 4 feet should be provided around chlorinators and disinfection equipment for maintenance purposes.
1.10.5 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.10.6 Inadequate provisions for sampling of individual processes.	New and Existing POTW's Provision should be made for sample collection at the effluent end of chlorine contact tanks (even if it is not the final plant discharge point).
1.10.7 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Provide monorail for unloading and moving chlorine cylinders. Refer to 1.1.28.
1.10.8 Inadequate scum handling and disposal system.	New and Existing POTW's Scum removal facilities, such as a scum trough, should be provided as part of the chlorine contact chamber. Scum should be removed from the plant and not recycled through it.

DEFICIENCY	CONSIDERATIONS
1.10.9 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.10.10 Lack of flexibility in disinfection systems to permit prechlorination for odor control or return sludge chlorination for control of bulking.	New POTW's The chlorination system should be designed to feed chlorine to both the influent pumping and sludge areas. Refer to 1.2.26 and 1.4.32.

Existing POTW's

Method: Provide valving and piping to facilitate chlorine addition as follows:

- Prechlorination for odor control

  1. Add to influent pump discharge line.

  2. Provide eductor or other in-line mixing device. Typical prechlorination dosages for odor control range from 10 to 20 mg/L.

- Control of bulking by return sludge chlorination

  (Chlorination is effective only in controlling bulking caused by filamentous growths.)

  1. Add chlorine to discharge line of return sludge pumps.

  2. Provide eductor or other in-line mixing device. Chlorination of return sludge should be based on the dry

DEFICIENCY	CONSIDERATIONS
	sludge solids concentration. A reasonable range is between 0.2 and 1.0 percent by weight. Control of bulking by return sludge chlorination has the disadvantages of returning a less viable and potentially toxic sludge to biological treatment systems and of increased chlorine requirements. Careful consideration must be given to the advantages and disadvantages before providing return sludge chlorination. Materials: Piping and valving to be compatible with existing influent piping and/or return sludge piping and to be suitable for service with chlorine.
1.10.11 Lack of ventilation promotes corrosion of electrical components.	New POTW's Chlorination facilities should be placed in separate, ventilated rooms for safety reasons and to help prevent chlorine gas from corroding equipment and instrumentation. Existing POTW's Method: Refer to 1.2.28.
1.10.12 Inadequate consideration of OSHA safety requirements.	New POTW's Chlorine leak detection equipment should be available, and the chlorinator room should be ventilated at a rate of one air change every three minutes. Ventilation fans should be located near the floor. Existing POTW's Method: Refer to 1.1.122.

DEFICIENCY | CONSIDERATIONS

1.10.13 Inadequate consideration of any potential freezing problems of plant components.

New and Existing POTW's

Refer to 1.1.127.

Unit Operation/Component: 1.11 Lagoons

1.11.1 Inadequate valving for maximum flexibility and proper maintenance.

New POTW's

Piping and valving should be provided between lagoons (or lagoon sections) to allow isolation and dewatering of individual units for maintenance.

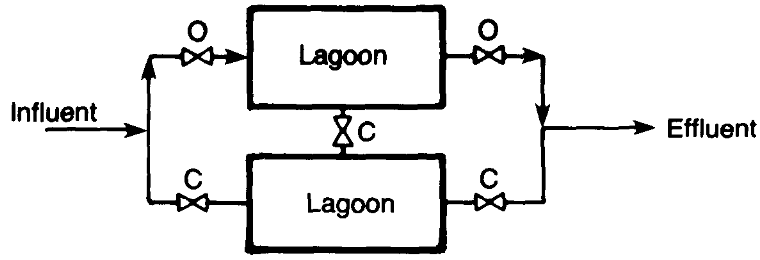
Existing POTW's

Method: Install piping and valving so that each lagoon can be isolated for maintenance and so that multiple lagoons can be used in parallel or in series.

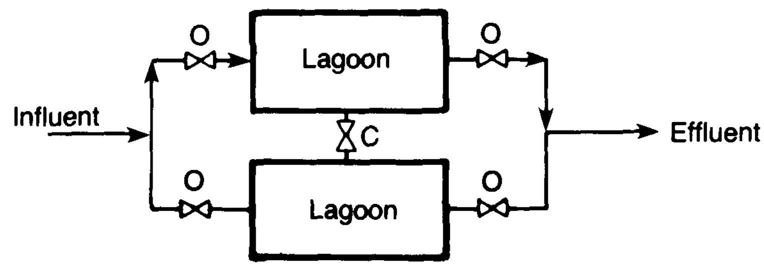
Materials: Piping and valving to be compatible with existing piping.

Sketch:

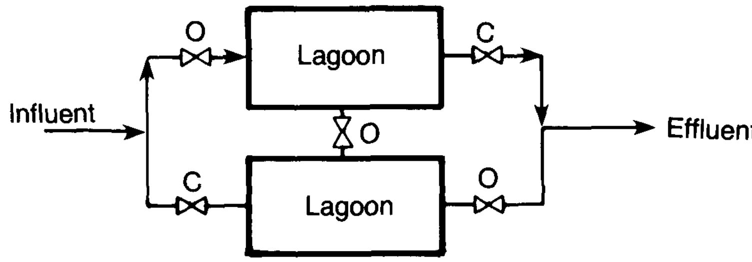
- Isolate one lagoon



- Parallel operation



DEFICIENCY	CONSIDERATIONS
	• Series operation



1.11.2 Inadequate process flexibility.	New POTW's Lagoon systems should be designed such that the lagoons can be operated in series or parallel. Refer to 1.11.1. Existing POTW's Method: Provide piping and valving per 1.11.1 so that the lagoons can be operated in parallel during the summer months and in series during the winter months. This method of operation conserves heat. The aerators in both lagoons are operated until ice formation forces the shutdown of the aerator(s) in the second lagoon. The second lagoon functions as an anaerobic pond during the winter months, but because the lagoon is covered with ice, odor problems are minimized. When the ice melts in the spring, the lagoons can be operated in parallel. In addition, provide capability to recycle a portion of the solids removed by settling.
1.11.3 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Berms around and between lagoons should be designed to allow vehicles to travel along the top of the berm.

DEFICIENCY	CONSIDERATIONS
1.11.4 Individual flow measurement not provided for each piece of parallel units.	New and Existing POTW's Refer to 1.4.17.
1.11.5 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17.
1.11.6 Inadequate provisions for manual valve operation during emergency conditions.	New and Existing POTW's Refer to 1.1.75.
1.11.7 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.

Unit Operation/Component: 1.12 Land Application

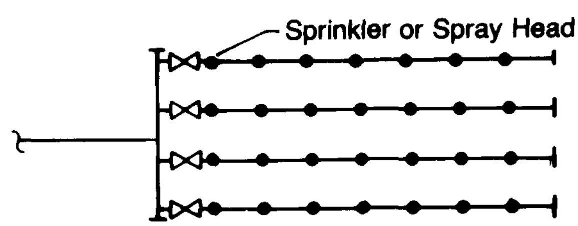
DEFICIENCY	CONSIDERATIONS
1.12.1 Inadequate valving for maximum flexibility and proper maintenance.	New POTW's Refer to 1.1.9.

Existing POTW's

Method: Provide valves and blind flanges on each pipe run to facilitate cleaning, as shown in the sketch below.

Materials: Valves and flanges to be compatible with existing piping.

Sketch:



DEFICIENCY	CONSIDERATIONS
	<u>Cost</u>: Under $50 for each flange, under $100 for each valve. Cost depends on pipe size and material.
1.12.2 Inadequate process flexibility.	<u>New POTW's</u> Provide storage facilities or alternate treatment approach for use during inclement weather conditions (i.e., rain, freezing temperatures). Refer to 1.1.18. <u>Existing POTW's</u> <u>Method</u>: Provide piping and valving per 1.12.1 to allow independent operation of each section of the application system. Provide interim storage facilities.
1.12.3 Insufficient number and poor placement of high-pressure hose hydrants throughout plant.	<u>New and Existing POTW's</u> Provide yard hydrants around preliminary treatment and any sludge handling equipment.
1.12.4 All valves not operable from floor level.	<u>New and Existing POTW's</u> Refer to 1.1.23.
1.12.5 Inadequate clearance around equipment for maintenance functions.	<u>New and Existing POTW's</u> Refer to 1.1.24.
1.12.6 Inadequate provisions for draining tanks and sumps.	<u>New POTW's</u> Refer to 1.1.26. <u>Existing POTW's</u> <u>Method</u>: Provide a frost-free valve at the low point of each run of distribution pipe.

DEFICIENCY	CONSIDERATIONS
	Materials: Frost-free valves to be of material compatible with existing piping. Cost: Under $150 for each line.
1.12.7 Inadequate provisions for sampling of individual processes.	New POTW's Provide capabilities to sample the effluent from preliminary treatment units. Refer to 1.1.27. Existing POTW's Method: Provide composite sampler or other means of sampling effluent from the leachate collection and treatment system. Provide capabilities to sample the effluent from preliminary treatment units. Refer to 1.1.27.
1.12.8 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's Refer to 1.1.28.
1.12.9 Individual flow measurement not provided for each piece of parallel units.	New and Existing POTW's Refer to 1.1.45 and 1.3.14.
1.12.10 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17 and 1.3.15.
1.12.11 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.

DEFICIENCY	CONSIDERATIONS
1.12.12 Inadequate consideration of OSHA safety requirements.	New and Existing POTW's Refer to 1.1.122.
1.12.13 Inadequate consideration of any potential freezing problems of plant components.	New POTW's Refer to 1.1.127 and 1.12.2. Existing POTW's Method: Provide cover material such that distribution piping is buried a minimum of 4 to 5 feet below ground. Provide frost-free drain valves at low point of each leg of the distribution header. All exposed piping and valves to be heat-traced (steam or electric).
1.12.14 Inadequate consideration of local weather conditions and their impact on the accessibility of a plant site.	New POTW's Rainfall and seasonal temperature ranges must be considered when selecting land application sites. Optimum application techniques can vary according to whether the site is located in an arid or cold weather area. Refer to 1.1.131. Existing POTW's Method: Provide an all-weather road to the plant site, and add all-weather roads within plant site as required for equipment access. Refer to 1.1.131. Materials: Asphalt or gravel. Cost: Gravel - \$2 per sq ft Asphalt - \$4 per sq ft

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.13 Small Package Plants	
1.13.1 Lack of spare pumps.	New POTW's Provide a spare pump(s) at every pumping installation in the plant or, as a minimum, spare pumps at major pumping stations (i.e., influent, sludge recycle/waste, intermediate lift, utility water, etc.) and portable pump hookups at small pumping stations (i.e., chemical feed, spray water, etc.). Existing POTW's Method: Refer to 1.1.2.
1.13.2 Lack of walkways around tanks, limiting operator access.	New POTW's Provide adequate walkways and/or stairways to allow operator access to valve handles, gates, instrumentation, etc., and/or to equipment and tank sidewalls for maintenance and clean-up purposes. Existing POTW's Method: Refer to 1.1.3.
1.13.3 Tall, above-ground tanks frequently require operator to climb long stairways.	New and Existing POTW's If space is available, size tanks with adequate width and length to minimize height requirements, and/or construct deep tanks at least partially in ground, or, as a minimum, provide hoists at the top of stairways to eliminate need for operator to carry equipment up long stairways.
1.13.4 Inadequate flexibility to by-pass units.	New POTW's For preliminary treatment units (grit chamber, bar screens, comminutors, etc.), provide by-pass channels. For large multi-unit systems (clarifiers, aeration tanks), tank piping should include necessary valves to allow the stoppage of flow

DEFICIENCY	CONSIDERATIONS
	to each tank. For pretreatment units such as equalization, oil and grease removal, odor control, etc., by-pass piping should also be provided. Existing POTW's Method: Refer to 1.1.7.
1.13.5 Inadequate consideration of means to remove equipment for repair or replacement.	New and Existing POTW's Provide doors large enough to permit passage of any vehicles or tools required to remove pieces of equipment from a building, and also large enough to permit passage of the equipment itself. Adequate passageways in the building and around the equipment should be provided to allow easy access for both maintenance and removal. A minimum working space of four feet should be provided around all equipment. Refer to 1.1.1 and 1.1.5.
1.13.6 Inadequate consideration of scum removal from plant.	New and Existing POTW's Refer to 1.2.2, 1.3.1, 1.4.2, and 1.6.1.
1.13.7 Inadequate valving for maximum flexibility and proper maintenance.	New and Existing POTW's Piping should be designed with enough valves, long radius elbows, tees, crosses, and cleanouts to provide for adequate maintenance and flexibility. Sufficient valving should be provided to allow by-passing pieces of equipment for maintenance purposes.
1.13.8 Inadequate consideration of consequences of rupture disc or shear pin failures.	New POTW's When considering rupture discs for piping systems (e.g., on discharge side of a positive displacement pump), specify disc to withstand pressure below the maximum allowable pressure for the piping sys-

DEFICIENCY	CONSIDERATIONS
	tem. In addition, pipe the blow-off valve (i.e., rupture disc, spring loaded type, etc.) to discharge to a nearby sump so that, in the event of a rupture disc failure, clean-up of sludge or other material will be minimized. When specifying shear pins (e.g., for clarifier or thickener mechanisms), also provide a high-torque switch wired to both alarm at a high torque prior to shut-down and to shut down the mechanism at a predetermined torque that is less than the shear pin failure torque. Existing POTW's Method: Refer to 1.1.10.
1.13.9 Inadequate laboratory facilities for process control.	New and Existing POTW's Provide laboratory facilities per EPA publication *Estimating Laboratory Needs for Municipal Wastewater Treatment Facilities* (Publication No. EPA-430/9-74-002). Refer to 1.15.6.
1.13.10 Inadequate stand-by equipment.	New POTW's Provide stand-by equipment per EPA publication *Design Criteria for Mechanical, Electric and Fluid System and Component Reliability* (Publication No. EPA-430-99-74-001). Existing POTW's Method: Refer to 1.1.16.
1.13.11 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's A plant drain system should be provided which is low enough to service all tankage and buildings in the plant. All tank and sump bottoms and building floors should be sloped to provide good drainage. Tanks

DEFICIENCY	CONSIDERATIONS
	should be equipped with mud (drain) valves and/or pump-out sumps. If possible, tanks should be drained to the plant drain system.
1.13.12 Inadequate provisions for sampling of individual processes.	New and Existing POTW's Sampling facilities should be provided throughout the POTW to allow performance evaluations of individual unit operations. Such facilities would include sample taps at pumping stations, sample ports in tanks, stairways and ladders that allow access to sampling sites, etc.
1.13.13 Inadequate consideration of access requirements for large equipment (cranes, trucks, etc.) required for maintenance.	New and Existing POTW's A crane, monorail or a support to which a hoist can be attached should be located above all major pieces of equipment. The roof or floor above the equipment should be designed for the lifting load of the hoist. Buildings that contain large pieces of equipment (i.e., filter presses, vacuum filters, pumps, etc.) should have adequate ceiling heights and floor loading capacities to allow entrance of equipment removal vehicles. The access area around equipment should be adequate for its removal. Access roads and access areas should be provided around all outdoor equipment.
1.13.14 Inadequate scum handling and disposal system.	New and Existing POTW's Scum removal facilities should be provided on all tanks (i.e., clarifiers, chlorine contact tanks, wet wells, splitter boxes, etc.) that provide quiescent conditions. A positive scum removal system consisting of sumps and pumps should be provided to transfer the scum from various collection points in the plant to a central holding site.

DEFICIENCY	CONSIDERATIONS
	The collected scum should be hauled to a final disposal site or be incinerated on-site along with plant sludge, and not allowed to recirculate through the treatment system.
1.13.15 Foam sprays not concentrated in basin corners where foam build-up occurs.	<u>New and Existing POTW's</u> Spray heads should be spaced one foot apart in basin corners to minimize foam buildups. Foam sprays may also be required in certain open channels, such as aeration basin influent and/or effluent channels.
1.13.16 No provision for water tap at top of above-ground package units.	<u>New and Existing POTW's</u> Provide water tap (i.e., hose bib) at top of unit, using plant effluent as utility water source. If city water is used, provide an air break (or back-flow preventer).
1.13.17 Inadequate consideration of groundwater movement into POTW site through sewer trenches.	<u>New and Existing POTW's</u> Impermeable barriers (i.e., bentonite clay or concrete) should be placed across sewer trenches leading to a POTW site. The barriers should extend between the trench walls and from the bottom of the trench to within one foot of the ground surface.
1.13.18 Use of single-speed pumps where variable-speed units are required.	<u>New and Existing POTW's</u> Consider the use of variable-speed (or two-speed) pumps at the following locations: • Influent pumping station. • Recycle pumps. • Chemical feed pumps. • Feed pumps to sludge dewatering systems.

DEFICIENCY	CONSIDERATIONS
1.13.19 No provisions made to allow periodic cleaning of the influent wet well.	New and Existing POTW's Refer to 1.2.16.
1.13.20 Use of city water rather than plant effluent for use as POTW utility water.	New and Existing POTW's Plant effluent in lieu of city water should be considered as a source of utility water in order to reduce annual operating costs. An effluent sump, utility water pump, flow control valves, and piping would be required to supply clean-up water throughout the plant. Refer to 1.1.44.
1.13.21 Inadequate consideration of possible development of septic conditions in channels and splitter boxes.	New and Existing POTW's Refer to 1.2.17, 1.3.15, 1.4.18, and 1.6.15.
1.13.22 Change in baseline conditions at a POTW between time of design and construction.	New and Existing POTW's Due to the extensive lag that generally occurs between the time a plant is designed, the Federal construction grants are received, and the plant is actually constructed, it is imperative that future waste loads are considered. This includes projecting municipal and industrial waste flows. It is emphasized that over-estimating or under-estimating future flows can cause serious operational problems. Refer to 1.1.13 and 1.1.47.
1.13.23 Samplers frequently clog.	New and Existing POTW's Specify that 3/4 inch or larger sample lines be used with wastewater samplers. In addition, clean-out

DEFICIENCY	CONSIDERATIONS
	taps should be provided on sample lines. For wastewaters with high solids levels, automatic line flushing systems (air or water) can be used.
1.13.24 Pumps are located above the normal water level, making them difficult to prime.	New and Existing POTW's Whenever possible, lay out pumping systems such that the pump suction line is flooded. If this is not feasible, specify self-priming pumps. Air bleed-off valves should also be provided at high points in the pump piping system to allow removal of airlocks and subsequent priming of the pumps.
1.13.25 Lack of mud valves in tanks.	New and Existing POTW's Provide mud valves or pump-out sumps at low point in tank bottoms. Refer to 1.1.26.
1.13.26 Lack of water supply near samplers.	New and Existing POTW's Provide a hose bib or yard hydrant near samplers for clean-up purposes.
1.13.27 Lack of sumps in dry wells.	New POTW's Provide pump-out sumps in all dry wells to allow removal of rainwater, clean-up water, etc. Existing POTW's Method: Refer to 1.1.65.
1.13.28 No mixing provided in scum tank to keep scum mixed during pumping.	New and Existing POTW's Refer to 1.3.21.
1.13.29 No positive method of removing scum from center well of clarifiers.	New and Existing POTW's Refer to 1.3.23.

DEFICIENCY	CONSIDERATIONS
1.13.30 Lack of tank dewatering systems to permit rapid servicing of submerged equipment.	New and Existing POTW's Refer to 1.1.26.
1.13.31 Lack of flexibility in disinfection systems to permit prechlorination for odor control or return sludge chlorination for control of bulking.	New and Existing POTW's Refer to 1.2.26.
1.13.32 Lack of a foam control system.	New and Existing POTW's Foam control systems should be provided for agitated tanks such as aeration basins and aerobic digesters. Foam control systems could consist of spray-water or defoamer chemical feed systems.
1.13.33 Absence of electrical outlets on top of treatment units.	New and Existing POTW's Provide electrical outlets to service each treatment area including outlets on various pieces of equipment such as clarifiers, aeration basins, thickeners, etc.
1.13.34 Placement of motor control centers too close to wash-down areas.	New POTW's Motor control centers (MCC) should not be placed in rooms with equipment that requires routine washdown. MCC's should generally be located in separate rooms or buildings. Existing POTW's Method: Refer to 1.1.91.
1.13.35 Inadequate electrical capacity to permit stand-by pumps and blowers to operate in parallel.	New and Existing POTW's Electrical systems should be sufficiently sized to allow the simultaneous use of designated operating and stand-by equipment. This is particularly important for pumping and aeration systems.

DEFICIENCY	CONSIDERATIONS
1.13.36 High water alarm systems not provided.	New and Existing POTW's Refer to 1.2.29.
1.13.37 Electrical control panels located below ground and exposed to potential flooding.	New and Existing POTW's All electrical control panels should be located in areas protected from flooding.
1.13.38 Lack of auxiliary power.	New and Existing POTW's All POTW's should include emergency power for major process equipment. This can be accomplished by use of diesel fuel, gasoline, natural gas or digester gas powered generators; or provide dual power feed lines to the plant site. The stand-by power could be automatically activated upon a plant electric power failure.
1.13.39 Electrical quick-disconnect plugs not provided with submerged pumps to facilitate rapid replacement.	New and Existing POTW's Quick-disconnect electrical plugs should be provided with submerged equipment (pumps, samplers, etc.) to allow rapid replacement with stand-by units when maintenance is required.
1.13.40 Inadequate plant lighting.	New and Existing POTW's Provide sufficient lighting to ensure safe operating conditions are attained in all areas of the plant. This is particularly important around open tanks, aeration basins, below grade tanks and sumps, stairways, etc. Design plant lighting system to conform to "lighting and thermal operation guidelines" published by the Federal Energy Administration. Refer to 1.1.88.
1.13.41 Stairways without non-skid surfaces.	New POTW's Specify non-skid surfaces for all stairways.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 1.1.100.
1.13.42 Inadequate handrailing and kick plates.	New POTW's Provide handrailing and kick plates on both sides of all stairways and on all walkways around tanks and equipment. Handrails and kick plates should meet OSHA requirements. Existing POTW's Method: Refer to 1.1.101.
1.13.43 Inadequate fencing around site.	New POTW's Provide fencing (a minimum of 8 feet high) around the entire site to make it inaccessible to all unauthorized personnel. Existing POTW's Method: Refer to 1.1.102.
1.13.44 Use of air headers as guard railing at small package-plant type POTWs.	New POTW's Air headers can become very hot and should not be used as guard railings. Refer to 1.1.101. Existing POTW's Method: Refer to 1.1.103.
1.13.45 Stairs inclined at too steep an angle.	New and Existing POTW's Design stairways to meet OSHA requirements; specify a maximum incline of 30 degrees.
1.13.46 Guard railing not provided around ground-level tanks.	New and Existing POTW's Guard railing or fencing should be provided around all tanks that have open tops at ground-level. Refer to 1.1.101.
1.13.47 Stairways provided with only one handrail.	New and Existing POTW's Refer to 1.1.101.

DEFICIENCY	CONSIDERATIONS
1.13.48 Inadequate consideration of noise control.	New POTW's Specifications for mechanical equipment and their associated electric motors should have a noise emission criteria section. Work areas should also be designed to meet OSHA noise criteria. Noise absorbing and/or containing enclosures should be considered only when equipment cannot be designed to meet the work place noise criteria. Existing POTW's Method: Refer to 1.1.110.
1.13.49 Dangerous chemicals not stored in separate area.	New and Existing POTW's Provide separate, well-ventilated areas for storage of hazardous chemicals. Ensure adequate clean-up facilities are also provided.
1.13.50 Inadequate security provisions.	New and Existing POTW's Provide plant lighting per 1.1.99 and fencing per 1.1.102.
1.13.51 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Provide portable or fixed hoist systems to move large pieces of equipment. Refer to 1.1.1 and 1.1.28.
1.13.52 Inadequate consideration of OSHA safety requirements.	New POTW's Refer to OSHA safety requirements during design of POTW. Existing POTW's Method: Conduct OSHA survey of the entire plant; make the required changes where necessary.

DEFICIENCY	CONSIDERATIONS
1.13.53 Inadequate consideration of potential freezing problems of plant components.	New and Existing POTW's Specify in-ground tanks in cold climate areas. Specify splash guards around fixed aerators to decrease freezing during winter months. Cover tanks if required. Provide insulation and/or heat tracing of exposed pipes and valves. Refer to 1.1.22 and 1.1.127.
1.13.54 Inadequate consideration of spill prevention plan.	New POTW's In order to prevent spills of oil and/or hazardous materials from contaminating surface or groundwaters, the following measures should be taken: • Provide dikes, berms, retaining walls, etc., around aboveground storage tanks with sufficient capacity to retain the entire contents of the largest tank. • Removal of the contents of the diked area must be by positive means, such as a manually-operated valve or pump, after an inspection of the material has determined where it should be directed. • Plant drainage systems from undiked areas should flow, if possible, into ponds, lagoons, or catchment basins if there is a possibility that runoff could come in contact with oil or hazardous chemicals. Existing POTW's Method: Refer to 1.1.132.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.14 Energy Conservation	
1.14.1 Use of a room as a BOD incubator is inconvenient because in-and-out traffic makes it difficult to maintain proper temperature.	New POTW's Large incubators should be used since they are more energy efficient than a room and would not be subject to the access door being frequently opened. Existing POTW's Method: Provide a large incubator since it is more efficient than a room and would not be subject to the access door being frequently opened. Cost: Under $4,000; actual price depends on size and controls.
1.14.2 Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	New and Existing POTW's Louvers should be specified as adjustable so that they can be closed during cold weather.
1.14.3 Use of single-pane glass windows.	New POTW's Use double- or triple-paned glass for windows. Existing POTW's Method: Add storm windows to all windows, or replace single-pane glass with thermal glass.
1.14.4 Design does not emphasize heating conservation measures.	New and Existing POTW's Refer to 1.1.74.
1.14.5 Motors oversized for future growth which never materializes, resulting in motors operating at less efficiency with lower power factors.	New and Existing POTW's Refer to 1.1.96.

DEFICIENCY	CONSIDERATIONS
1.14.6 Insufficient use of high-efficiency motors.	New and Existing POTW's Refer to 1.1.97.

Unit Operation/Component: 1.15 Laboratory

DEFICIENCY	CONSIDERATIONS
1.15.1 Use of a room as a BOD incubator is inconvenient because in-and-out traffic makes it difficult to maintain proper temperature.	New and Existing POTW's Refer to 1.14.1.
1.15.2 Lab building air vents are located too close to air conditioning air intakes.	New POTW's To prevent vented laboratory fumes re-entering the building, locate air conditioning intakes on the opposite side of the building from any lab vents. Existing POTW's Method: Relocate vents, or lengthen and/or reposition vents so that lab exhaust does not enter air intakes.
1.15.3 Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	New and Existing POTW's Refer to 1.1.6 and 1.14.2.
1.15.4 Lack of vents in laboratory sink drain lines.	New POTW's Provide vents at each lab sink to prevent air locks and resultant drain back-ups. Existing POTW's Method: Provide vent in each laboratory sink drain line which vents to atmosphere above roof. This is required by most local plumbing codes.

DEFICIENCY	CONSIDERATIONS
	Materials: PVC or any material compatible with existing piping.
1.15.5 Hoods not provided in labs.	New POTW's Each lab should be provided with a fume hood for refluxing apparatus. Existing POTW's Method: Provide exhaust hood(s) in labs wherever heating operations are conducted and fumes are emitted (i.e., over hot plates, ovens, reflux apparatus, etc.). Vent the hoods to the outside. Cost: Approximately \$500 to \$3,000, depending on size and accessories.
1.15.6 Inadequate laboratory facilities for process control.	New POTW's Refer to 1.13.9. Existing POTW's Method: NPDES permit limitations are generally based on BOD, pH, suspended solids, and fecal coliform, as a minimum. The following equipment is required for each of the determinations (refer to "Standard Methods" for additional equipment requirements): • BOD: Incubator, BOD bottles, D.O. meter, distilled water. • pH: pH meter with probe, buffer solutions to standardize probe, wash bottle, beaker. • Suspended solids: Glass fiber filter discs, filter holder, Gooch crucibles, suction flask, vacuum pump, drying oven, desiccator, analytical balance.

DEFICIENCY	CONSIDERATIONS
	• <u>Fecal coliform</u>: Culture medium, culture dishes, incubator, vacuum filter, filter holder, membranes, pipets. If storage space is limited, add shelves (open or in cabinets) above and below the work bench to store glassware and reagents. Most frequently-used items should be easily accessible and supplies which are spare or used infrequently can be stored further away. If counter space is limited, perhaps storing easily-moved equipment (such as magnetic stirrers, small hot plates, etc.) can be stored under the counter, providing more working space. However, instruments such as pH meters should be moved as little as possible. Other steps, such as placing the incubator in a room adjacent to the lab, can give more working space in the lab. If all of the steps above do not provide sufficient laboratory space, investigate enlarging the existing lab.
1.15.7 Laboratory vacuum system has insufficient capacity.	<u>New POTW's</u> The vacuum system should be adequately sized to handle all laboratory equipment plus an additional 20 percent. <u>Existing POTW's</u> <u>Method</u>: Provide additional laboratory vacuum pump(s). <u>Cost</u>: \$100 to 3,000, depending on size and service requirements.
1.15.8 Use of single-pane glass windows.	<u>New and Existing POTW's</u> Refer to 1.14.3.

DEFICIENCY	CONSIDERATIONS
1.15.9 Design does not emphasize heating conservation measures.	New and Existing POTW's Refer to 1.1.74.
1.15.10 Lab electrical circuits on same circuits as POTW equipment, causing interference with lab instrumentation.	New and Existing POTW's The lab electrical system should be on a separate circuit. Refer to 1.1.82.
1.15.11 Lack of both 110V and 220V electrical service to labs.	New and Existing POTW's Provide both 110V and 220V electrical service to laboratories since some equipment, such as muffle furnaces, require 220V service.

Unit Operation/Component: 1.16 Chemical Handling

DEFICIENCY	CONSIDERATIONS
1.16.1 No provisions for moving equipment and supplies from one building floor to another.	New and Existing POTW's Refer to 1.1.5.
1.16.2 Excessive length of chemical feed lines, particularly lime slurry recirculation loops.	New and Existing POTW's Chemical feed facilities should be located as close as possible to points of application. Refer to 1.1.12.
1.16.3 Inadequate provisions for draining tanks and sumps.	New and Existing POTW's Refer to 1.1.26.
1.16.4 Lack of floor trenches around pumps to carry water spills to sumps.	New and Existing POTW's Refer to 1.1.46.
1.16.5 Lack of flow metering device on chemical feed lines.	New and Existing POTW's Refer to 1.1.48.

DEFICIENCY	CONSIDERATIONS
1.16.6 Chemical feed line is connected to more than one basin at different elevations, causing line to drain rapidly into lower basin and requiring time to fill header before the higher basin can be fed.	New and Existing POTW's When feeding a chemical to more than one tank, use separate feed lines and metering pumps. If feeding chemical through a common header, specify that discharge points in different tanks be at the same elevation. If discharge points must be at different elevations, provide throttle valve at lower basins, so that both (all) basins are fed at same rate; also, provide a check valve in the chemical feed lines to prevent the back flow of chemical from one tank to the other.
1.16.7 No convenient means provided to feed dry chemicals into top-loading feeders.	New and Existing POTW's Refer to 1.1.51.
1.16.8 Lack of drains on chemical mix tanks.	New and Existing POTW's Refer to 1.1.52.
1.16.9 Pressure gauges not located on inlet side of back-pressure relief valves, making it difficult to check and/or adjust the valve.	New and Existing POTW's Provide pressure gauges on upstream and down stream side of back pressure valves and on pressure side of relief valves.
1.16.10 Chemical feed pumps are too small to allow high dosages of chemical during emergencies.	New POTW's Chemical feed pumps should be sized to feed both maximum and minimum dosages. The use of metering pumps with variable stroke adjustment allows a broad pumping capacity range. Multiple pumps should also be specified; this would allow the use of the spare pump during emergency periods when high chemical dosages are required.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 1.1.58.
1.16.11 Improper water pressure is supplied to rotameters, causing them to burst.	New and Existing POTW's Refer to 1.1.68.
1.16.12 Lack of wyes, tees, and crosses to facilitate cleaning chemical lines.	New POTW's All chemical lines, particularly lime slurry, should be specified with wyes and tees for cleaning. Flushing water should be provided near the cleanouts. Existing POTW's Method: Refer to 1.1.77.
1.16.13 Placement of motor control centers too close to wash-down areas.	New and Existing POTW's Refer to 1.1.91.
1.16.14 Lack of ventilation promotes corrosion of electrical components.	New and Existing POTW's Refer to 1.1.93.
1.16.15 High water alarm systems not provided.	New and Existing POTW's Provide high water alarms in chemical mix and day tanks.
1.16.16 Dangerous chemicals not stored in separate areas.	New and Existing POTW's Chemicals should be stored in separate rooms with adequate ventilation and safety showers.
1.16.17 Inadequate consideration of spill prevention plan.	New and Existing POTW's All chemical tanks should be provided with a dike around the storage area. Refer to 1.1.132.

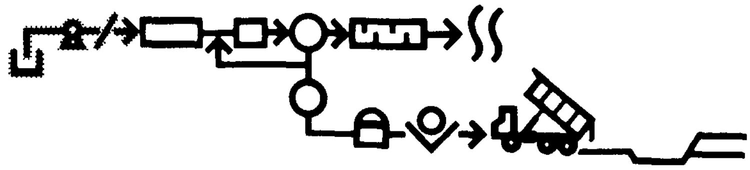
DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.17 Control Building	
1.17.1 No provisions for moving equipment and supplies from one building floor to another.	New and Existing POTW's Refer to 1.1.5.
1.17.2 Lab building air vents are located too close to air conditioning air intakes.	New and Existing POTW's Refer to 1.15.2.
1.17.3 Use of fixed louvers in buildings that cannot be shut during winter weather conditions.	New and Existing POTW's Refer to 1.1.6.
1.17.4 Lack of vents in laboratory sink drain lines.	New and Existing POTW's Refer to 1.15.4.
1.17.5 Hoods not provided in labs.	New and Existing POTW's Refer to 1.15.5.
1.17.6 Inadequate communication capabilities between buildings and process areas.	New and Existing POTW's Refer to 1.1.14.
1.17.7 Inadequate laboratory facilities for process control.	New and Existing POTW's Refer to 1.15.6.
1.17.8 Inadequate view of unit processes from control building.	New and Existing POTW's Refer to 1.1.25.
1.17.9 Control panels not easily accessible (i.e., too high off ground or placed in close quarters).	New and Existing POTW's Refer to 1.1.31.

DEFICIENCY	CONSIDERATIONS
1.17.10 Floor drain piping system undersized.	New and Existing POTW's Refer to 1.1.34 and 1.5.13.
1.17.11 Drains from buildings discharge into basins with normally (or periodically) high-water levels, causing drains to back-up.	New and Existing POTW's Refer to 1.1.35.
1.17.12 Use of single-pane glass windows.	New and Existing POTW's Refer to 1.14.3.
1.17.13 Design does not emphasize heating conservation measures.	New and Existing POTW's Refer to 1.1.74.
1.17.14 Lab electrical circuits on same circuits as POTW equipment, causing interferences with lab instrumentation.	New and Existing POTW's Refer to 1.1.82.
1.17.15 Lack of both 110 v and 220 v electrical service in labs.	New and Existing POTW's Refer to 1.15.11.
1.17.16 Placement of motor control enters too close to wash-down areas.	New and Existing POTW's Refer to 1.1.91.
1.17.17 Lack of ventilation promotes corrosion of electrical components.	New and Existing POTW's Refer to 1.1.93.
1.17.18 Handling facilities not provided for mechanical components over 100 pounds.	New and Existing POTW's Refer to 1.1.121.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 1.18 Site Selection	
1.18.1 Lack of all-weather roads to pump stations.	New and Existing POTW's Refer to 1.1.19.
1.18.2 Electrical control panels located below ground where exposed to flooding.	New and Existing POTW's Refer to 1.1.94.
1.18.3 Plant located in flood plain.	New and Existing POTW's Elevate plant site during construction above the plain level or build a dike around the plant to protect it against flooding. Refer to 1.1.125.
1.18.4 Inadequate buffer zone to alleviate problems due to noise, odor, aerosol, fog, etc.	New and Existing POTW's Refer to 1.1.126.
1.18.5 Inadequate consideration of any potential freezing problems of plant components.	New and Existing POTW's Refer to 1.1.127.
1.18.6 Inadequate consideration of odor development and control.	New and Existing POTW's Plants should be isolated from high-populated areas. Refer to 1.1.126 and 1.1.128.
1.18.7 Inadequate consideration of local weather conditions and their impact on the accessibility of a plant site.	New and Existing POTW's Refer to 1.1.131.

Design Considerations

Category: 2.0 Preliminary Treatment



Unit Operation/Component: 2.1 Manual Bar Screens

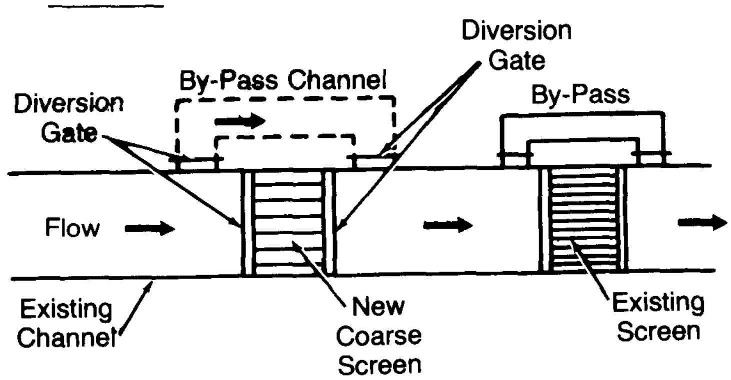
DEFICIENCY	CONSIDERATIONS
2.1.1 Lack of additional coarse screen for combined sewers.	New POTW's Provide coarse screen prior to normal bar screen for removal of large debris.

Existing POTW's

Method: Construct coarse bar screen chamber upstream of normal bar screen.

Materials: Concrete to form new chamber, and coarse screen to be installed in new chamber.

Sketch:



2.1.2 Lack of provision to remove floating material.	New POTW's Provide a scum and floating solids removal device such as an overflow trough, vacuum lift, etc.

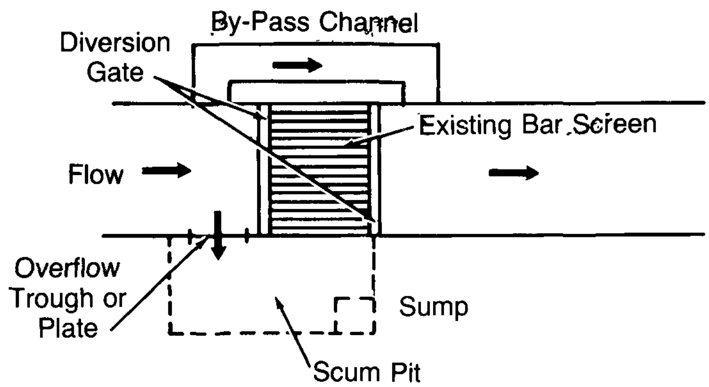
DEFICIENCY | CONSIDERATIONS

Existing POTW's

Method: Construct a scum pit and install an adjustable overflow trough or plate immediately upstream of bar screen.

Materials: Concrete to form pit, and plastic or metal overflow trough.

Sketch:



2.1.3 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.

New POTW's

Locate bar screens and grit removal facilities upstream of influent pumps.

Existing POTW's

Method: Construct bar screen with by-pass and floating material removal facilities upstream of influent pumps.

Materials: Concrete to form chamber, by-pass, and scum pit, and a metal bar screen.

2.1.4 Inadequate consideration of proper disposal of coarse screenings and grit.

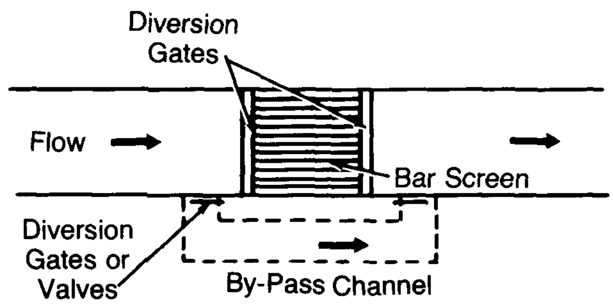
New POTW's

Provide proper facilities, such as a covered dumpster, to store screenings and subsequently dispose of the material at regular intervals.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Provide a covered dumpster or wheeled container to store screenings and dispose of the collected material at regular intervals (minimum of once per day) along with plant sludges. Materials: A covered dumpster or container.
2.1.5 Improper spacing of bars on bar screens.	New POTW's Provide bar screens with the proper bar spacing that matches bar screen cleaning equipment and complies with state design requirements. Existing POTW's Method: Remove existing screen and replace with one that has bars spaced 1 and 2 inches apart. Materials: New bar screen and appurtenances.
2.1.6 No provision for bypassing flow during maintenance.	New POTW's Provide a second bar screen or secondary flow channel around the bar screen. Bar screens should be able to be completely isolated by diversion plates, valves, etc. to allow complete dewatering of the bar screen chamber. Existing POTW's Method: Construct a screen by-pass. Materials: Concrete to form by-pass channel, and valves or diversion plates to divert flow around the bar screen.

DEFICIENCY | CONSIDERATIONS

Sketch:



2.1.7 Improper velocity in bar screen chamber leading to grit deposition.

New POTW's

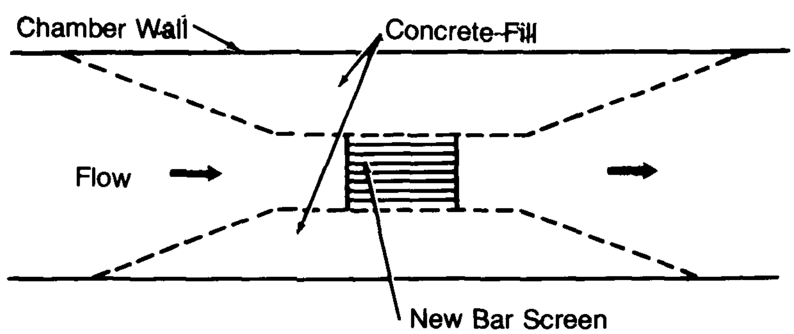
Design bar screen chambers to provide an average cross-sectonal velocity between 2 and 5 feet per second.

Existing POTW's

Method: Decrease width of chamber and provide new screen.

Materials: Concrete to fill in chamber walls and new bar screen.

Sketch:



2.1.8 Inadequate consideration of potential freezing.

New POTW's

In climates where freezing is possible, provide a weather-proof, heated enclosure around the bar screen.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Construct heated enclosure around bar screen chamber. Materials: Wood, masonry, or metal building materials and adequate building heating equipment (such as space heaters).

Unit Operation/Component: 2.2 Mechanical Bar Screens

DEFICIENCY	CONSIDERATIONS
2.2.1 Lack of additional coarse screen for combined sewers.	New and Existing POTW's Refer to 2.1.1.
2.2.2 Lack of provision to remove floating material.	New and Existing POTW's Refer to 2.1.2.
2.2.3 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Refer to 2.1.3.
2.2.4 Inadequate consideration of proper disposal of coarse screenings and grit.	New and Existing POTW's Refer to 2.1.4.
2.2.5 Improper spacing of bars on bar screens.	New and Existing POTW's Refer to 2.1.5.
2.2.6 No provision for by-passing flow during maintenance.	New and Existing POTW's Refer to 2.1.6.

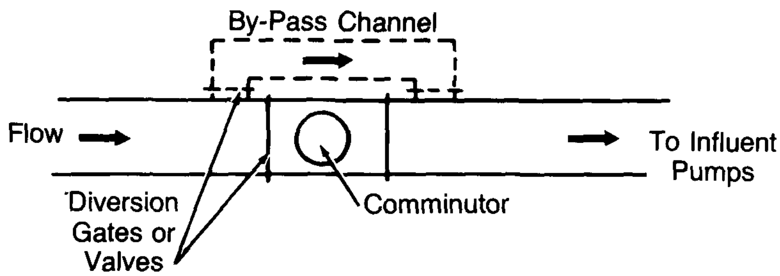
DEFICIENCY	CONSIDERATIONS
2.2.7 Improper velocity in bar screen chamber leading to grit deposition.	New and Existing POTW's Refer to 2.1.7.
2.2.8 Inadequate consideration of effect of waste material on mechanical reliability.	New POTW's Provide mechanical scraper mechanism which is proven to be reliable and durable enough for the intended application. Ensure the characteristics of any industrial wastewaters that will be present have been considered. Provide manually-cleaned bar screen as a stand-by. Existing POTW's Method: Replace scraper unit with a more durable and reliable unit, and provide a stand-by manual bar screen. Materials: Replacement scraper unit.
2.2.9 Inadequate consideration of potential freezing.	New and Existing POTW's Refer to 2.1.8.

Unit Operation/Component: 2.3 Comminutor

DEFICIENCY	CONSIDERATIONS
2.3.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New POTW's Provide comminutor upstream of influent pumps. Existing POTW's Method: Install a comminutor upstream of influent pumps. Materials: Concrete to form the comminutor chamber and new comminutor.

DEFICIENCY | CONSIDERATIONS

Sketch:



2.3.2 Comminutors not located downstream of grit removal equipment resulting in excessive wear.

New and Existing POTW's
Provide grit removal equipment upstream of comminutor. Refer to 2.1.3.

2.3.3 No bar screen provided for protection of mechanical components.

New POTW's
Provide bar screen upstream of comminutor. Refer to 2.1.3.

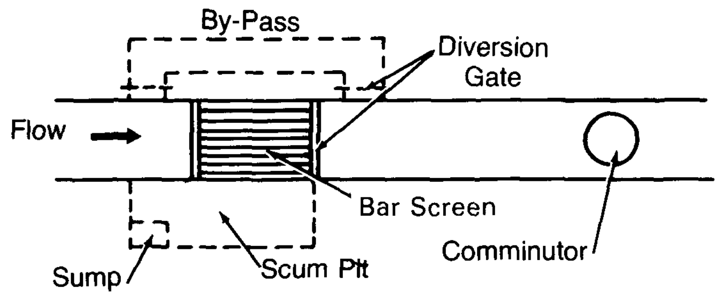
Existing POTW's
Method: Install bar screen upstream of comminutor.

Materials: Concrete to form bar screen chamber with by-pass and scum pit, and bar screen and related appurtenances for floating solids and screenings removal.

DEFICIENCY

CONSIDERATIONS

Sketch:



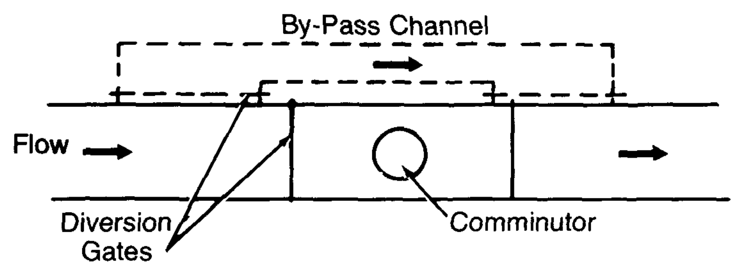
2.3.4 No provision for by-passing flow during maintenance.

New POTW's
Provide by-pass for comminutor.

Existing POTW's
Method: Construct by-pass for diverting flow around comminutor.

Materials: Concrete to form by-pass channel or chamber and metal diversion gates or valves to divert flow and to isolate comminutor.

Sketch:



2.3.5 No rock traps provided.

New POTW's
Provide rock traps upstream of comminutor.

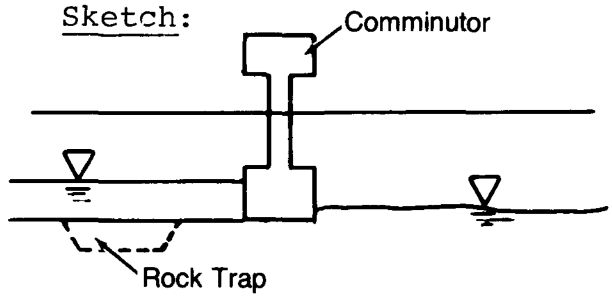
DEFICIENCY | CONSIDERATIONS

Existing POTW's

Method: Construct rock traps upstream of comminutor.

Materials: Concrete to form trap.

Sketch:



2.3.6 Inadequate design of obstructions downstream of control section induces inaccuracies in flow measurement.

New POTW's

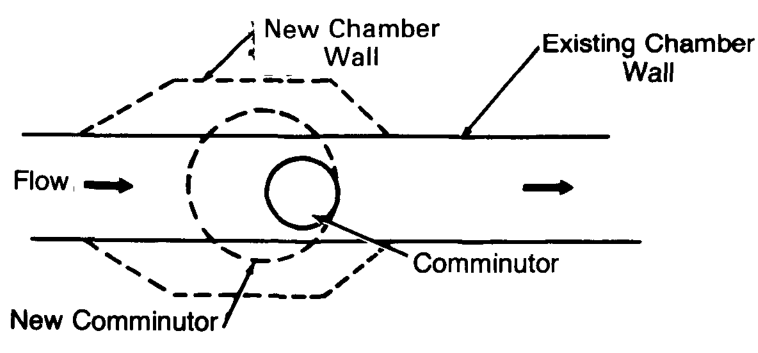
Provide comminutor which does not affect flow characteristics at flow measurement device or provide adequate distance between comminutor and flow measurement device to prevent influence of backwater effects.

Existing POTW's

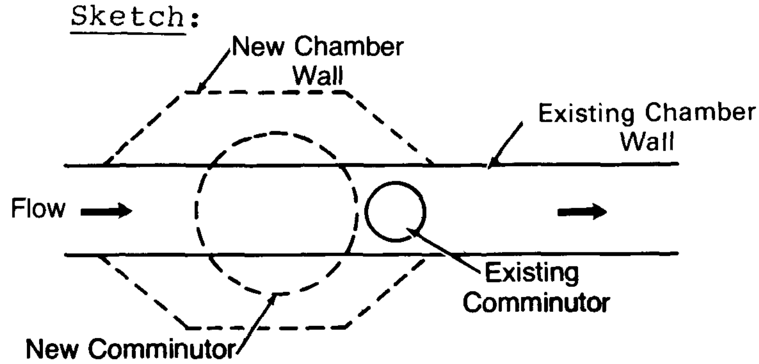
Method: Replace comminutor with larger model.

Materials: Concrete to form larger chamber and new comminutor.

Sketch:



DEFICIENCY	CONSIDERATIONS
2.3.7 Inadequate design permits grit deposits in control section of flow measurement device.	New POTW's Provide larger capacity comminutor capable of passing grit. Existing POTW's Method: Install larger capacity comminutor. Materials: Concrete to form new chamber for comminutor and new comminutor. Sketch:

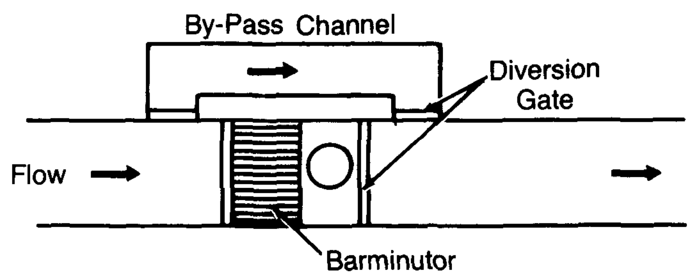


2.3.8 Inadequate consideration of effect of waste material on mechanical reliability.	New and Existing POTW's Provide a comminutor which is adequately sized and which is designed to handle wastes of the character anticipated. Particular attention should be given to industrial wastewater discharges.

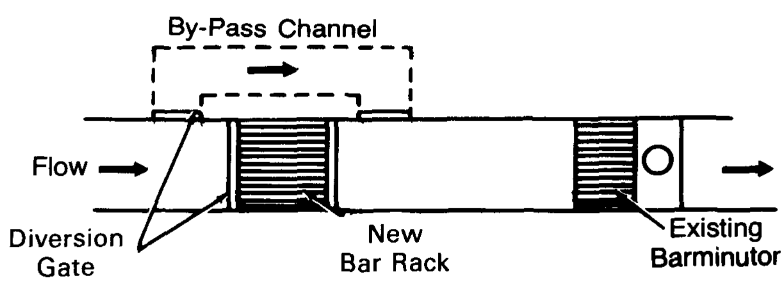
Unit Operation/Component: 2.4 Barminutor

2.4.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New POTW's Provide barminutor upstream of influent pumps. Refer to 2.1.3.

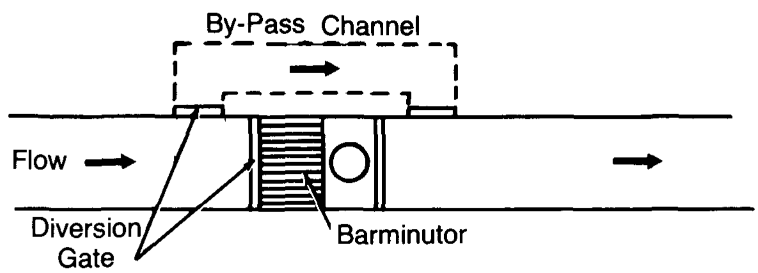
DEFICIENCY	CONSIDERATIONS
	<u>Existing POTW's</u> <u>Method</u>: Install barminutor upstream of influent pumps. <u>Materials</u>: Concrete to form barminutor chamber and new barminutor. <u>Sketch</u>:



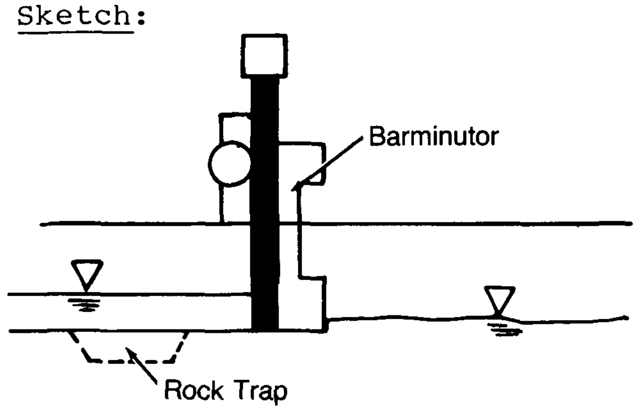
DEFICIENCY	CONSIDERATIONS
2.4.2 No bar screens provided for protection of mechanical components.	<u>New POTW's</u> Provide bar screen upstream of barminutor. <u>Existing POTW's</u> <u>Method</u>: Install bar rack upstream of barminutor. <u>Materials</u>: Concrete to form bar rack chamber and by-pass, and bar rack. <u>Sketch</u>:

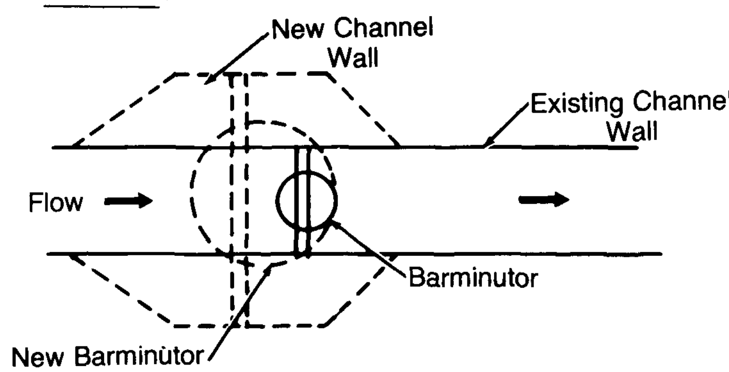


DEFICIENCY	CONSIDERATIONS
2.4.3 No provision for by-passing flow during maintenance.	New POTW's Provide by-pass for barminutor. Existing POTW's Method: Construct by-pass for diverting flow around barminutor. Materials: Concrete to form by-pass channel, and metal diversion gates or valves to divert flow and isolate barminutor. Sketch:

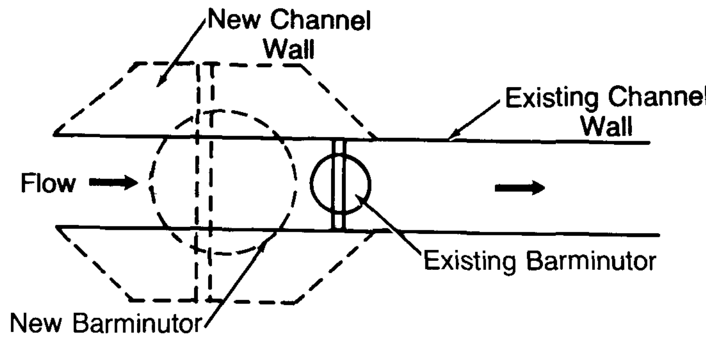


DEFICIENCY	CONSIDERATIONS
2.4.4 No rock traps provided.	New POTW's Provide rock traps upstream of barminutor. Existing POTW's Method: Construct rock trap upstream of barminutor. Materials: Concrete to form trap. Sketch:



DEFICIENCY	CONSIDERATIONS
2.4.5 Inadequate design of obstructions downstream of control section induces inaccuracies in flow measurement.	New POTW's Provide barminutor which does not affect flow characteristics at flow measurement device or provide adequate distance between barminutor and flow measurement device to prevent influence of backwater effects. Existing POTW's Method: Replace barminutor with larger model. Materials: Concrete to form larger chamber and new barminutor. Sketch: 
2.4.6 Inadequate design permits grit deposits in control section of flow measurement device.	New POTW's Provide larger capacity barminutor capable of passing grit. Existing POTW's Method: Install larger capacity barminutor. Materials: Concrete to form new chamber for barminutor and new barminutor.

DEFICIENCY	CONSIDERATIONS
	Sketch:



2.4.7 Improper bar spacing.

New POTW's

Refer to 2.1.5.

Existing POTW's

Method: Replace bars with 1 to 2 inch bar spacing.

Materials: New bar screen.

2.4.8 Inadequate consideration of effect of waste material on mechanical reliability.

New and Existing POTW's

Refer to 2.3.8.

Unit Operation/Component: 2.5 Macerator

2.5.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.

New and Existing POTW's

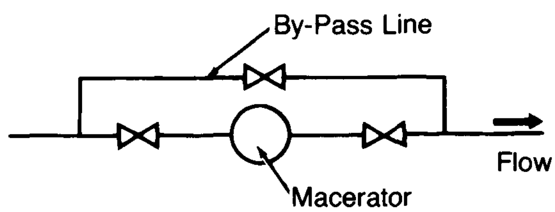
Provide macerators upstream of pumping stations.

2.5.2 No bar screen provided for protection of mechanical components.

New POTW's

Provide bar screen upstream of macerator.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install bar screen upstream of macerator. Refer to 2.4.2. Materials: Concrete to form bar screen chamber with by-pass and scum pit, and bar screen and related appurtenances for floating solids and screenings removal.
2.5.3 No provision for by-passing flow during maintenance.	New POTW's Provide by-pass for macerator upstream of macerator. Existing POTW's Method: Construct by-pass for diverting flow around macerator. Materials: Piping and valves to construct by-pass and to isolate macerator. Sketch:



DEFICIENCY	CONSIDERATIONS
2.5.4 No rock traps provided.	New POTW's Provide rock traps. Existing POTW's Method: Construct rock trap upstream of macerator. Refer to 2.3.5.
2.5.5 Inadequate design of obstructions downstream of control section induces inaccuracies in flow measurement.	New POTW's Provide macerator which does not affect flow characteristics at flow measurement device or provide adequate distance between macerator and flow measurement device to prevent influence of backwater effects.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Replace macerator with larger model or move flow meter upstream. Materials: Piping and electrical to relocate meter.
2.5.6 Inadequate design permits grit deposits in control section of flow measurement device.	New POTW's Provide larger capacity macerator capable of passing grit. Existing POTW's Method: Install larger capacity macerator capable of passing grit or move macerator further upstream of flow meter. Materials: New macerator and/or piping.
2.5.7 Inadequate consideration of effect of waste material on mechanical reliability.	New and Existing POTW's Provide macerator which is adequately sized and which is designed to handle wastes of the character anticipated. Particular attention should be given to the potential effects of industrial wastes that will be present in the wastewater. Refer to 2.3.8.

Unit Operation/Component: 2.6 Manually Cleaned Grit Chambers

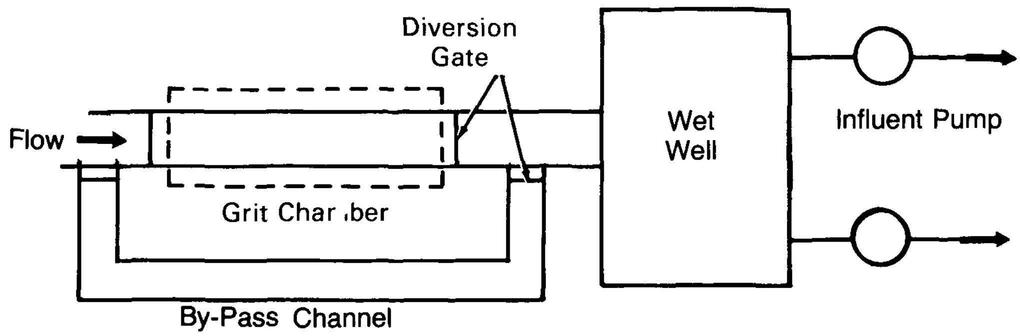
DEFICIENCY	CONSIDERATIONS
2.6.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New POTW's Provide grit chamber upstream of influent pumps. Existing POTW's Method: Construct grit chamber upstream of influent pumps.

DEFICIENCY

CONSIDERATIONS

Materials: Concrete to form chamber and necessary appurtenances.

Sketch:



2.6.2 Comminutors not located downstream of grit removal equipment resulting in excessive wear.

New POTW's

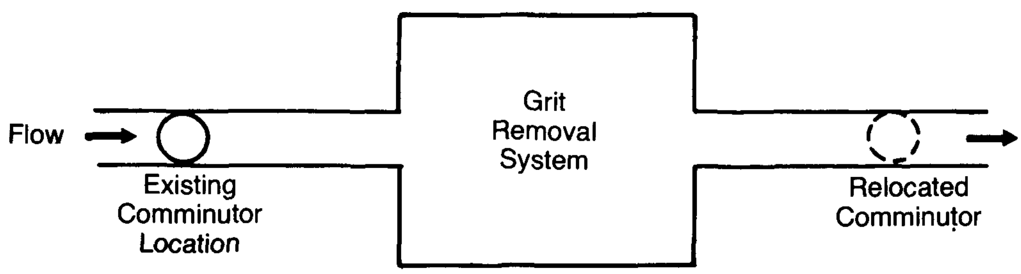
Provide grit chamber upstream of comminutor. Refer to 2.1.3 and 2.3.2.

Existing POTW's

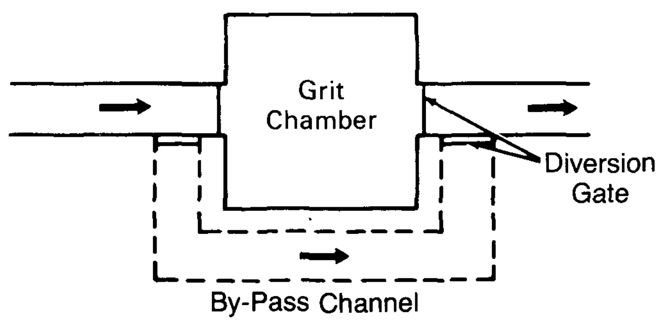
Method: Reinstall comminutor downstream of grit chamber.

Materials: Concrete to form comminutor chamber.

Sketch:



DEFICIENCY	CONSIDERATIONS
2.6.3 Inadequate consideration of proper disposal of coarse screenings and grit.	New and Existing POTW's Provide a covered dumpster to temporarily store collected grit and periodically haul the grit to an approved landfill.
2.6.4 No provision for by-passing flow during maintenance.	New POTW's Provide a by-pass around the grit chamber. Existing POTW's Method: Construct by-pass. Materials: Concrete to form channel and diversion gates or valves to divert flow and isolate chamber. Sketch:



DEFICIENCY	CONSIDERATIONS
2.6.5 Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.	New POTW's Lack of grit removal at the head end of the POTW would result in increased wear on pumps, accumulation of grit deposits in tanks, wear and extra loads on clarifications mechanisms, etc. The obvious result would be increased O&M costs. Existing POTW's Method: Construct grit chamber or degritter. Materials: Concrete to form chamber or channel, and related equipment.

DEFICIENCY	CONSIDERATIONS
2.6.6 Inadequate velocity through process due to poor flow control.	New and Existing POTW's Utilize a twin-compartment grit chamber with weir control, a proportional weir, or a vertical throat to maintain a constant flow velocity through the grit chamber with changing influent flow rate.
2.6.7 Improper flow-through velocity in grit chamber.	New POTW's Design cross-sectional area of chamber to provide velocity of 1.0 foot/second at design flow. Existing POTW's Method: Reduce width of chamber if velocity is low; increase width of chamber if velocity is high. Materials: Concrete to form new walls.
2.6.8 Short-circuiting in grit chamber.	New POTW's Provide baffles in the grit chamber. Existing POTW's Method: Construct baffles to increase distance of flow-through chamber. Materials: Metal or plastic baffles.
2.6.9 Inadequate consideration of potential freezing.	New and Existing POTW's Provide heated enclosure around grit removal and storage area. Design chamber sides and inlet/outlet appurtenances to withstand ice build-up and/or to allow ice removal.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 2.7 Mechanically Cleaned Grit Chambers	
2.7.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Provide grit chamber upstream of influent pumps. Refer to 2.6.1.
2.7.2 Comminutor not located downstream of grit removal equipment resulting in excessive wear.	New and Existing POTW's Provide grit chamber upstream of comminutor. Refer to 2.6.2.
2.7.3 Inadequate consideration of proper disposal of coarse screenings and grit.	New and Existing POTW's Refer to 2.6.3.
2.7.4 No provision for by-passing flow during maintenance.	New and Existing POTW's Provide a by-pass around the grit chamber. Refer to 2.6.4.
2.7.5 Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.	New and Existing POTW's Refer to 2.6.5.
2.7.6 Inadequate velocity through process due to poor flow control.	New and Existing POTW's Refer to 2.6.6.
2.7.7 Improper flow-through velocity in grit chamber.	New and Existing POTW's Design cross-sectional area of chamber to provide velocity of 1.0 foot/second at design flow. Refer to 2.6.7.
2.7.8 Short-circuiting in grit chamber.	New and Existing POTW's Provide baffles in chamber. Refer to 2.6.8.

DEFICIENCY	CONSIDERATIONS
2.7.9 Inadequate consideration of effect of waste material on mechanical reliability.	New POTW's Provide grit collector which is designed for the waste material to be handled. Particular attention should be given to the characteristics of any industrial wastes present in the wastewater. Existing POTW's Method: Replace mechanical grit collector with more-reliable unit. Materials: New mechanical grit collector and appurtenances.

Unit Operation/Component: 2.8 Aerated Grit Chambers

2.8.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Provide grit chamber upstream of influent pumps. Refer to 2.6.1.
2.8.2 Comminutors not located downstream of grit removal equipment resulting in excessive wear.	New and Existing POTW's Provide grit chamber upstream of comminutor. Refer to 2.6.2.
2.8.3 Inadequate consideration of proper disposal of coarse screenings and grit.	New and Existing POTW's Refer to 2.6.3.
2.8.4 No provision for by-passing flow during maintenance.	New and Existing POTW's Provide a by-pass around the grit chamber. Refer to 2.6.4.
2.8.5 Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.	New and Existing POTW's Refer to 2.6.5.

DEFICIENCY	CONSIDERATIONS
2.8.6 Improper flow-through velocity in grit chamber.	New and Existing POTW's Design cross-sectional area of chamber to provide velocity of 1.0 foot/second at design flow. Refer to 2.6.7.
2.8.7 Short-circuiting in grit chamber.	New and Existing POTW's Provide baffles in chamber. Refer to 2.6.8.

Unit Operation/Component: 2.9 Degritter

DEFICIENCY	CONSIDERATIONS
2.9.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Provide grit chamber upstream of influent pumps. Refer to 2.6.1.
2.9.2 Comminutors not located downstream of grit removal equipment resulting in excessive wear.	New and Existing POTW's Provide grit chamber upstream of comminutor. Refer to 2.6.2.
2.9.3 Inadequate consideration of proper disposal of coarse screenings and grit.	New and Existing POTW's Refer to 2.6.3.
2.9.4 No provision for by-passing flow during maintenance.	New and Existing POTW's Provide a by-pass around the degritter. Refer to 2.6.4.
2.9.5 Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.	New and Existing POTW's Refer to 2.6.5.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 2.10 Grit Pumps	
2.10.1 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Provide grit chamber upstream of influent pumps. Refer to 2.6.1.
2.10.2 Inadequate consideration of increased O&M and energy costs resulting from elimination of grit removal process.	New and Existing POTW's Refer to 2.6.5.
2.10.3 Inadequate consideration of effect of waste material on mechanical reliability.	New POTW's Provide pumps which are adequately sized, and which are specifically designed to handle abrasive material. Existing POTW's Method: Replace grit pumps with new units designed for the waste material. Refer to 2.7.9. Materials: New grit pump and related appurtenances.
Unit Operation/Component: 2.11 Influent Flow Measurement	
2.11.1 Measurement control section not compatible with flow measurement device.	New and Existing POTW's Check with manufacturers of the type of flow measurement device desired to determine the proper control section required.
2.11.2 Inadequate design of downstream channel slope and geometry causes back-up in control section.	New POTW's Provide adequate slope and geometry (i.e., no quick change in channel direction) in the downstream channel to prevent back-up.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Reinstall flow measurement device further upstream or provide a new type measurement device which is not affected by back-up. Materials: Hardware or appurtenances for reinstallation of new measurement device.
2.11.3 Inadequate design of obstructions downstream of control section induces inaccuracies in flow measurement.	New POTW's Consider effect of obstructions located downstream on flow conditions at flow measurement device.
	Existing POTW's Method: Reinstall flow measurement device further upstream or provide a new type measurement device which is not affected by back-up. Materials: Hardware or appurtenances for reinstallation of new measurement device.
2.11.4 Inadequate consideration of debris in wastewater in selection of float for flow measurement.	New POTW's Provide type of float which is self-cleaning or which inhibits debris build-up. Consider using a stilling well.
	Existing POTW's Method: Install a self-cleaning float and a stilling well, or, if necessary, replace existing level measurement with a sonic unit. Materials: New float or new level measurement device.

DEFICIENCY	CONSIDERATIONS
2.11.5 Flow meters located such that backwater elevation changes, due to clogging of bar screen, affect accuracy of meter.	New POTW's Provide bar screen upstream of flow meter. Existing POTW's Method: Reinstall flow meters downstream of bar screen. Materials: Concrete to form meter chamber and necessary appurtenances.
2.11.6 Inadequate consideration of diurnal flow patterns in sizing of flow measurement equipment results in measurement equipment being inaccurate at the high and/or low flow ranges.	New and Existing POTW's Equipment specifications should include expected maximum and minimum flows to ensure the selected manufacturer will provide equipment which will accurately measure flows over the entire flow range anticipated.
2.11.7 Inadequate approach channel length results in flow measurement inaccuracies.	New POTW's Determine from equipment manufacturers the length of approach channel required to allow flow measurement equipment to operate accurately. Existing POTW's Method: Reinstall flow meter downstream where approach channel length is sufficient to provide laminar flow; a rule-of-thumb is that the approach channel length should be 10 times the channel diameter. Materials: Concrete to form new meter chamber and necessary appurtenances.

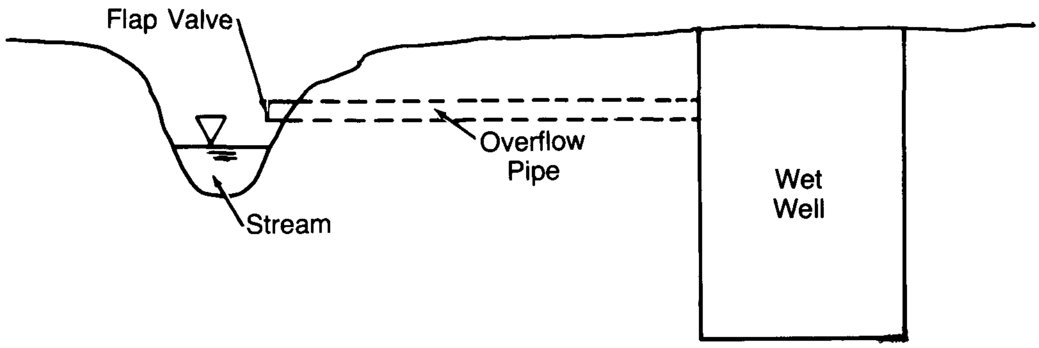
DEFICIENCY	CONSIDERATIONS
2.11.8 Inadequate consideration of humidity in influent structure results in inaccuracies to flow sensor.	New POTW's Provide flow sensors and associated metering equipment which are suitable for continuous use in humid conditions. Existing POTW's Method: Install dehumidifier or replace sensor with one which is not affected by humidity. Materials: New sensor or dehumidifier.
2.11.9 Inadequate consideration of potential freezing.	New and Existing POTW's Provide flow measurement equipment which is designed for operation in cold weather conditions. Also consider covering the flow measurement station to prevent freezing problems.

Unit Operation/Component: 2.12 Raw Waste Pumping

DEFICIENCY	CONSIDERATIONS
2.12.1 Inadequate selection of the number, size, and type of pumps.	New POTW's Select proper number, size, and type of pumps for the peak flow rate, wastewater characteristics, and discharge conditions anticipated. Spare pumps should be provided and pump vendor manuals utilized in selecting the type of pump required. Existing POTW's Method: Install additional pumping capacity needed to handle low and/or peak flows; provide a spare unit. Materials: New pumps and necessary appurtenances.

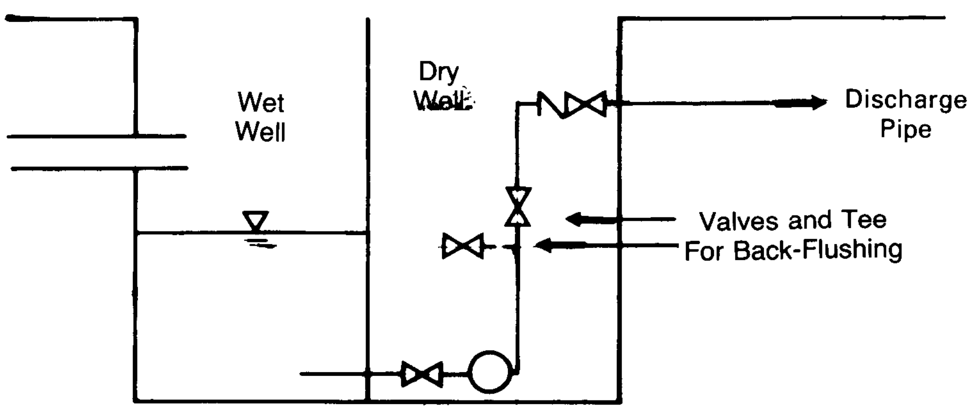
DEFICIENCY	CONSIDERATIONS
2.12.2 Inadequate provisions for removing scum from wet well.	New POTW's Provide scum removal facilities (such as a swing pipe or telescopic valve) in wet well. Existing POTW's Method: Construct scum pit or access for scum pump suction. Materials: Concrete for scum pit and metal for overflow control, or additional manhole for suction hose.
2.12.3 No provisions for odor control in wet well.	New and Existing POTW's Provide adequate ventilation and, if necessary, aeration, chlorination, or hydrogen peroxide dosing facilities.
2.12.4 Not locating grit removal and/or screening devices ahead of influent pumps to protect pumps from clogging or excessive abrasion.	New and Existing POTW's Provide grit removal and/or screening device upstream of influent pumps. Refer to 2.1.13, 2.3.1, and 2.6.1.
2.12.5 No provisions to periodically clean the wet well.	New and Existing POTW's Provide facilities to either temporarily stop influent to the wet well, divert flow to an alternate wet well or other storage facility, or provide a compartmentalized wet well that allows partial dewatering of the well.
2.12.6 No bar screens provided for protection of mechanical components.	New and Existing POTW's Provide bar screen upstream of influent pumps. Refer to 2.1.3.
2.12.7 Inadequate design of pumping station results in frequent cycling of units causing flow surges in downstream processes.	New POTW's Provide an adequately sized wet well and lift pumps to prevent a rapid drop in the water depth in the wet well and a resultant on-off cycling of the pumps.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Increase wet well storage volume by changing level controls and throttle pumps with valves, or install variable-speed pumps. Materials: Variable-speed pumps and necessary controls.
2.12.8 Lack of emergency overflow.	New POTW's Provide emergency overflow from wet well. Existing POTW's Method: Construct overflow. Materials: Pipe and flap valve. Sketch:



DEFICIENCY	CONSIDERATIONS
2.12.9 Improperly sized wet wells resulting in long detention times and odor problems, or too short detention time and cycling of pumps.	New POTW's Provide wet well with an average detention time of 10 minutes during average flow conditions. Existing POTW's Method: Adjust wet well level controls to decrease or increase storage volume or construct additional wet wells.

DEFICIENCY	CONSIDERATIONS
	Materials: Concrete to form new wet wells, and piping and valves for interconnection.
2.12.10 Lack of spare air compressor for bubbler system.	New POTW's Provide spare-air compressor. Existing POTW's Method: Install stand-by air compressor or large in-storage tank. Materials: New air compressor or air storage tank.
2.12.11 Inability to back-flush influent pumps for cleaning purposes.	New POTW's Provide back-flush facilities. Existing POTW's Method: Install tee and valves in pump discharge piping. Materials: Tee and valves. Sketch:



2.12.12 Corrosive and/ or explosive gases close to electrical motors and equipment.	New and Existing POTW's Provide adequate ventilation and specify explosion-proof motors and equipment.

DEFICIENCY	CONSIDERATIONS
2.12.13 Wet well level float controls may become greasy.	New POTW's Provide a stilling well or a sheath around floats and facilities for periodically cleaning float controls. Existing POTW's Method: Clean floats periodically with detergent, or replace floats with bubbler system. Materials: Bubbler system.
2.12.14 Lack of proper ventilation at lift station.	New and Existing POTW's Provide continuous or intermittent ventilation of both wet and dry wells. Refer to the applicable state guidelines for ventilation requirements.

Unit Operation/Component: 2.13 In-Line Flow Equalization

DEFICIENCY	CONSIDERATIONS
2.13.1 Surface floating aerators do not allow basin to be dewatered.	New POTW's Provide access for removal of aerators before dewatering, or consider use of fixed turbine aerators, a diffused aeration system, or static mixers/aerators. Existing POTW's Method: Install pulleys at the aerator cable support posts that allow the cable to be released and the floating aerator lowered as the basin liquid level drops.
2.13.2 Inadequate or lack of facilities to flush solids and grease accumulations from the basin walls.	New and Existing POTW's Provide high pressure water at basin for connection of hoses for cleaning. Also ensure safe access is provided around the basin. Refer to 1.1.20.
2.13.3 Lack of facilities for withdrawing floating material and foam.	New and Existing POTW's Provide a scum collection device such as a swing pipe, a scum pit, and pump.

DEFICIENCY	CONSIDERATIONS
2.13.4 Lack of emergency overflow.	New POTW's Provide emergency overflow back to head end of the plant. Existing POTW's Method: Install overflow pipe or channel. Materials: Pipe and valves, concrete to form channel, and metal diversion gates.
2.13.5 Lack of depth gauges provided on basins that operate at varying levels.	New POTW's Provide depth gauges which are capable of indicating all depths anticipated. Existing POTW's Method: Install float or capacitance probe gauges which indicate basin depth. Materials: New gauges.

Unit Operation/Component: 2.14 Side-Line Flow Equalization

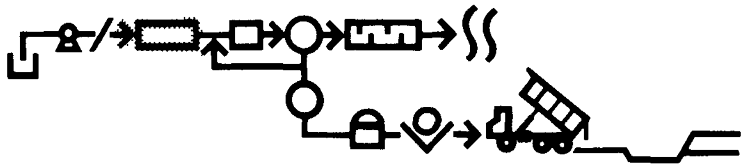
2.14.1 Surface floating aerators do not allow basin to be dewatered.	New and Existing POTW's Refer to 2.13.1.
2.14.2 Inadequate or lack of facilities to flush solids and grease accumulations from the basin walls.	New and Existing POTW's Refer to 2.13.2.
2.14.3 Lack of facilities for withdrawing floating material and foam.	New and Existing POTW's Refer to 2.13.3.
2.14.4 Lack of emergency overflow.	New and Existing POTW's Refer to 2.13.4.

DEFICIENCY	CONSIDERATIONS
2.14.5 Lack of depth gauges provided on basins that operate at varying levels.	New and Existing POTW's Refer to 2.13.5.

Unit Operation/Component: 2.15 General

DEFICIENCY	CONSIDERATIONS
2.15.1 No access to raw wastewater flow for sampling before side-stream addition occurs.	New POTW's Provide access for sampling before sidestream addition. Existing POTW's Method: Construct new manhole or access chamber upstream of where sidestream enters. Materials: Concrete to form manhole or chamber and manhole frame and cover or access hatch.
2.15.2 Inadequate consideration of needs for odor control.	New POTW's Provide covered dumpsters for storing screenings and grit, and, if necessary, a deodorant distribution system around the site. Existing POTW's Method: Install covers over screenings, scum and grit storage facilities, and/or construct deodorant system around site. Materials: Covers and necessary ventilation equipment and/or piping, valves, etc. for deodorant system.
2.15.3 Difficulty in handling high peak flows.	New POTW's Design facilities for peak flows and/or provide for emergency storage of wastewater. Existing POTW's Method: Construct flow equalization or storage facilities.

DEFICIENCY	CONSIDERATIONS
	Materials: Concrete or earth embankments and impermeable liner to form basin, and necessary pumps, piping, valves, etc.
2.15.4 Weirs and gates are not watertight.	New POTW's Specify watertight weirs and gates where necessary. Existing POTW's Method: Clean scaling surface and install flexible gasket material to allow better sealing. Materials: Flexible gasket material.

Design Considerations **Category:** 3.0 Primary Treatment	
Unit Operation/Component: 3.1 General	

DEFICIENCY

3.1.1 Inadequate odor control where excess waste activated sludge is received at primary clarifier.

CONSIDERATIONS

New POTW's

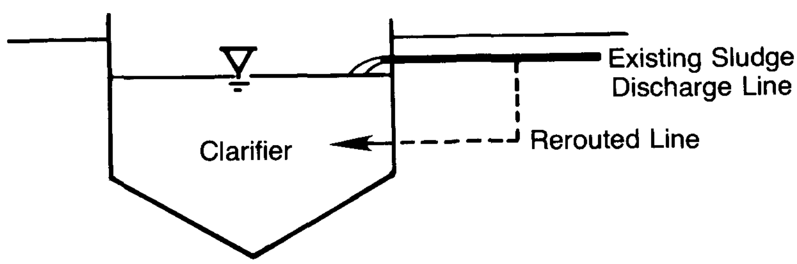
Provide for complete mixing of excess sludge and influent wastewater below water surface.

Existing POTW's

Method: Reroute piping to allow excess sludge discharge sufficiently below water level.

Materials: Pipe and related appurtenances.

Sketch:



DEFICIENCY	CONSIDERATIONS
3.1.2 Lack of screening and grit removal ahead of primary sedimentation.	New POTW's Provide screening and grit removal facilities upstream of primary sedimentation. Existing POTW's Method: Construct bar screen and/or grit chamber upstream of primary clarifier. Materials: Concrete to form chamber, and screen and mechanical cleaning equipment.
3.1.3 Inadequate provisions for sampling of raw sludge.	New POTW's Provide sampling point in raw sludge withdrawal line. Existing POTW's Method: Install sampling tap in sludge withdrawal line before sludge treatment units. Materials: Tap, valve, piping, and related appurtenances.

Unit Operation/Component: 3.2 Primary Clarifier

DEFICIENCY	CONSIDERATIONS
3.2.1 Improper length to width ratios.	New and Existing POTW's Provide clarifier with a length to width ratio of at least 3 to 1, and a minimum length of 10 feet.
3.2.2 Inadequate clarifier depth.	New POTW's Provide at least 7-foot side water depth, and up to a minimum of 14 feet for large clarifiers. Existing POTW's Method: Construct parallel clarifier and thereby reduce weir overflow rate in existing unit.

DEFICIENCY	CONSIDERATIONS
	Materials: Concrete to form new clarifier and necessary sludge removal equipment.
3.2.3 Design includes a common sludge removal pipe for two or more clarifiers resulting in unequal sludge removal from the clarifiers.	New and Existing POTW's Provide separate sludge removal pipes to each clarifier, or provide valves on each clarifier outlet when using a common removal pipe.
3.2.4 Effluent weir not uniformlylevel.	New POTW's Specify that the effluent weir must be level. Existing POTW's Method: Level weir.
3.2.5 Improper baffling resulting in short-circuiting.	New POTW's Provide adequate baffling to pre-vent short-circuiting. Existing POTW's Method: Rearrange baffles so that length of flow through clarifier is at least 10 feet and length to width ratio of tank is at least 3 to 1.
3.2.6 Short-circuiting causing poor solids removal.	New POTW's Provide baffling to prevent short-circuiting. Existing POTW's Method: Construct baffles in tank to increase flow length through tank (to at least 10 feet). Materials: Baffles and related installation hardware.

DEFICIENCY	CONSIDERATIONS
3.2.7 Septic conditions resulting from overloading.	<u>New POTW's</u> Provide clarifier with adequate surface area--less than 600 gallons per square foot for normal domestic sewage and sufficient sludge withdrawal capacity. <u>Existing POTW's</u> <u>Method</u>: Increase sludge withdrawal pumping capacity. <u>Materials</u>: Mechanical equipment for sludge removal, and all necessary appurtenances.
3.2.8 Inadequate consideration of impact of waste secondary sludge pumping on clarifier loading.	<u>New POTW's</u> Size clarifier with adequate volume and surface area to handle both influent and any waste sludge flows. <u>Existing POTW's</u> <u>Method</u>: Construct additional primary clarification units or discontinue sludge pumping to clarifier. <u>Materials</u>: Concrete to form tank and sludge removal equipment and necessary appurtenances.
3.2.9 Inadequate consideration of impact of various trickling filter recirculation rates and strategies on clarifier loadings.	<u>New POTW's</u> Provide adequately sized clarifier for influent, recirculation, and waste sludge flows. <u>Existing POTW's</u> <u>Method</u>: Reroute recirculation water downstream of clarifier. <u>Materials</u>: Piping and necessary appurtenances.

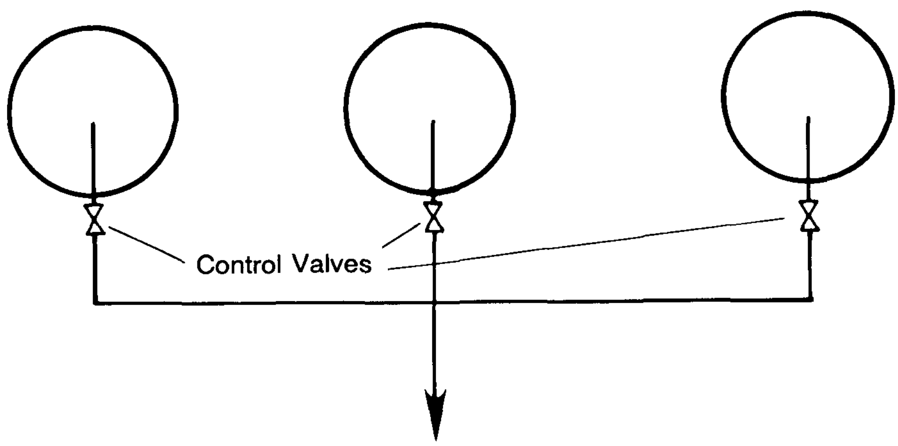
DEFICIENCY	CONSIDERATIONS
3.2.10 Inadequate consideration of clarifier inlet design.	New POTW's Provide inlet which will dampen the inlet velocity and distribute flow equally across the width of the clarifier. Existing POTW's Method: Construct baffles and flow deflectors to obtain equal flow distribution across the width of the clarifier. Materials: Baffles, plates, and necessary appurtenances.
3.2.11 Inadequate sizing of torque requirement for sludge removal mechanism.	New POTW's Specify that the sludge removal mechanism must have adequate torque to collect the sludge. Refer to manufacturers' specifications for torque ratings provided for various applications. Existing POTW's Method: Install larger motor and/or stronger removal mechanisms. Materials: New motor and/or mechanism and related appurtenances.
3.2.12 Heavy wear on scrapers due to grit.	New and Existing POTW's Provide grit removal facilities upstream of clarifier. Refer to 2.1.3.

Unit Operation/Component: 3.3 Primary Sludge Removal

DEFICIENCY	CONSIDERATIONS
3.3.1 Flushing and cleanout connections for sludge line not provided.	New POTW's Provide sufficient number of cleanouts or flushing connections to clean all lines between tanks and equipment.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install flushing and cleanout connections at both ends of sludge lines. Materials: Tees or wyes and related appurtenances.
3.3.2 Primary sludge pumps located too far away from clarifiers.	New POTW's Provide pumps as close as possible to clarifiers. Existing POTW's Method: Relocate pumps closer to clarifiers. Materials: Materials for housing pumps and required piping materials.
3.3.3 Inadequate provisions for preventing frequent maintenance resulting from stringy material in wastewater.	New POTW's Provide cutter mechanism in sludge line upstream of pump, or provide pump which can handle stringy material. Existing POTW's Method: Install cutter mechanism upstream of pumps or easily opened hatch in pump volute for stringy material removal. Materials: Cutter mechanism or new pumps and necessary appurtenances.
3.3.4 Inadequate provisions for chain, flight, and sprocket repair and replacement.	New POTW's Provide duplex primary clarifiers so that dewatering, repair, and replacement can be done. Existing POTW's Method: Install new type of scraper mechanism which has critical moving parts above the water level, or construct another clarifier so that one can be taken off-line for repairs.

DEFICIENCY	CONSIDERATIONS
	Materials: New scraper mechanism or concrete to form new clarifier and scraper, pumps, piping, and related appurtenances.
3.3.5 Design includes a common sludge removal pipe for two or more clarifiers resulting in unequal sludge removal from the clarifiers.	New POTW's Provide separate sludge removal pipes and pumps to each clarifier, or provide valves on each clarifier outlet when using a common removal pipe.
	Existing POTW's Method: Install control valves on lines from each clarifier. Materials: Valves and necessary appurtenances. Sketch:



DEFICIENCY	CONSIDERATIONS
3.3.6 Inadequate provisions for sampling of raw sludge.	New POTW's Provide sampling facilities for raw sludge at each clarifier or raw sludge pump.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install sampling tap on line from each clarifier. Materials: Tapping tee, piping, and necessary appurtenances.
3.3.7 Operator is not provided with the capability to observe sludge while pumping.	New and Existing POTW's Provide sight-glass or sludge density meter on suction side of sludge pumps.
3.3.8 Inadequate flexibility in sludge pumping system.	New and Existing POTW's Provide spare pumps at each pumping station and the flexibility to pump from the clarifier desired if more than one clarifier is provided.
3.3.9 Improper materials selection.	New and Existing POTW's Provide sludge removal equipment constructed from materials which are compatible with the wastewater anticipated. Particular attention should be given to any industrial wastes that will be in the POTW wastewater.
3.3.10 No provisions for measuring sludge flow.	New and Existing POTW's Provide flow meter on withdrawal line from each clarifier.
3.3.11 Inadequate consideration of character of sludge in sizing and layout of sludge lines.	New POTW's Sludge lines should be a minimum of 4 inches in diameter, and long runs and sharp turns should be avoided whenever possible. Existing POTW's Method: Constrictions in piping should be eliminated by replacement of small pipes (less than 4 inches) or sharp bends, etc. Materials: New piping, fittings, etc.

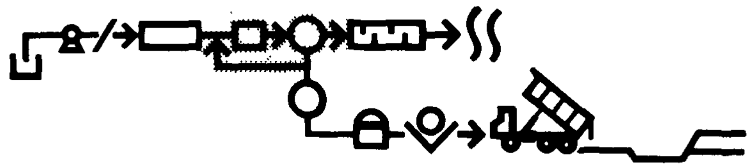
DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 3.4 Primary Sludge Pumps	
3.4.1 Flushing and cleanout connections for sludge line not provided.	New POTW's Provide flushing connections and cleanouts at the ends of sludge lines and at other critical areas (such as elbows and tees). Existing POTW's Method: Install flushing and clean-out connections at both ends of sludge lines and at all pumps, meters, etc. Materials: Tees or wyes and related appurtenances.
3.4.2 Primary sludge pumps located too far away from clarifiers.	New and Existing POTW's Provide sludge pump as close as possible to clarifiers.
3.4.3 Inadequate provisions for preventing frequent maintenance resulting from stringy material in wastewater.	New and Existing POTW's Provide cutter mechanism upstream of pumps or provide cutter pumps. Refer to 3.3.3.
3.4.4 Improper sizing of increments on time clock results in pumping of unnecessarily thin sludge.	New and Existing POTW's Provide time clock with 1/2 hour time increments.
3.4.5 Operator is not provided with the capability to observe sludge while pumping.	New and Existing POTW's Refer to 3.3.7.
3.4.6 Inadequate flexibility in sludge pumping system.	New and Existing POTW's Refer to 3.3.8.

DEFICIENCY	CONSIDERATIONS
3.4.7 Improper materials selection.	New and Existing POTW's Refer to 3.3.9.
3.4.8 No provisions for measuring sludge flow.	New and Existing POTW's Provide flow meters on all sludge lines.
3.4.9 Inadequate consideration of character of sludge in sizing and layout of sludge lines.	New and Existing POTW's Refer to 3.3.11.

Unit Operation/Component: 3.5 Scum Removal

DEFICIENCY	CONSIDERATIONS
3.5.1 Poor flotation of grease.	New POTW's Provide pre-aeration and skimming. Existing POTW's Method: Install pre-aeration tank with scum skimmer or install aeration equipment feed channel to primary clarifiers. Materials: Concrete to form tank, aeration, and skimming equipment and necessary appurtenances.
3.5.2 Inadequate provisions for preventing frequent maintenance resulting from stringy material in wastewater.	New POTW's Refer to 3.3.3 and 3.4.3. Existing POTW's Method: Install alternative scum removal equipment and cutter in withdrawal line. Materials: New scum removal equipment, cutter, and necessary appurtenances.

DEFICIENCY	CONSIDERATIONS
3.5.3 Improper placement of scum removal equipment hinders clarifier performance.	New POTW's Provide scum removal equipment near clarifier outlet. Existing POTW's Method: Relocate or replace scum removal equipment. Materials: New scum removal equipment and necessary appurtenances.
3.5.4 Scum is recycled through the plant and not removed from the system.	New and Existing POTW's Provide facilities for wasting the scum out of the plant along with the waste sludge.
3.5.5 Improper selection of scum pumping facilities results in excessive O&M.	New POTW's Provide scum pumping facilities which are compatible with scum handled (i.e., pumps that can handle a thick liquid with large solids). Existing POTW's Method: Install new scum pumps or new cutter mechanism upstream of pumps. Materials: New pumps, cutters, piping, valves, etc.
3.5.6 Inadequate freeze protection.	New and Existing POTW's Provide heated enclosure over tank or provide type of removal mechanism not subject to freezing.

Design Considerations Category: 4.0 Air Activated Sludge	
Unit Operation/Component: 4.1 Aeration Basin	

DEFICIENCY

4.1.1 Lack of flexibility to operate in different modes (i.e., complete mix, plug flow, contact-stabilization, etc.).

CONSIDERATIONS

New POTW's

Provide piping and valving so that multiple aeration basins can be operated in the complete mix mode, the plug-flow mode, or the contact-stabilization mode, as shown in the sketches below.

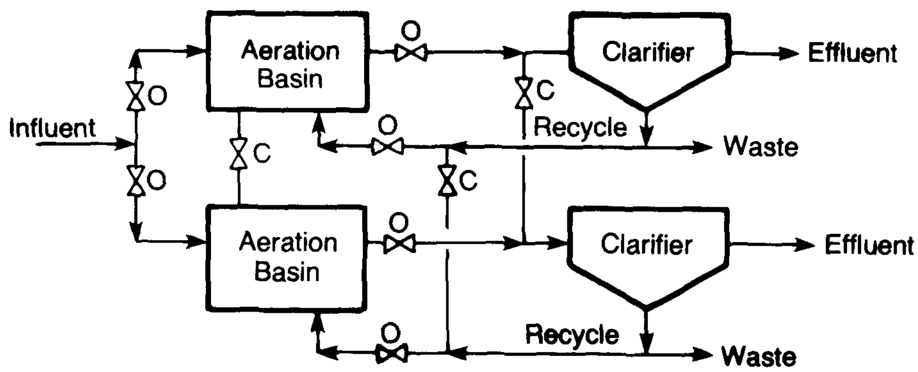
Existing POTW's

Method: If plant layout warrants, install piping and valving so that multiple aeration basins can be operated in the complete-mix mode, the plug-flow mode, or the contact-stabilization mode.

Materials: Valving and piping to be compatible with existing piping.

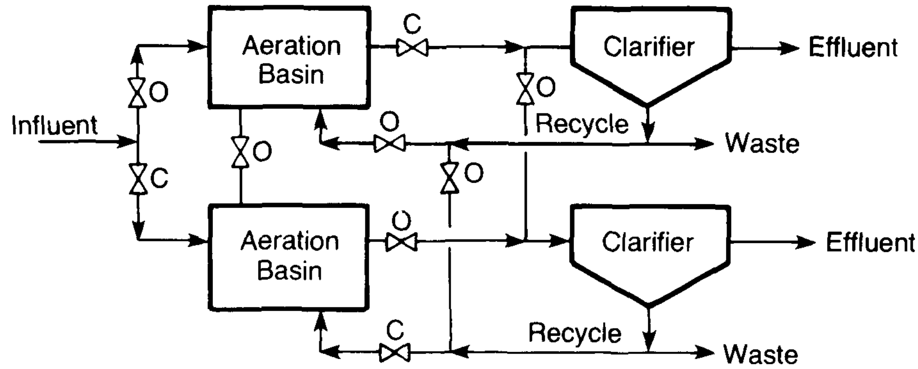
Sketch:

- Complete Mix

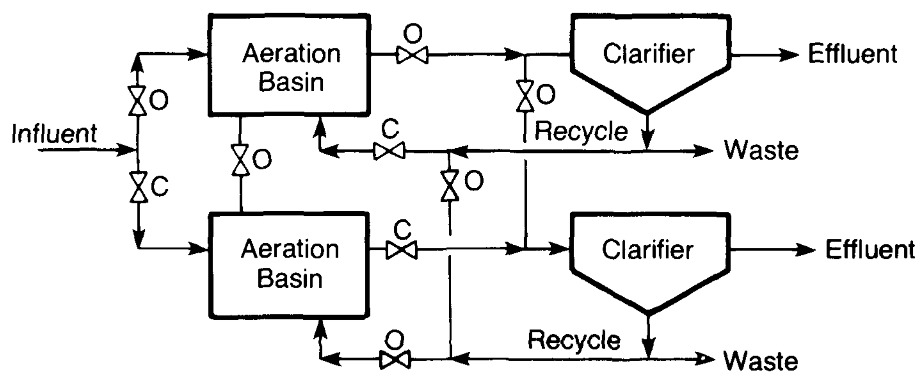


DEFICIENCY | CONSIDERATIONS

- Plug Flow



- Contact Stabilization



4.1.2 Aerator spacing not adequately considered.

New POTW's

To ensure adequate mixing in an aeration basin and the prevention of "dead zones", the influence zones of the aerators in a basin must slightly overlap. Spacing of mechanical aerators depends on the type of aerator utilized, depth of the basin, size of aerator, etc. Vendor literature should be referred to in order to identify proper spacing between aerators and between aerators and basin sidewalls. Generally, diffusers should be spaced more than 6 inches and less than 24 inches on center. The spacing of

DEFICIENCY	CONSIDERATIONS
	static mixers is dependent on the design mixed liquor suspended solids concentration and can vary from 5 to 30 feet.
	Existing POTW's Method: If a fixed aerator is too close to the wall of an aeration basin which causes splashing problems, add splash shields under the aerator platform or along the top of the aeration basin wall. If there is low D.O. and/or inadequate mixing within the aeration basin, add baffling between aerator zones of influence or add diffused aeration or floating aerators to supplement the aeration capability of the existing aerators.
4.1.3 Inadequate consideration for alkalinity adjustment.	New POTW's Alkalinity control is especially important in activated sludge systems designed for nitrification. During the conversion of ammonia to nitrate, mineral acidity is produced. If insufficient alkalinity is present in the wastewater, the pH of the system will drop, and nitrification may be inhibited. Approximately 7.1 mg of alkalinity as $CaCO_3$ is destroyed per mg of ammonia nitrogen oxidized, and, depending on buffering capacity of the wastewater, approximately 5.4 kg of hydrated lime is required per kg of ammonia nitrogen oxidized if a constant pH must be maintained. In order to maintain a constant pH during nitrification, practice has shown that a residual alkalinity of 50 mg/L for aeration and at least 150 mg/L for high-purity oxygen systems is considered desirable.

DEFICIENCY	CONSIDERATIONS
	Provide for lime addition facilities for alkalinity control, including (as required) lime storage, lime slurry mixing equipment, chemical feed pump(s), and pH monitoring. Size the lime storage for at least a one-month supply, and size the lime slurry mixing and/or storage tanks such that the slurry will have to be made up no more frequently than once per shift. Existing POTW's Method: Install an alkalinity adjustment system. Materials: Storage silo, mixing tank, feed pumps, pH controller; piping with victaulic couplings or heavy-duty flexible rubber hoses and appurtenances. Cost: • Lime ≈ \$35/ton. • Sodium bicarbonate ≈ \$220/ton
4.1.4 Inadequate foam control.	New POTW's Provide foam control facilities if foaming may be a problem, such as when high organic loadings or high oil-and-grease concentrations are expected. Facilities for foam control include: • Foam spray water system. • Defoaming agent addition facility. • Yard hydrants to allow periodic cleaning of aeration basin sidewalls.

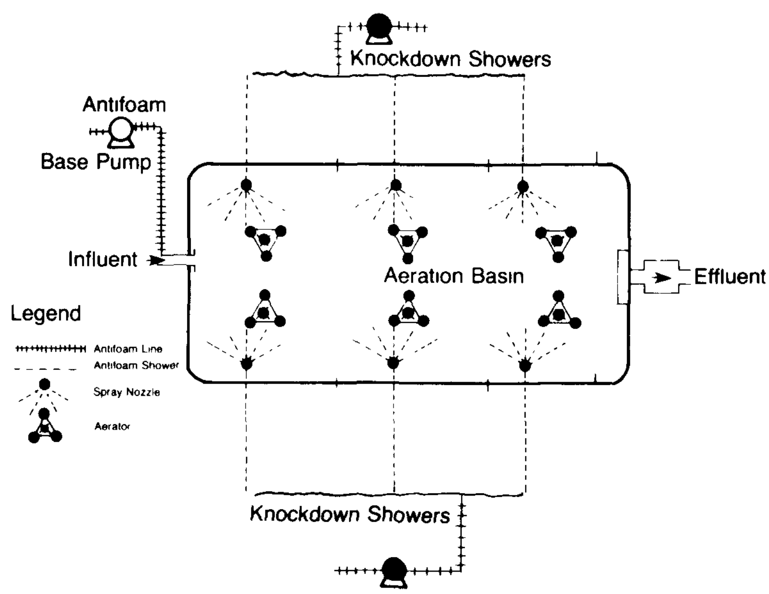
DEFICIENCY | CONSIDERATIONS

Existing POTW's

Method: Install a defoaming agent addition system to include a spray water system in the aeration basin. As a minimum, acquire a metering pump and 55-gallon drums of defoamer agent. The defoamer addition system should be located close to the appli- tion point(s).

Materials: Spray headers, pipe and related appurtenances, defoamer metering pumps, and spray water pumps. Piping should be insulated in cold-weather regions.

Sketch:



4.1.5 Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.

New POTW's

Aeration systems should be sized (i.e., horsepower specified) based on both mixing and oxygen requirements. Factors to be considered include basin depth, aerator spacing baffles, system horsepower, and

DEFICIENCY	CONSIDERATIONS
	basin geometry. Rule of thumb for mixing in diffused aeration systems is 20 to 30 scfm/1,000 cu ft; for surface aerators, it is 0.50 to 1.0 hp/1,000 cu ft.
	Existing POTW's Method: Refer to 4.1.2.
4.1.6 Inadequate screening of raw wastes causes plugging of aerators and return/waste sludge pumping system.	New POTW's Provide preliminary treatment via comminutors and bar screens. Remove rags and screenings from system rather than grinding them up and putting them back into the system.
	Existing POTW's Method: Construct grit removal and screening devices upstream of influent wet well. Refer to 2.1.3, 2.3.1 and 2.6.1. Materials: Concrete to form grit removal and screening chamber, and necessary equipment.
4.1.7 Inflexible design does not permit isolation of reactors and changes in flow schemes for maintenance purposes and/or to adjust for changes in wastewater characteristics.	New and Existing POTW's Provide parallel treatment tanks to permit changes in operational mode and for one tank to be dewatered for maintenance while the remaining tank(s) continue in service. Refer to 4.1.1.
4.1.8 Inadequate consideration of impact and control of in-plant sidestreams.	New POTW's When sizing aeration basins, the BOD and SS loadings from various plant sidestreams (i.e., thickener overflows, filtrates, centrates, digester supernatants, etc.) must be considered. The aeration basin must have

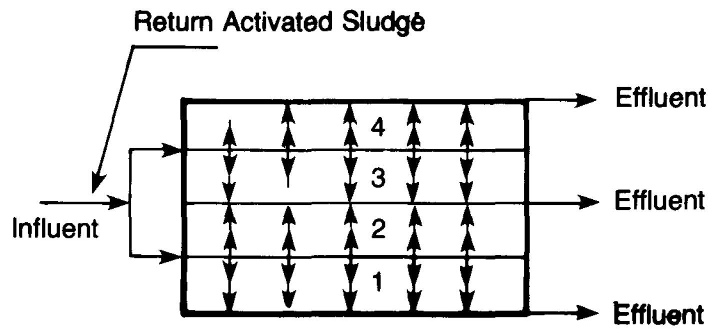
DEFICIENCY	CONSIDERATIONS
	sufficient volume and aeration capacity to treat the additional sidestream loadings. Pretreatment of sidestreams may be warranted to reduce pollutant loadings and/or to equalize flows.
	Existing POTW's Method: Implement pretreatment and/or equalization of sidestreams prior to discharge to the POTW aeration basin.
4.1.9 Inability to dewater tanks for repair.	New and Existing POTW's Provide mud valves in aeration basins that allow the basins to be drained to the plant drain system. Sumps should also be provided in the tank bottoms to allow complete dewatering. Refer to 1.1.26 and 1.2.8.
4.1.10 Inadequate provisions for by-passing aeration basin.	New POTW's Refer to 4.1.7.
	Existing POTW's Method: Install by-passes around basins that preferably discharge to other aeration basins. Refer to 4.1.1. Materials: Piping, valves, and related appurtenances.
4.1.11 No provisions for flow division boxes.	New and Existing POTW's Provide a flow division box to equally split, regulate, and/or shut off flow to the individual units that make up a parallel treatment train.

DEFICIENCY	CONSIDERATIONS
4.1.12 Improper sidewater (SWD) and baffling cause splashing problems in basin.	New POTW's Provide a minimum SWD of 2 ft in aeration basins. When surface aerators are utilized, splash shields should be installed on top of basin walls closest to the aerators. For small tanks, splash shields should be used to protect walkways from water spray generated by surface aerators. Existing POTW's Method: Construct splash shields along base of walkway. Refer to 4.1.2. Materials: Stainless steel, fiberglass, or reinforced plastic.
4.1.13 Inability to control and measure mixed liquor flow distribution to multiple secondary clarifiers.	New and Existing POTW's Provide necessary piping, valving, and flow measuring facilities (i.e., in-line magnetic meters, V-notch weirs, etc.) to allow operator to route, adjust, and measure flow from the aeration basin to any group of multiple secondary clarifiers.
4.1.14 Inability to change placement of return sludge in aeration basins.	New POTW's Design return sludge piping with the flexibility to direct sludge to multiple points (i.e., at basin influent gates, at surface aerators, etc.) in aeration basins. The recycle sludge discharge flexibility should be compatible with the treatment mode options listed in 4.1.1, i.e., complete mix, step aeration, plug flow, and contact stabilization. Examples of piping and flow options are shown in the following sketches:

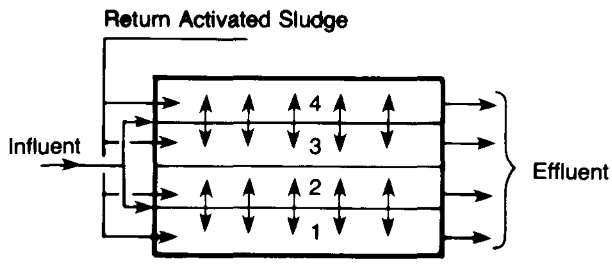
DEFICIENCY

CONSIDERATIONS

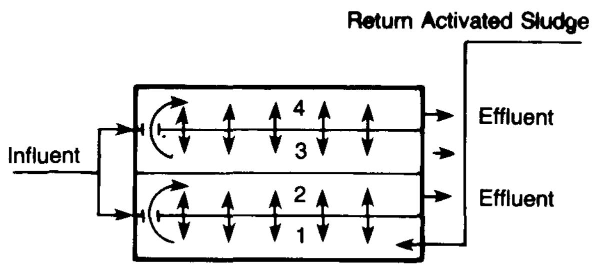
- Complete Mix



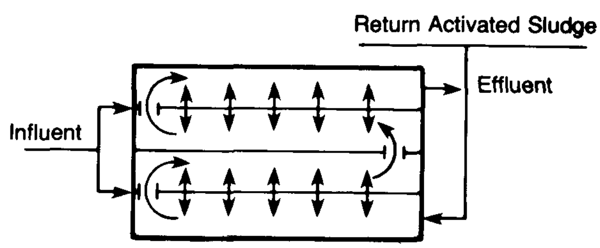
- Step Aeration



1 Pass Step Aeration



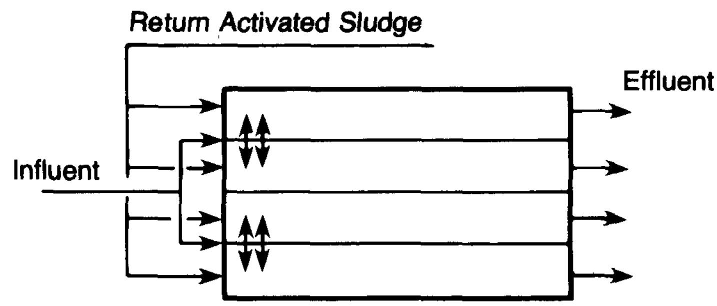
2 Pass Step Aeration



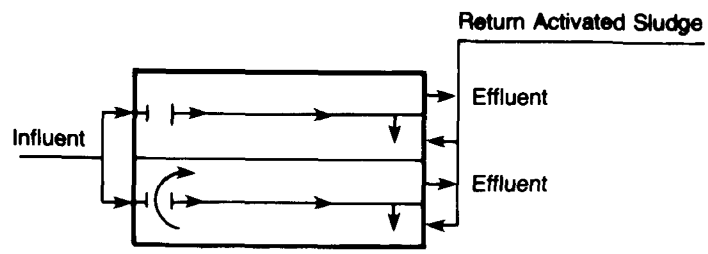
4 Pass Step Aeration

DEFICIENCY | CONSIDERATIONS

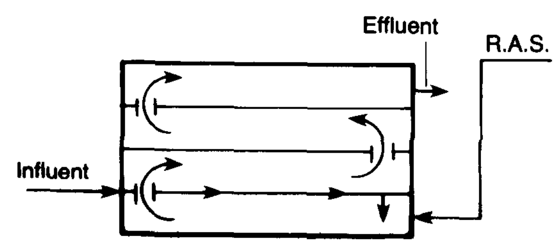
- Plug Flow



1 Pass Conventional



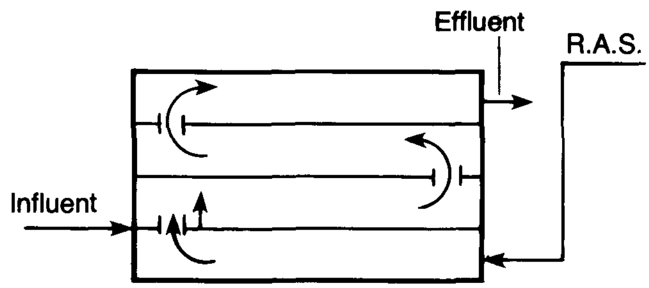
2 Pass Conventional



4 Pass Conventional

DEFICIENCY | CONSIDERATIONS

- Contact Stabilization



Existing POTW's

Method: Install additional piping required to direct sludge to multiple points in the aeration basin.

Materials: Piping, valves, and related appurtenances.

4.1.15 Inadequate consideration of impact of changing aeration basin levels on aerator performance.

New POTW's

Changing the submergence (i.e., the aeration basin level) of fixed surface aerators by just a few inches can greatly affect their performance. Diffuser aeration or turbine aerators should be used in basins that will operate at varying levels. Adjustable effluent gates should be provided to allow setting the proper liquid level in the aeration basin.

In small aeration basins, significant changes in forward flow could change the operating level (i.e., the level over the effluent gates) in the basin, and, consequently, the performance of surface aerators. Maximum flows must be considered, therefore, in sizing the aeration basins.

DEFICIENCY	CONSIDERATIONS
	For floating aerators, snubbers should be provided at each mooring to allow adjustment of the support cables with changes in basin operating levels. Existing POTW's Method: For fixed surface aerators, install adjustable effluent weirs/gates to allow adjustment of the aeration basin liquid level. Install snubbers on mooring cables to floating surface aerators. Materials: Concrete to form new weir base; adjustable weirs and related appurtenances for fixed surface aerators; snubbers for floating aerators.
4.1.16 Multicompartmental basins do not have reinforced inner walls; therefore, individual tanks cannot be dewatered.	New and Existing POTW's Specify reinforced common walls inside multicompartmental basins to allow draining of individual tanks. Also, specify drain valves in each tank.
4.1.17 Inability to drain foam spray system results in freezing problems.	New POTW's Design foam spray water systems with: pumps with casing drain plugs, or piping systems with drain valves at all low points. If portions of exposed piping cannot be drained by gravity via removal of a plug, provide taps to allow for an air purge. Existing POTW's Method: Install drain valves/plugs at low points in piping system and on pumps. If necessary, install taps to allow air purging the lines. Materials: One-inch drain plugs/valves.

DEFICIENCY	CONSIDERATIONS
4.1.18 Supports for air drop pipes cannot be seen when aeration basin is full, making it difficult to re-install the drop pipes.	<u>New and Existing POTW's</u> Provide top guides to bottom air drop pipe supports that are located above the highest operating level in the aeration basin. Provide means, such as a clasp, to secure pipe to top guide.
4.1.19 Lack of splash shields in front of effluent gates.	<u>New and Existing POTW's</u> Provide splash shields in front of effluent gates in order to allow accurate setting of the gates and a relatively-constant flow from the basin. Splash shields will also help minimize foam build-up in effluent troughs.
4.1.20 Quick disconnect plugs on aerators become wet and short out.	<u>New and Existing POTW's</u> Locate quick disconnect plugs out of the splashing range of aerators and specify weather-proof plugs. Specify the use of moisture/explosion proof electrical couplings that include locking collars, screws, or latches to prevent the unintentional loosening of the coupling.
4.1.21 Inadequate consideration of freezing problems and effect of cold temperatures on efficiency of biological treatment.	<u>New POTW's</u> As wastewater temperature drops, the efficiency of biological treatment systems will also drop (unless operational adjustments are made). To minimize this potential problem in areas characterized by low seasonal temperatures, consideration must be given to: • Diffused aeration versus mechanical aerators. • Below-grade versus above-ground tank installation for improved insulation. • Covered tanks.

DEFICIENCY	CONSIDERATIONS
	• Sludge recycle systems with a capacity equal to 100 percent of forward flow.
	Existing POTW's Method: Construct an earthen berm around above-ground tanks to insulate the tank; install wind shields around tank perimeter; supplement surface aerators with diffused aeration system; and/or provide covers over open tanks. Materials: Commercially-available tank covers; stainless steel or fiberglass windshields; diffused aeration system.

Unit Operation/Component: 4.2 Diffusers

DEFICIENCY	CONSIDERATIONS
4.2.1 Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.	New POTW's A rule of thumb for mixing requirements for diffused aeration systems is 20 to 30 scfm/1,000 cu ft. Oxygen requirements must also be considered. Refer to 4.1.5. Existing POTW's Method: Increase the horsepower of existing blowers. Install baffles to improve basin mixing patterns. Supplement aeration systems with additional diffusers. Refer to 4.1.2.
4.2.2 Inadequate aeration capacity.	New and Existing POTW's When sizing aeration systems, both mixing and oxygen requirements must be considered. Refer to WPCF MOP No. 5, Ten States Standards, and local standards for aeration capacity guidelines. Refer to 4.1.2 and 4.2.1.

DEFICIENCY	CONSIDERATIONS
4.2.3 Inadequate screening of raw wastes causes plugging of aerators and return/waste sludge pumping systems.	New and Existing POTW's Provide bar screens, grit chambers, and primary sedimentation facilities prior to aeration in order to minimize plugging of aerators and return sludge systems. Effective preliminary treatment is particularly important for contact-stabilization processes. Refer to 2.1.3, 2.3.1, 2.6.1, and 4.1.6.
4.2.4 Inadequate or no air cleaners provided on blowers.	New and Existing POTW's Provide air filters on intake side of blowers to minimize clogging of diffusers. Refer to blower manufacturer recommendations.
4.2.5 No provisions for removing air diffuser drop pipes from aeration tanks.	New POTW's Provide necessary equipment (hoists, fittings, flexible joints, etc.) to facilitate the removal of air diffuser drop pipes for inspection and maintenance. For small, package-type treatment plants, specify lifting rings be placed at the top of drop pipes to allow the operator to tie-off the pipe before disconnecting it from the header. This will prevent the pipe from accidentally falling into the aeration basin. Existing POTW's Method: Install mobile gantry-type hoist on aeration basin. For small, package type plants, weld lifting rings at the top of each drop pipe. Materials: Commercially available hoists.
4.2.6 Air valves not graduated to allow even distribution of air flow to diffusers.	New POTW's Specify for each drop pipe (i.e., diffuser) air valves that have position indicators (fully open, half open, fully closed, etc.).

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Replace existing valves in air lines to individual diffuser heads with graduated butterfly valves. Materials: Butterfly valves with position indicators.
4.2.7 Supports for air drop pipes cannot be seen when aeration basin is full, making it difficult to re-install drop pipes.	New and Existing POTW's Refer to 4.1.18.
4.2.8 Diffusers plug due to dirty air supply.	New and Existing POTW's Provide air filters on intake side of blowers. Refer to 4.2.4.

Unit Operation/Component: 4.3 Fixed Mechanical Aerators

4.3.1 Aerator spacing not adequately considered.	New POTW's The zone of influence for surface aerators is dependent on horsepower and must be considered during design to determine proper spacing between aerators and between aerator and basin sidewalls. Aeration basin geometry may be dictated by aerator spacing requirements. Vendor specifications should be referred to for spacing information. Existing POTW's Method: Refer to 4.1.2.
4.3.2 Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.	New POTW's Refer to 4.1.5.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Increase the horsepower of existing aerators. Install baffles to improve basin mixing patterns. Supplement existing surface aeration system with diffused aeration or a pure oxygen system. Refer to 4.1.2.
4.3.3 Inadequate aeration capacity.	New and Existing POTW's Refer to 4.2.2.
4.3.4 Inadequate consideration of debris in wastewater.	New POTW's Provisions should be made for screening devices upstream of aeration tanks. Refer to 4.1.6. Existing POTW's Method: Refer to 4.2.3.
4.3.5 Inadequate consideration of impact of changing aeration basin levels on aerator performance.	New and Existing POTW's Refer to 4.1.15.
4.3.6 Improper placement of gear box drains causes oil to drain into aeration basin.	New POTW's Specify aerators with gear boxes that can be easily drained, and minimize the possibility of oil spilling into the aeration basin. The drains should be placed such that a container can be placed under the drain to collect waste oil. The operator should not be required to install or modify the equipment with additional drain pipes, valves, or fittings after construction. Existing POTW's Method: Use hand drill attached pump and pump waste oil into suitable container. If possible, install a pipe from the drain plug to a position that provides convenient access by the operator.

DEFICIENCY	CONSIDERATIONS
	Materials: Drill pump, 1/4" O.D. tubing. Cost: $5 to $10 for drill pump.
4.3.7 Amp meters not provided at motor control center so operators cannot tell if proper amperage is being drawn.	New POTW's Amp meters should be specified for installation at aerator circuit breakers to allow the operator to determine if aerators are drawing the proper amperage. If the aerator blade is submerged too much, this can cause the aerator to draw too many amps and damage the aerator. This is particularly helpful during POTW start-ups. Existing POTW's Method: Install amp meters at MCC circuit breakers. Materials: Electrical wire and suitable connectors. Cost: Approximately $500 per unit.
4.3.8 No time delay relays provided to limit stress shock to aerator gears when shifting from high speed to low speed.	New POTW's Specify time delay relays be provided on aerator motors that will allow the aerator blade to slow down before the motor shifts into low speed in order to minimize stress shocks when switching aerators from high speed to low speed. Existing POTW's Method: Install time delay relays in aerator controllers. Materials: Electrical wire and suitable connectors. Cost: Approximately $250 per unit.

DEFICIENCY	CONSIDERATIONS
4.3.9 Spray from surface aerators makes walkways slippery.	New POTW's Specify splash shields for aerators that are placed in small tanks and are located adjacent to walkways. Spray shields can also be mounted along the outside edge of walkways to prevent spray water collecting on walkways. Existing POTW's Method: Install spray shields along outside edge of walkways to prevent spray water collecting on walkways. Install aerator spray shields. Materials: Stainless steel or fiberglass walkway spray shields. Refer to aerator manufacturer for recommendations concerning aerator splash plates.

Unit Operation/Component: 4.4 Floating Aerators

DEFICIENCY	CONSIDERATIONS
4.4.1 Aerator spacing not adequately considered.	New and Existing POTW's Refer to 4.1.2 and 4.3.1.
4.4.2 Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.	New POTW's Refer to 4.1.5. Existing POTW's Method: Refer to 4.1.3 and 4.3.2.
4.4.3 Inadequate aeration capacity.	New POTW's Refer to 4.2.2. Existing POTW's Method: Refer to 4.1.2 and 4.3.2.

DEFICIENCY	CONSIDERATIONS
4.4.4 Inadequate consideration of debris in wastewater.	New POTW's Refer to 4.3.4. Existing POTW's Method: Refer to 4.1.6 and 4.2.3.
4.4.5 Floating aerators located too close to wall or pontoons not aligned properly, causing pontoons to strike the basin wall when starting up.	New and Existing POTW's Provide for safe installation of floating aerators by: • Specifying use of low voltage starters to minimize initial torque levels and lateral movement. • Minimizing slack in mooring cables by using "snubbers". • Assuring pontoons are properly aligned according to manufacturers' specifications. • Locating aerators a safe distance from the nearest wall.
4.4.6 Improper placement of gear box drains causes oil to drain into aeration basin.	New and Existing POTW's Refer to 4.3.6.
4.4.7 Amp meters not provided at motor control center so operator cannot tell if proper amperage is being drawn.	New and Existing POTW's Refer to 4.3.7.

DEFICIENCY	CONSIDERATIONS
4.4.8 Quick disconnect plugs on aerators become wet and short out.	New and Existing POTW's Refer to 4.1.20.
4.4.9 No time delay relays provided to limit stress shock to aerator gears when shifting from high speed to low speed.	New and Existing POTW's Refer to 4.3.8.
4.4.10 Spray from surface aerators makes walkways slippery.	New and Existing POTW's Refer to 4.1.2 and 4.3.9.

Unit Operation/Component: 4.5 Blowers

DEFICIENCY	CONSIDERATIONS
4.5.1 Inadequate aeration capacity.	New and Existing POTW's Provide blowers with sufficient capacity and discharge pressure to both thoroughly mix and provide oxygen to the entire contents of the aeration basin. Provide a stand-by blower for use during unusually high oxygen demand periods and/or when another unit is out of service. Refer to 4.2.2.
4.5.2 Inadequate or no air cleaners provided on blowers.	New and Existing POTW's Provide air cleaners (filters) on the intake side of each blower. This will help prevent damage to blowers and clogging in fine bubble diffusers. Refer to 4.2.4.
4.5.3 Blower silencers not provided.	New and Existing POTW's Provide silencers on both the intake and discharge side of blowers. Refer to blower manufacturers' recommendations.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 4.6 Air Distribution System	
4.6.1 Inability to adequately measure and adjust air flow rates to control D.O. levels and energy consumption.	New POTW's Provide flow meters on all main air headers to aeration tanks. Provide graduated valves in each drop pipe to diffusers to allow air flow regulation. Existing POTW's Method: Install annubar flow element in air supply pipe to each basin. Install butterfly control valves with indicator markings for throttling on individual assembly units of diffusers. Materials: Flow elements and graduated butterfly valves.
4.6.2 Improper air piping material.	New POTW's Specify non-scaling material for air piping systems. Avoid organic coatings such as coal tar dips which may deteriorate with time and cause fine particles to dislodge and clog air diffusers. Existing POTW's Method: To intercept piping scale, install fine mesh strainer in diffuser drop-leg. Material: Basket-type strainer.
4.6.3 No provisions for removing air diffuser drop pipes from aeration tanks.	New POTW's Refer to 4.2.5. Existing POTW's Method: Install adjustable gantry on aeration basin. Weld lifting rings to top of air drop pipes.

DEFICIENCY	CONSIDERATIONS
	Materials: Commercially available.
4.6.4 Air valves not graduated to allow even distribution of air flow to diffusers.	New and Existing POTW's Refer to 4.2.6.
4.6.5 Supports for air drop pipes cannot be seen when aeration basin is full, making it difficult to re-install the drop pipes.	New and Existing POTW's Refer to 4.1.18.

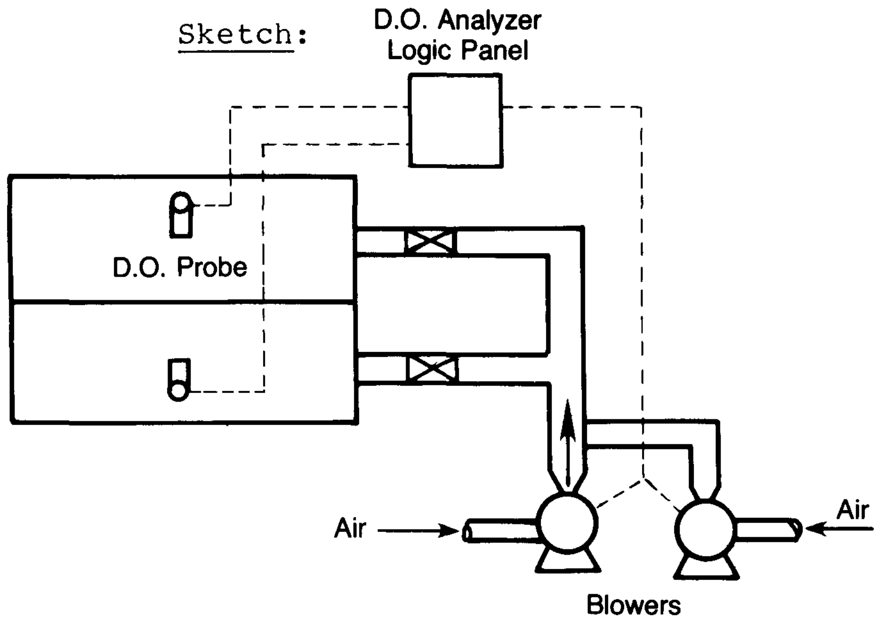
Unit Operation/Component: 4.7 D.O. Control and Measurement

4.7.1 Inability to adequately measure and adjust air flow rates to control D.O. levels and energy consumption.	New POTW's Where varying organic loads are applied to aeration basins, provisions are needed to constantly monitor and control dissolved oxygen levels in the basins. As a minimum, D.O. probes should be specified to monitor D.O. levels. For large plants, an automatic D.O. analyzer and a D.O. controller should be considered to automatically control the "ON-OFF-SPEED" setting on plant aerators/blowers. Refer to 4.6.1. Existing POTW's Method: Install automatic D.O. system to vary air input, by controlling the "ON-OFF-SPEED" setting of the blowers according to the basin D.O. level. Materials: Dissolved oxygen monitoring system and related automatic control systems.

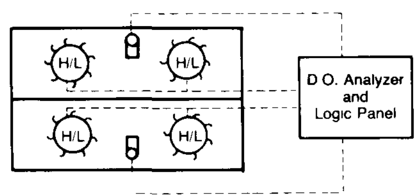
DEFICIENCY | CONSIDERATIONS

Cost: Approximately $20,000 to $30,000.

Sketch:



- As D.O. level decreases below set-point, blower speeds are increased and more blowers are started.
- As D.O. level increases above set-point, blower speeds are decreased and some blowers are stopped.



- As D.O. level decreases below set-point, 2-speed aerator shifts from low to high speed.
- As D.O. level increases above set-point, 2-speed aerator shifts from high to low speed.

DEFICIENCY	CONSIDERATIONS
4.7.2 Inadequate consideration of impact and control of in-plant side-streams.	New and Existing POTW's Refer to 4.1.8.
4.7.3 Air valves not graduated to allow even distribution of air flow to diffusers.	New and Existing POTW's Refer to 4.2.6.
4.7.4 Improper design of D.O. measuring instrumentation does not allow easy removal of equipment for routine inspection and maintenance.	New POTW's Specify D.O. measuring instrumentation that can be conveniently removed for cleaning the probe, calibration, and for general maintenance purposes. Existing POTW's Method: Install swivel-type support to handrail to permit easy removal from basin. Materials: 1-1/2" swivel joint.

Unit Operation/Component: 4.8 Return Sludge Pumping

DEFICIENCY	CONSIDERATIONS
4.8.1 Inadequate screening of raw wastes causes plugging of aerators and return/waste sludge pumping system.	New and Existing POTW's Specify sludge piping with a minimum diameter of four inches. Pump impellers should be non-clog type, able to easily handle heavy solids that may accumulate in the secondary clarifier. Provide capability to flush out (back-flush) pumps and lines with high pressure water. Consideration should be given to using progressive cavity pumps in lieu of centrifugal pumps. Refer to 4.1.6.

DEFICIENCY	CONSIDERATIONS
4.8.2 Inflexible design does not permit isolation of reactors and changes in flow schemes for maintenance purposes and/or to adjust for changes in waste characteristics.	New and Existing POTW's Return sludge pumps and piping should be designed to allow the isolation of aeration basins. The return sludge system should include: common pump suction line from clarifiers to allow switching pumps; common discharge header; valving system that allows diverting sludge flow in order to isolate a basin; one recycle pump for each basin; plus a common spare. Refer to 4.1.1 and 4.1.14.
4.8.3 Inadequate consideration of impact and control of in-plant sidestreams.	New and Existing POTW's Provide sufficient recycle capacity to make adjustments in the aeration basin mixed liquor to compensate for increased loads from in-plant sidestreams. Refer to 4.1.8.
4.8.4 Inadequate provisions for sampling and observation of return and waste activated sludge.	New and Existing POTW's Provide sampling taps on recycle and waste sludge discharge lines. Sampling taps should have a minimum diameter of two inches. Consideration should also be given to specifying in-line sludge density meters. In addition, when possible, provide a "free fall" discharge of return sludge flow to aeration basins and waste sludge to aerobic digesters, holding tanks, etc. Refer to 1.1.17.
4.8.5 Inadequate consideration of debris in wastewater.	New and Existing POTW's Refer to 4.1.6 and 4.8.1.
4.8.6 Improper selection of valves for sludge lines.	New POTW's Provide valves that will minimize the possibility of solids getting jammed into the moving and projecting parts. Avoid: spring-loaded vertical-lift-disk check valves and solid wedge or single-gate valves. Provide: plug valves, knife gate valves, or pinch valves.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Replace existing valves with proper type. Materials: Plug valves, knife gate valves, or pinch valves.
4.8.7 Improper return sludge flow splitting.	New POTW's Provide positive control of return sludge distribution. Do not rely entirely on piping wyes and tees to split flow evenly. Valving should be provided to adjust flows to different points within an aeration basin, and separate recycle pumps should be used to distribute flow to multiple aeration tanks. Existing POTW's Method: Install a flow splitter box to ensure even distribution of recycled sludge to multiple aeration basins and/or application points. Install valves in existing recycle lines to provide better flow control. Provide overflow weirs and/or in-line magnetic flow meters to measure sludge flow rates. Refer to 4.8.6.
4.8.8 Inadequate sludge recycle/ waste capacity.	New POTW's Provide sufficient sludge recycle pumping and piping capacity to allow the operator to recycle 100 percent of the forward flow. As a minimum, one stand-by pump should be supplied. Existing POTW's Method: Install additional recycle/ waste sludge pump or increase the impeller and/or motor size of the existing sludge pumps. Refer to 1.3.16.

DEFICIENCY	CONSIDERATIONS
	Materials: Concrete to form pump pad, motor controls, piping, valves, and related appurtenances.
4.8.9 Inadequate sludge flow measurement for small plants using air lift pumps.	New and Existing POTW's Provide magnetic flow meters with flow indication in gpm as part of each sludge return (and waste) system. As a minimum, provide a flow box equipped with a V-notch weir to allow the operator to manually determine sludge flow rates.
4.8.10 Inability to adjust, measure, and control return/ waste sludge flows.	New POTW's Refer to 1.3.16, 4.1.1, 4.8.2, 4.8.6, 4.8.7, 4.8.8, and 4.8.9.
	Existing POTW's Method: Install an automatic flow control valve, and a flow meter in the return sludge line.
	Materials: Flow meters, control valve, and related appurtenances.
4.8.11 Inability to change placement of return sludge in aeration basin.	New and Existing POTW's Refer to 4.1.14.
4.8.12 Scum accumulation in flow splitter boxes.	New POTW's Design flow splitter boxes such that flow is distributed from the top of the box rather than at the bottom; the constant overflow will prevent sludge from accumulating in the box. If an underflow splitter box is required, provide means, such as a scum trough, to remove scum from the box.
	Existing POTW's Method: For splitter boxes with distribution pipes at the bottom of the box:

DEFICIENCY	CONSIDERATIONS
	• Relocate the discharge pipes to the top of the box. • Install an overflow weir inside the box so that water must flow over the weir and drop down to the bottom discharge pipes. • Install a scum trough and scum collection pit.
4.8.13 Lack of instrumentation to totalize recycle/waste sludge flows.	New and Existing POTW's Provide flow meters on sludge recycle and waste lines and specify a flow totalizer as part of the instrumentation package. This allows the POTW operator to compute a solids balance for solids handling purposes. Refer to 4.8.10.

Unit Operation/Component: 4.9 Waste Sludge Pumping

4.9.1 No separate waste sludge pumps.	New POTW's For large plants (greater than 5 mgd), provide separate waste sludge pumps. Existing POTW's Method: Install separate waste sludge pumps. Materials: Concrete to form pump pad, starter/control panel, piping, magnetic flow meter and related instrumentation and valves.
4.9.2 Inadequate screening of raw wastes causes plugging of aerators and return/waste sludge pumping system.	New and Existing POTW's Refer to 4.1.6 and 4.8.1.

DEFICIENCY	CONSIDERATIONS
4.9.3 Inadequate consideration of impact and control of in-plant side-streams.	New POTW's Provide sufficient sludge wasting capacity to handle increased sludge loadings generated by in-plant side-streams. Existing POTW's Method: Provide increased sludge wasting capacity to handle increased sludge loadings generated by in-plant sidestreams. Materials: New wasting pump and/or larger pump motor and/or pump impeller.
4.9.4 Inadequate provisions for sampling and observation of return and waste activated sludge.	New and Existing POTW's Refer to 4.8.4.
4.9.5 Inadequate considerations of debris in wastewater.	New and Existing POTW's Refer to 4.1.6 and 4.8.1.
4.9.6 Improper selection of valves for sludge lines.	New and Existing POTW's Refer to 4.8.6.
4.9.7 Inadequate waste sludge pipe sizing for "slip-stream" wasting.	New POTW's Design sludge piping to allow simultaneous maximum wasting and recycling flow rates. For large plants, provide separate wasting pumps in lieu of a "slip-stream" wasting scheme. Existing POTW's Method: Install separate waste sludge pumps.

DEFICIENCY	CONSIDERATIONS
4.9.8 Inadequate sludge recycle/ waste capacity.	New POTW's Provide waste pumping capacity to handle expected peak flows. Sludge generation from in-plant sidestreams should be considered. A spare pump should be provided to help handle peak flows and for use when another pump is out of service. Existing POTW's Method: Refer to 4.8.8.
4.9.9 Inadequate sludge flow measurement for small plants using air lift pumps.	New and Existing POTW's Refer to 4.8.9.
4.9.10 Inability to adjust, measure, and control return/ waste sludge flows.	New and Existing POTW's Refer to 4.8.10, 4.9.7, 4.9.8 and 4.9.9.
4.9.11 Scum accumulation in flow splitter boxes.	New and Existing POTW's Refer to 4.8.12.
4.9.12 Lack of instrumentation to totalize recycle/waste sludge flows.	New and Existing POTW's Refer to 4.8.10 and 4.8.13.

Unit Operation/Component: 4.10 Secondary Clarification

DEFICIENCY	CONSIDERATIONS
4.10.1 No provision for addition of chemicals to improve settling characteristics.	New POTW's Provide a chemical addition system to enable the operator to feed settling aids such as alum or polymer to secondary clarifiers. Specify flocculator-clarifiers for the secondary treatment system, particularly if the design overflow rate (OFR) is less than 500 gpd/sq ft.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install chemical addition system near effluent trough of aeration basin. Allow in-line mixing between effluent trough and center well of clarifier. Materials: Chemical make-up and storage system, piping, and related appurtenances. Building to house equipment and chemicals.
4.10.2 Improper type of sludge removal mechanism selected.	New and Existing POTW's Ensure the sludge removal mechanism selected is compatible with the clarifier geometry. Traveling bridge mechanisms are suitable for rectangular clarifiers, while circular plow type units (with or without positive sludge withdrawal through the rake arms) are designed for use with circular clarifiers. Plow type mechanisms are suitable for heavy sludges such as primary or some chemical sludges. Positive withdrawal mechanisms are suitable for lighter sludges such as secondary sludges from an activated sludge POTW.
4.10.3 Improper clarifier sidewater depth (SWD).	New POTW's Provide a minimum clarifier sidewater depth of 10 feet for clarifiers up to 40 feet in diameter. This depth should increase proportionally by 1 foot of SWD for each additional 20 feet of diameter up to a 15-foot SWD for tank diameters 140 feet and over. Another rule of thumb is to increase the SWD by 1 foot for each 1,000 mg/L increase in MLSS. To compensate for depth limitations, reduce the overflow rate 100 gpd/sq ft for each lost foot of sidewater depth.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: If hydraulically feasible, raise the height of the clarifier effluent troughs (this may require an intermediate pumping station). Install additional effluent troughs to reduce weir overflow rates, and reduce upward velocities in the clarifier. Construct additional clarifier to reduce system overflow rates.
4.10.4 Inadequate access to weirs for sampling and maintenance.	New POTW's Provide clarifiers that permit operator easy and safe access to weirs for sampling and maintenance. Clarifiers should have effluent troughs of sufficient width to permit operator to walk along the trough. Hand railings should be provided around the outside perimeter of the clarifier. Existing POTW's Method: Bridgeway of clarifier is used to obtain sample from effluent trough. For those clarifiers built above-grade, operator may walk inside effluent launder with attached safety line. Where this is not feasible, construct access walkway around periphery of tank. Refer to 1.1.3. Materials: Handrail, grating, supports, and related appurtenances.
4.10.5 Inflexible design does not permit isolation of reactors and changes in flow schemes for maintenance purposes and/or to adjust for changes in waste characteristics.	New POTW's Provide necessary piping and valving to allow recycle of sludge from each clarifier to any one of the POTW's aeration basins.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 4.1.1.
4.10.6 Inadequate consideration of impact and control of in-plant side-streams.	New POTW's When sizing clarifiers, include the in-plant sidestream flows that will be generated and ultimately discharged to the clarifiers. Peak flows that could occur should be considered. The effects of sidestreams on the settling characteristics of the waste should also be evaluated prior to sizing any units since settling aids may be required. Existing POTW's Method: Refer to 4.1.8 and 4.10.1.
4.10.7 Overflow rate (OFR) of clarifiers too high to meet effluent SS limitations.	New POTW's Conduct pilot and/or laboratory settling tests to identify design overflow rates. Normally, the range will be 400 to 600 gpd/sq ft. If the design OFR is less than 500 gpd/sq ft, consideration should be given to providing a flocculator-clarifier and a polymer addition system. Existing POTW's Method: Install a polymer addition system to enhance settling. Install additional effluent troughs to reduce upward velocities in the clarifier. Refer to 4.10.12.
4.10.8 No provisions for flow division boxes.	New and Existing POTW's Provide flow division boxes that permit operator to control flow distribution to multiple final clarifiers.
4.10.9 Short-circuiting in clarifiers.	New POTW's Provide inlet design to achieve horizontal and vertical distribution of the incoming flow across the entire cross-sectional flow-through area, while minimizing short circuiting and turbulence factors.

DEFICIENCY	CONSIDERATIONS
	The inlet in a rectangular clarifier should consist of a baffle placed in front of the influent point(s) to distribute the flow laterally and vertically and to minimize short circuiting. Baffles are usually installed 2 to 3 feet in front of the inlets, submerged 18 to 24 inches, with the top of the baffle 2 inches below the water surface. In circular clarifiers with center feed, uniform distribution of the influent is accomplished by a concentric influent baffle to reduce velocity and to distribute the flow uniformly towards the outlet. With 100-percent recirculation, circular tank inlet wells should not be less than 20 percent of the tank diameter and have a depth of 55 to 65 percent of the SWD. Outlet devices are commonly "V"-notch weirs. A weir loading of 15,000 gpd/ft is necessary to prevent excessive upflow currents. In order to maintain an adequate weir overflow rate, multiple weirs may be necessary. Outlet velocity should be reduced to less than 10,000 gpd/ft for suspensions with poor settling characteristics. Existing POTW's Method: Install additional baffles in rectangular clarifiers. Refer to 3.2.5 and 3.2.6.
4.10.10 Lack of consideration of inlet-outlet losses.	New POTW's When sizing clarfiers, the clarification area losses due to inlet and outlet structures must be considered in order to ensure that the actual "effective area" of the clarifier is

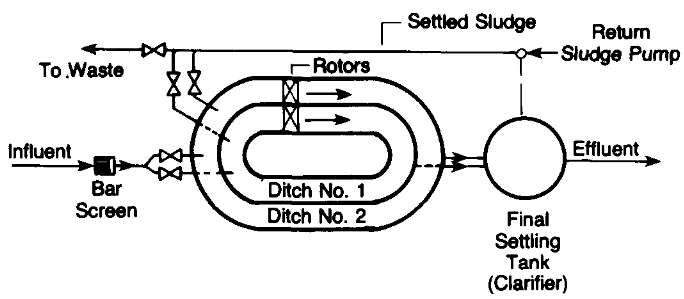
DEFICIENCY	CONSIDERATIONS
	sufficient. For small clarifiers, loss in the clarification area can be as high as 40 percent. Existing POTW's Method: Refer to 4.10.9.
4.10.11 Improper or no use of a scale-down factor to convert lab overflow rate (OFR) to design OFR.	New POTW's Overflow rates identified during laboratory treatability studies must be scaled down for design use due to losses (i.e., inlet, outlet, density currents, etc.) in the clarifier. The lab OFR's are generally reduced by 40 to 50 percent up to an OFR of 800 gpd/sq ft. A design overflow rate above this value is not recommended for secondary clarifiers. Existing POTW's Method: Refer to 4.10.7.
4.10.12 Improper weir placement (i.e., proper weir length but closely placed troughs create high, localized upward velocities within clarifier).	New POTW's If multiple weir troughs are required in a clarifier, space the troughs far enough apart to prevent high, localized upward velocities within the unit and resultant solids carry-over. The weirs should also be distributed over the entire effluent end (or perimeter) of the clarifier to prevent high rising velocities in isolated sections of the clarifier. The upflow velocity in the immediate vicinity of weirs should be limited to approximately 18 fph. Existing POTW's Method: Separate effluent troughs.
4.10.13 Improper length-to-width ratio.	New POTW's Common geometrical configurations for rectangular clarifiers are: • Length-width of 3:1 to 4:1. • Width-depth of 1:1 to 2:1.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Provide polymer addition system to enhance settling. Upgrade the clarifier(s) to attain proper geometrical configuration.
4.10.14 Inadequate or no provisions for scum removal from secondary clarifiers.	New POTW's Provide a scum removal system which discharges scum to a separate holding tank and does not recycle scum back into the treatment system. The scum should be disposed of separately along with sludge hauled from the plant. Existing POTW's Method: Install a scum trough that discharges to a scum collection pit. Install a skimmer on circular clarifiers.
4.10.15 Long scum lines frequently become clogged.	New POTW's Eliminate long scum lines from POTW designs. If required, provide facilities to flush scum pumps after they have shut off in order to clear the pumps and scum lines of residual material. Also, provide clean-outs along entire length of scum piping. Existing POTW's Method: Install macerator upstream of scum pumps. Install pump flushing system to flush lines after each pumping cycle. Install clean-outs along the length of the scum lines and hose bibs to allow manual flushing. Materials: Piping, solenoid valves, timer, and related appurtenances.
4.10.16 Scum will not flow from scum tanks once subnatant is pumped out.	New and Existing POTW's Provide sloped bottoms in scum tanks to enhance scum removal. In addition, provide a water tap at the scum tanks to allow the operator to peri-

DEFICIENCY	CONSIDERATIONS
	odically flush out excess scum and prevent scum build-ups.
4.10.17 Sludge lines periodically clog with rags, and no back-flush facilities are provided.	New and Existing POTW's Provide bolted flanges and flexible couplings in exposed sludge piping to facilitate pipe dismantling and the insertion of cleaning equipment. Tees with 1.5- to 2.5-inch hose connections should be placed at the ends of long pipe runs to allow rodding and flushing of the sludge piping.
4.10.18 Inability to conveniently dewater scum pits.	New and Existing POTW's Scum pits should be provided with permanent scum pumps or, as a minimum, a sump into which a portable pump can be lowered. The floor of the scum pit should slope toward the pump-out sump. Refer to 4.10.16.
4.10.19 Inadequate consideration of freezing problems and effect of cold temperatures on efficiency of biological treatment.	New POTW's In cold weather regions, consideration should be given to using in-ground tanks and also providing covers over clarifiers. Piping, such as chemical addition and utility water lines, to clarifiers should be heat traced. Input from operators at existing POTWs in the area should be solicited in order to identify the need to cover equipment. Existing POTW's Method: Construct an earthern berm around above-ground tanks to insulate the tank, install wind shields around the tank perimeter, and provide covers over open tanks. Piping (such as chemical addition and utility water lines) to clarifiers should be heat traced. Materials: Commercially-available tank covers, stainless steel or fiberglass windshields.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 4.11 Oxidation Ditch	
4.11.1 Inadequate consideration for alkalinity adjustment.	<u>New and Existing POTW's</u> Refer to 4.1.3.
4.11.2 Insufficient mixing to prevent solids deposition and provide uniform SS and D.O. concentrations in the basin.	<u>New POTW's</u> Design channel flow velocities of 1 to 2 feet per second to ensure thorough mixing and to prevent solids settling. Normally, for a standard 27.5-inch rotor, 16,000 gallons of ditch volume per foot of rotor length will provide a channel velocity sufficient to maintain solids in suspension. Refer to 4.1.5. <u>Existing POTW's</u> <u>Method</u>: Increase speed of rotor or depth of rotor submergence. Consult the equipment manufacturer: if the rotor speed exceeds 90 rpm and a 6-inch depth of immersion for 27-1/2-inch rotors; if the rotor speed exceeds 60 rpm and a 10-inch immersion for a 42-inch rotor installation. If sufficient mixing continues to be a problem, add another rotor to the channel. Install baffles in the channel to improve mixing patterns.
4.11.3 Inadequate aeration capacity.	<u>New POTW's</u> Consult manufacturer's design criteria for oxygenation capacity versus rotor speed and depth of submergence. Provide adjustable effluent weir to allow varying the liquid level in the channel in order to regulate the amount of oxygen transfer. Refer to 4.2.2.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Increase rotor speed and/or depth of rotor immersion. Consult equipment manufacturer's design curves for rotor speed and depth of immersion versus oxidation capacity. Refer to 4.11.2.
4.11.4 Inadequate screening of raw wastes causes plugging of aerators and return/ waste sludge pumping system.	New and Existing POTW's Refer to 4.1.6 and 4.8.1.
4.11.5 Inflexible design does not permit isolation of reactors and changes in flow schemes for maintenance purposes and/or to adjust for changes in waste characteristics.	New POTW's For those installations which have a varied usage (loading) over the year (roadside rest areas, amusement parks, etc.), it is desirable to use the following layout. During the winter the outer ditch would normally be out of operation.



Oxidation Ditch Plant for Extreme Load Variation Summer to Winter Where Dual Tanks Are Required

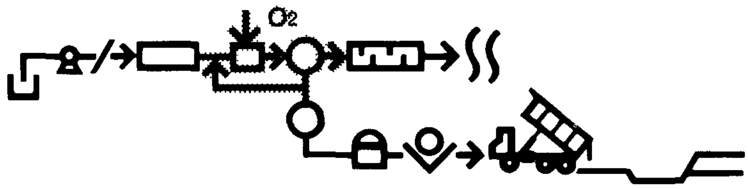
DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 4.1.14 and 4.10.5.
4.11.6 Inadequate consideration of impact and control of in-plant sidestreams.	New and Existing POTW's Refer to 4.1.8.
4.11.7 Inadequate provisions for sampling	New and Existing POTW's Refer to 4.8.4.

DEFICIENCY	CONSIDERATIONS
and observation of return and waste activated sludge.	
4.11.8 Inadequate consideration of debris in wastewater.	New and Existing POTW's Refer to 4.1.6.
4.11.9 Inadequate provision for by-passing aeration basin.	New and Existing POTW's Refer to 4.1.7 and 4.11.5.
4.11.10 Improper sidewater depth (SWD) and baffling cause splashing problems in basin.	New and Existing POTW's Provide splash shields adjacent to rotor installation on each side of ditch. Consult manufacturer's design data for rotor size; too large a rotor will cause excessive splashing (and velocity through ditch). Refer to 4.1.12.
4.11.11 Inability to control and measure mixed liquor flow distribution to multiple secondary clarifiers.	New and Existing POTW's Refer to 4.1.13 and 4.10.8.
4.11.12 Inadequate consideration of impact of changing aeration basin levels on aerator performance.	New POTW's The depth the rotor is submerged affects the aeration capacity of the units; therefore, the oxidation ditch design should include provisions for adjusting the liquid level in the channel. Existing POTW's Method: Install an adjustable effluent gate in the channel to allow the operator to change the rotor submergence.
4.11.13 Improper installation of flow control walls	New POTW's The ends of the oxidation ditch must be rounded to prevent eddying

DEFICIENCY	CONSIDERATIONS
results in inadequate mixing.	and dead areas, and the outside edges of the curves must always be given erosion protection.
	Existing POTW's Method: Install baffles or guide vanes to prevent eddying and dead areas.
4.11.14 Improper placement of gear box drains causes oil to drain into aeration basin.	New and Existing POTW's Refer to 4.3.6.
4.11.15 Improper selection of bearings which are not compatible with excessive moisture.	New POTW's Provide sealed bearings or bearing closures; use pre-mounted bearings or pillow blocks with labyrinth seals.
	Existing POTW's Method: Replace bearings with sealed-type bearings.
4.11.16 Improper support of rotors results in misalignment and premature bearing failure.	New POTW's Properly mount rotors according to manufacturer's specifications. Shaft deflection should be held to no more than 0.0002 inch per inch.
	Existing POTW's Method: Properly support and (shim) align rotors according to manufacturer's specifications.
4.11.17 Spray from surface aerators makes walkways slippery.	New and Existing POTW's Refer to 4.3.9.
4.11.18 Inadequate consideration of freezing problems and effect of cold temperatures on efficiency of biological treatment.	New and Existing POTW's In cold weather regions, provide protective housings over rotors to avoid damage or inoperability due to ice build-up. Rotors should be sized to handle MLSS concentrations up to 10,000 mg/L for winter operation. Refer to 4.1.21.

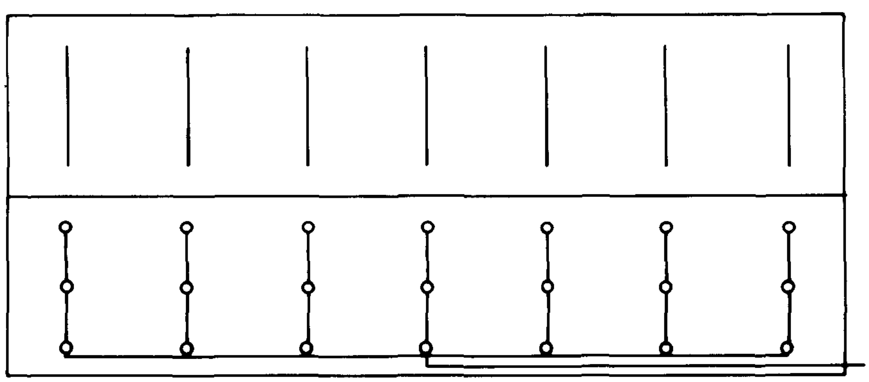
Design Considerations

Category: 5.0 Oxygen Activated Sludge

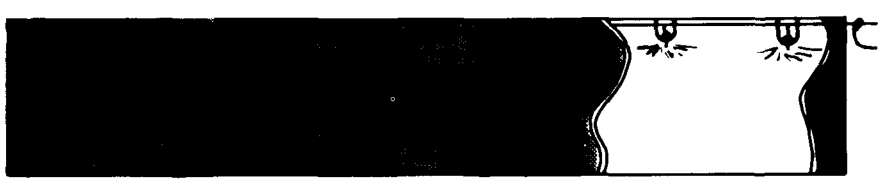


Unit Operation/Component: 5.1 Aeration Basin

DEFICIENCY	CONSIDERATIONS
5.1.1 Inadequate access for maintenance to antifoam spray headers in covered tanks.	<u>New POTW's</u> Lay out spray headers longitudinally along the covered basin (reactor). Install spray header into hangers suspended from cover. The connection between the feeder and each header should be a quick disconnect type. Provide access ports on reactor sidewall <u>in line with</u> each spray header. The header can then be removed for maintenance by removing the access port, disconnecting the header from the feeder, rotating the header 180°, and sliding the header out of the reactor on the suspended hangers. Refer to sketch.



Plan View



Section View

5.1.1

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install strainers on spray water supply line to minimize clogging of spray nozzles. At next scheduled dewatering of reactor, install accessible flushing taps to backflush spray headers and feed lines.

Unit Operation/Component: 5.2 Air Compressors

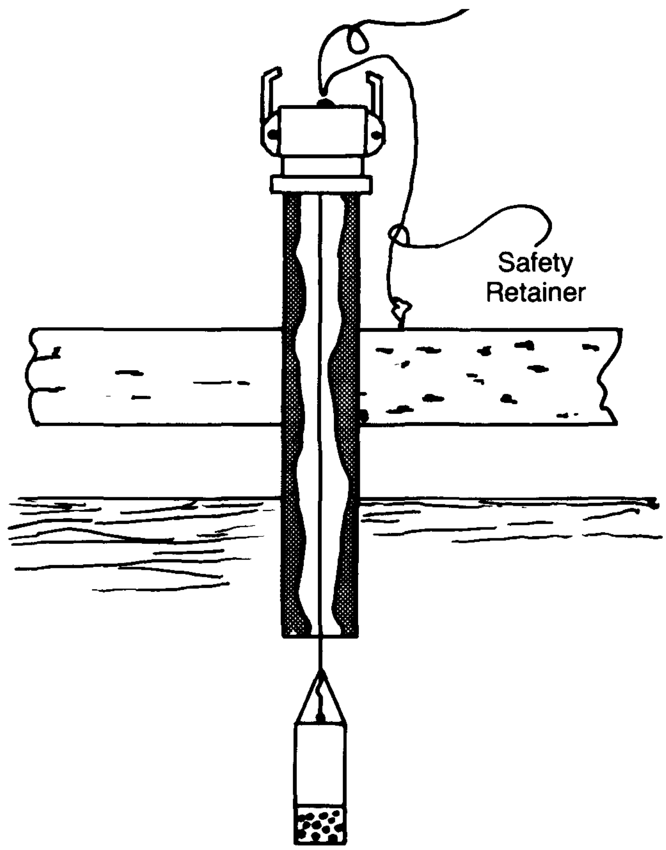
DEFICIENCY	CONSIDERATIONS
5.2.1 Inadequate turndown capability due to selection of rotary compressor.	**New POTW's** Evaluate the use and efficiency of reciprocating and centrifugal compressors to supply air to the pressure swing adsorption oxygen supply system. The compressor should be able to be turned down or idled during periods of low demand to conserve energy. **Existing POTW's** Method: Replace existing rotary compressor with a centrifugal or reciprocating compressor. Modify control equipment to vary the loading of the compressor as a function of oxygen (pressure) requirement.

Unit Operation/Component: 5.3 D.O. Measurement

DEFICIENCY	CONSIDERATIONS
5.3.1 Inadequate access to D.O. measuring equipment due to mounting in flanged portholes.	**New POTW's** Provide for mounting the probes through access ports as shown in the sketch. This will allow convenient removal of probes for maintenance/calibration. Note: Tap through dust cover should be of adequate size to pass end coupler. Utilize a split grommet for penetration through cover.

DEFICIENCY

CONSIDERATIONS

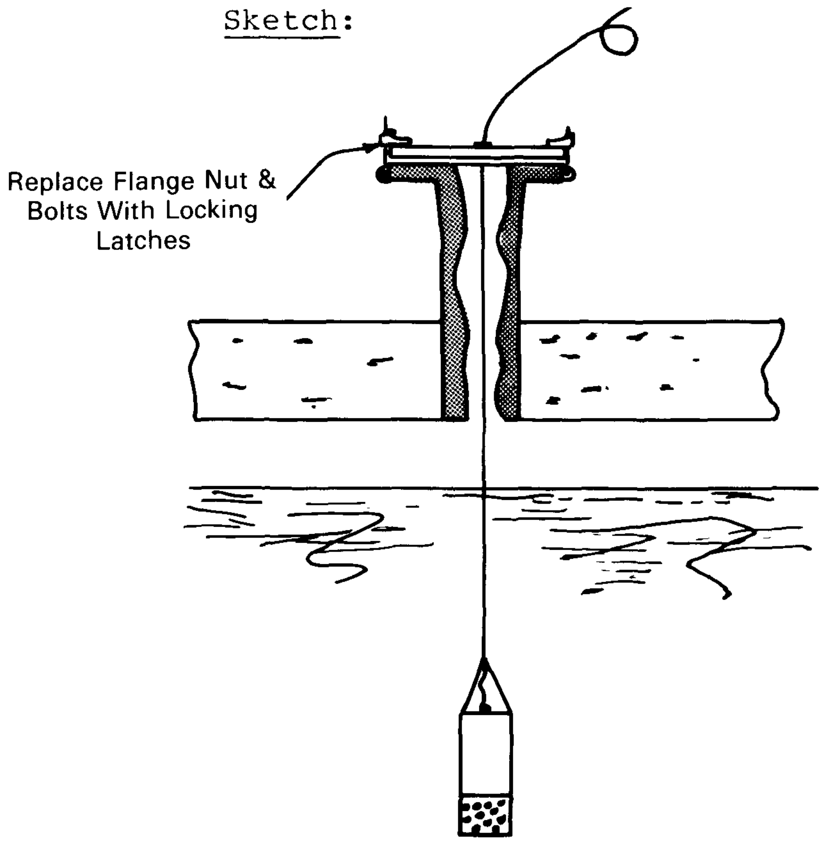


Existing POTW's

Method 1: Replace the existing flange nuts and bolts with locking latches as shown in the sketch for Method 1. This will facilitate removal of the D.O. probe for calibration and/or maintenance. Note: Maintain existing gasketing and seals around flange penetration.

DEFICIENCY CONSIDERATIONS

Sketch:



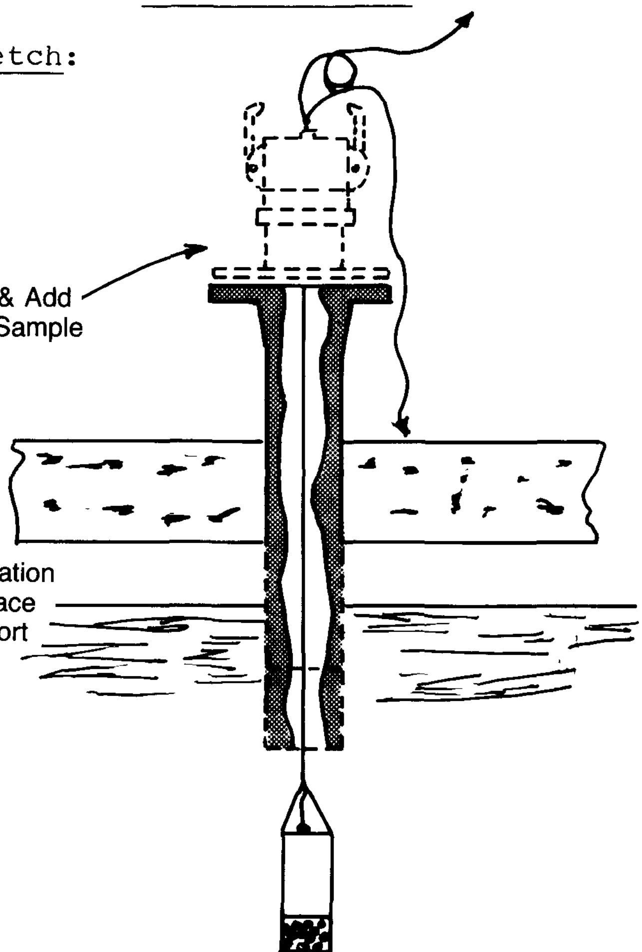
Existing POTW's

Method 2: Modify the top portion of the flange to accept the addition of piping and dust cover as shown in the sketch for Method 2. Extend the pipe penetration below the water surface as per the sample port.

Materials: Materials used must be suitable for oxygen service.

DEFICIENCY | CONSIDERATIONS

Sketch:



Unit Operation/Component: 5.4 D.O. Control

DEFICIENCY	CONSIDERATIONS
5.4.1 Inadequate access to D.O. measuring equipment due to mounting in flanged portholes.	New and Existing POTW's Refer to 5.3.1.

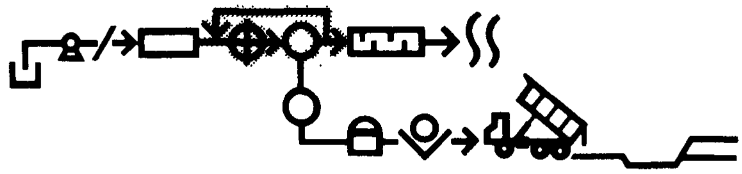
Unit Operation/Component: 5.5 Pressure Swing Absorption

DEFICIENCY	CONSIDERATIONS
5.5.1 Inadequate turndown capability due to selection of rotary compressor.	New and Existing POTW's Refer to 5.2.1.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 5.6 Oxygen Gas Flow Control	
5.6.1 Overly sensitive instrumentation responding to hydraulic ripples and cycling O_2 gas flow.	New POTW's Provide reactor pressure measurement instrumentation with signal dampening capability. Existing POTW's Method: Modify pressure measurement instrumentation to dampen reactor pressure signals. This may include replacement of the differential pressure transmitter or modification of the existing unit.
Unit Operation/Component: 5.7 Influent Flow Control	
5.7.1 Inadequate forward flow control causing ripples in reactor.	New and Existing POTW's Provide an accessible stilling well around level probe/bubbler tube in forward flow wet well. Locate probe in calm area of wet well.
Unit Operation/Component: 5.8 Sampling and Monitoring	
5.8.1 Inadequate condensate removal in reactor gas sample lines.	New and Existing POTW's Provide condensate removal traps and moisture indicator/detectors downstream of the traps. This will serve to protect the oxygen and lower explosive limit analyzers from moisture damage.
5.8.2 Inadequate consideration for freezing of reactor gas sample lines.	New and Existing POTW's The humid air space in the oxygen reactor is sampled for oxygen and lower explosive limit analysis; therefore, the exposed sample lines upstream of the condensate trap should be heat traced to prevent freezing.

Design Considerations

Category: 6.0 Trickling Filter



Unit Operation/Component: 6.1 Trickling Filter

DEFICIENCY

6.1.1 Improper design and installation of distribution arms cause clogging and rotation problems.

CONSIDERATIONS

New POTW's

To preclude distribution arm clogging problems:

1. Provide a minimum 2" diameter port size.

2. Provide "quick opening" gates at the end of each arm to permit easy flushing.

3. Provide preliminary grit and rag removal. Shredding or grinding of rags is insufficient; they should be removed.

To prevent rotary reaction distribution arm moving too slowly for adequate distribution:

1. Provide for adequate flow recirculation during periods of low flow.

2. Assure filter feed pumps have sufficient discharge head to drive rotary distributor.

Existing POTW's

Method: To minimize clogging problems in the distribution arms because port sizes are too small, provide preliminary screening to remove large solids. (Remove rags rather than just grinding them.)

DEFICIENCY	CONSIDERATIONS
	If the rotary reaction distributor arm moves too slowly for adequate distribution, provide larger pumps for higher head and/or provide a motor drive for the existing distributor arm.
6.1.2 Side wall not high enough to prevent splashing or aerosol drifting.	New POTW's Assure side wall is at least 2 feet above top of distributor arm. Provide 3-foot wide concrete walks around filter to eliminate fly problems. Existing POTW's Method: Provide splash plates along the top of the side wall. Materials: Choose weather-resistant materials such as galvanized steel, aluminum, treated wood. Cost: \$10-\$25 per linear foot, depending on material.
6.1.3 Lack of flexibility to flood the filter.	New POTW's Provide valving and/or slide gates on inlet and discharge end of filter to permit flooding. Existing POTW's Method: Provide a slide gate in the effluent pipe of the filter. The gate can be completely or partially closed to control flies, snails, odors, etc. Materials: Stainless or galvanized steel, aluminum, etc. Cost: \$3,000 per filter, installed.
6.1.4 Lack of flexibility to chlorinate the filter.	New POTW's Provide separate chlorine solution line from the influent line to each filter.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Tap into the chlorine solution manifold and run a separate supply to the filter influent line.
6.1.5 Poor ventilation of filter causes odor problems.	New POTW's Provide aeration chamber before inlet to filter to raise D.O. to filter. Avoid excessive bed depth which may promote anaerobic conditions. Provide forced air ventilation. Prechlorinate the filter influent. Existing POTW's Method: Install additional vents (4"-dia. vertical risers); install continuous duty blower on vents; cover filter and deodorize the off gas; install an aeration chamber prior to the inlet of the filter to raise the influent D.O.
6.1.6 Clogging of distributor orifices caused by inadequate primary treatment.	New and Existing POTW's Assure primary treatment is adequate to remove grease as well as settleable solids. 1. Provide "quick opening" gates at end of distributor arms to permit easy flushing. 2. Provide for removal of rags rather than just grinding them.
6.1.7 Inflexibility related to isolation of reactors and changes in flow and/or recirculation strategy.	New and Existing POTW's Provide necessary pumps and piping to permit operator to place reactors in series or parallel, flood the filter, take the filter out of service, and recirculate flow.
6.1.8 Inadequate consideration of overspray on filter walls and resulting fly problems.	New POTW's Provide side wall height which is a minimum of 2 feet above the top of the distributor arm.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install splash shields along the top of the filter wall or build up the wall to a height 2 feet above the distributor arm.
6.1.9 Inadequate sizing of filter unit to meet a more stringent effluent limitations requirement.	New and Existing POTW's Provide chemical feed systems (ferric chloride, alum, etc.) for nutrients removal and anticipate larger sludge volumes. 1. Set up for series versus parallel operation. 2. Provide for phosphorus and nitrogen removal. 3. Consider use of plastic media packed towers.
6.1.10 Insufficient flow, particularly during low flow conditions, to rotate the distribution arm.	New and Existing POTW's Provide recirculation system to divert effluent from the secondary clarifier back to the influent of the secondary trickling filter.
6.1.11 Excessive sloughing from filter due to excessive organic loading.	New and Existing POTW's Provide recirculation system to dilute influent flow. Provide equalization to dampen anticipated shock loads.
6.1.12 Recirculation of secondary clarifier effluent causes high flows through the clarifier, resulting in clarifier solids carry-over.	New and Existing POTW's Consider recirculation flow during clarifier design. Specify variable-speed recirculation pumps. Provide baffles in clarifier to avoid short circuiting.
6.1.13 No provision for flushing underdrains.	New and Existing POTW's Provide for flushing underdrains via peripheral head channel with vertical vents. Inspection facilities should also be provided.

DEFICIENCY	CONSIDERATIONS
6.1.14 Inadequate flow to filter causes media plugging.	New and Existing POTW's Provide for recirculation system and assure media is properly and uniformly sized.
6.1.15 Inadequate freeze protection.	New and Existing POTW's Provide piping flexibility that will permit series and parallel operation. Provide sidewalls 2 feet higher than top of distribution arm to provide a wind break. Insulate and heat trace exposed piping. If warranted, provide a filter cover.
6.1.16 Ice build-up on filter media.	New and Existing POTW's Provide adjustable splash plates to minimize spraying during excessive cold weather. Provide cover for filter in extreme cold weather locations. Provide wind barriers.

Unit Operation/Component: 6.2 Rock Media

DEFICIENCY	CONSIDERATIONS
6.2.1 Poor ventilation of filter causes odor problems.	New and Existing POTW's Assure media is uniform in size. Provide vents around periphery of filter. Provide large enough underdrain system so that conduits do not exceed 50 percent of capacity during peak flows. Refer to 6.1.5.
6.2.2 Improper sizing of media.	New POTW's Select media of a uniform size, between 2" and 4" in diameter. (Avoid nonuniform media since the smaller pieces fit between the larger ones, and thus make it easier for the slimes to plug the filter.) Select plastic media which provides a large surface area per unit and is uniform in size.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Remove existing media and replace with proper size, or use plastic media.
6.2.3 Improper selection of media without good weathering properties.	New POTW's Refer to ASCE Manual 13, Filtering Materials for Sewage Treatment Plants, prior to selection of filter media. Existing POTW's Method: Replace media.
6.2.4 Inadequate air circulation provided during periods of high flows.	New and Existing POTW's Size underdrain system so that it does not exceed 50 percent full during peak flows. Provide vents (vertical risers) around the periphery of the filter. Provide mechanical ventilating system. Refer to 6.1.5.
6.2.5 Inadequate flow to filter causes media plugging.	New and Existing POTW's Refer to 6.1.13 and 6.1.14.
6.2.6 Ice build-up on filter media.	New and Existing POTW's Refer to 6.1.15 and 6.1.16.

Unit Operation/Component: 6.3 Plastic Media

6.3.1 Poor ventilation of filter causes odor problems.	New and Existing POTW's Refer to 6.1.5 and 6.2.1.
6.3.2 Inadequate air circulation provided during periods of high flows.	New and Existing POTW's Refer to 6.1.5 and 6.2.4.
6.3.3 Inadequate flow to filter causes media plugging.	New and Existing POTW's Refer to 6.1.13 and 6.1.14.
6.3.4 Ice build-up on filter media.	New and Existing POTW's Refer to 6.1.15 and 6.1.16.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 6.4 Flow Splitting to Filters	
6.4.1 Lack of flexibility to flood the filter.	New and Existing POTW's Refer to 6.1.3.
6.4.2 Poor ventilation of filter causes odor problems.	New and Existing POTW's Refer to 6.1.5 and 6.2.1.
6.4.3 Inflexibility related to isolation of reactors and changes in flow and/or recirculation strategy.	New and Existing POTW's Refer to 6.1.7.
6.4.4 Inability to adjust, measure, and control recirculation rate.	New and Existing POTW's Provide for controls to measure and adjust recirculation rate (flow meter, throttling valve, speed controls, etc.).
6.4.5 Insufficient flow, particularly during low flow conditions, to rotate the distribution arm.	New and Existing POTW's Refer to 6.1.10.
Unit Operation/Component: 6.5 Distribution of Media	
6.5.1 Improper design and installation of distribution arms cause clogging and rotation problems.	New and Existing POTW's Refer to 6.1.1.
6.5.2 Lack of flexibility to flood the filter.	New and Existing POTW's Refer to 6.1.3.

DEFICIENCY	CONSIDERATIONS
6.5.3 Poor ventilation of filter causes odor problems.	New and Existing POTW's Assure media is of uniform diameter (sizing) so that smaller size stones will not fill the voids. Refer to 6.1.5 and 6.2.1.
6.5.4 Clogging of distributor orifices caused by inadequate primary treatment.	New and Existing POTW's Refer to 6.1.6.
6.5.5 Inadequate air circulation provided during periods of high flows.	New and Existing POTW's Refer to 6.1.5 and 6.2.4.
6.5.6 Inadequate flow dosing equipment.	New and Existing POTW's Provide for twin dosing tanks to ensure that flow is sufficient to discharge from all nozzles.
6.5.7 Insufficient flow, particularly during low flow conditions, to rotate the distribution arm.	New and Existing POTW's Refer to 6.1.10.
6.5.8 Inadequate freeze protection.	New and Existing POTW's Refer to 6.1.15 and 6.1.16.

Unit Operation/Component: 6.6 Flow Recirculation

DEFICIENCY	CONSIDERATIONS
6.6.1 Inflexibility related to isolation of reactors and changes in flow and/or recirculation strategy.	New and Existing POTW's Refer to 6.1.7.
6.6.2 Inadequate consideration of overspray on filter walls and resulting fly problems.	New POTW's Refer to 6.1.2 and 6.1.8.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Raise the filter walls and/or install deflectors on distributor arms.
6.6.3 Inability to adjust, measure, and control recirculation rate.	New and Existing POTW's Refer to 6.4.4.
6.6.4 Lack of proper recirculation pumping capacity.	New POTW's Provide pumps of sufficient discharge volume and head to rotate distributor arms and keep media wet. Existing POTW's Method: Install larger impeller and/or horsepower on existing pumps. Use speed controls, auxiliary pump, or replacement pump.
6.6.5 Recirculation of secondary clarifier effluent causes high flows through the clarifier, resulting in clarifier solids carry-over.	New and Existing POTW's Refer to 6.1.12.
6.6.6 Inadequate consideration of effects of recirculation through primaries on clarifier loadings.	New and Existing POTW's Consider recirculation flows when sizing clarifiers. Refer to 6.1.12.
6.6.7 Inadequate consideration of effects on the sludge blanket of taking recirculation flow from below weirs of clarifier.	New and Existing POTW's Take recirculation flow from the clarifier effluent pipe.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 6.7 Secondary Clarifier	
6.7.1 Inability to add flocculants to aid settling.	New POTW's Provide chemical addition facilities and specify floc clarifiers. Existing POTW's Method: Replace section of existing piping with mixing chamber. Excavate and connect chemical feed line to existing piping at a point to provide sufficient mixing before next treatment unit.
6.7.2 Inability to adjust and control flows to clarifiers.	New and Existing POTW's Provide piping and throttling valves necessary to control flow to individual clarifiers. Also, provide flow measuring facilities (i.e., weirs, flow meters, etc.).
6.7.3 Recirculation of secondary clarifier effluent causes high flows through the clarifier, resulting in clarifier solids carryover.	New and Existing POTW's Refer to 6.1.12.
6.7.4 Inadequate consideration of clarifier inlet and outlet structures to optimize hydraulic characteristics.	New POTW's Consider inlet and outlet losses during clarifier sizing. Provide inlet and outlet baffles to minimize turbulence in the clarifier. Existing POTW's Method: Inlet baffles should be installed to dissipate the inlet velocity, distribute the flow evenly, and prevent short-circuiting. Scum baffles should be installed ahead of overflow weirs. Use mechanical scum skimmers on circular clarifiers.

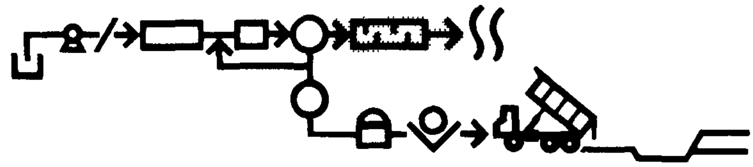
DEFICIENCY	CONSIDERATIONS
6.7.5 Inadequate consideration of effects on the sludge blanket of taking recirculation flow from below weirs of clarifier.	<u>New and Existing POTW's</u> Refer to 6.6.7.

Unit Operation/Component: 6.8 Sludge Pumping

6.8.1 Lack of proper recirculation pumping capacity.	<u>New and Existing POTW's</u> Refer to 6.6.4.

Design Considerations

Category: 7.0 Disinfection



Unit Operation/Component: 7.1 General

DEFICIENCY	CONSIDERATIONS
7.1.1 Hoist rail does not extend beyond edge of building, making cylinder unloading more difficult.	<u>New and Existing POTW's</u> Provide hoist rail which extends beyond edge of building to facilitate unloading chlorine cylinders from truck or rail car. Hoist rail should be high enough to pick up a cylinder off the truck, and have sufficient clearance to lift one cylinder over another.
7.1.2 No provision for sampling at outfall.	<u>New and Existing POTW's</u> Provide access to outfall for manual sampling, or provide automatic composite sampler with sample transfer pump.
7.1.3 Lack of consideration of upstream NH_3 concentration.	<u>New POTW's</u> Since NH_3 exerts a chlorine demand, the upstream NH_3 concentration must be considered. NH_3 monitoring (occasional or routine) should be provided, and the pH should be controlled to prevent the formation of noxious products during the reaction of Cl_2 and NH_3. <u>Existing POTW's</u> <u>Method</u>: Knowledge of the upstream NH_3 concentration is important because NH_3 in the waste stream combines with the Cl_2. The NH_3 concentration can be determined

DEFICIENCY	CONSIDERATIONS
	quickly by means of a specific ion electrode, and the Cl_2 feed rate can be adjusted as required.
7.1.4 Improper location of utility water suction draws excess solids into system.	New POTW's Locate the utility water suction a minimum of 2 feet from the bottom of the chlorine contact chamber. Existing POTW's Method: Relocate the utility water suction line to a higher elevation (i.e., 2-ft minimum from tank bottom), or construct an overflow baffle around the utility water intake to prevent solids from entering the system.
7.1.5 Inadequate consideration of present and future flows in equipment sizing.	New POTW's Both present and future maximum and minimum flows must be considered when sizing disinfection systems. The chlorine contact tank should be sized to provide a contact time of 30 minutes at average flow, and not less than 15 minutes contact time at peak flow. Local standards should be used during design. Chlorination equipment should be sized to feed approximately 50-100 lbs Cl_2/million gallons treated. To provide for future flow increases, equipment can be specified to feed a range of dosages, and/or dual units can be installed. Existing POTW's Method: If forward flow through the POTW has increased significantly over that expected in the original design, increasing the capacity of the existing chlorinator or installation of an additional chlorination/ozonation system may be required.

DEFICIENCY	CONSIDERATIONS
7.1.6 Inadequate safety equipment.	New and Existing POTW's Adequate safety features and equipment must be included as part of the chlorination system design. These requirements are stipulated in each state's individual design standards for municipal wastewater works. Two additional references are the following Water Pollution Control Federation (WPCF) manuals of practice (MOP): • MOP No. 1 -- Safety in Wastewater Works • MOP No. 4 -- Chlorination of Wastewater

Unit Operation/Component: 7.2 Chlorine Contact Chamber

DEFICIENCY	CONSIDERATIONS
7.2.1 Lack of scum removal facilities.	New and Existing POTW's Provide baffles in the chlorine contact chamber to prevent the discharge of floating solids. Provide a scum collecting device, such as a trough, and pump the scum to the collection point for scum from other sources in the treatment plant or remove the scum directly from the POTW.
7.2.2 Inadequate use of concrete coatings, which slough off tank walls and plug pipes and pumps.	New POTW's Epoxy coatings should be used to protect contact chamber tank walls. Suggested materials of construction for handling various disinfection components are presented in the Water Pollution Federation Manual of Practice No. 4. Existing POTW's Method: Drain the existing chlorine contact tank, scrape off the remaining coating, and apply a new coating following the guidelines presented.

DEFICIENCY	CONSIDERATIONS
7.2.3 Improper location of chlorine diffuser.	New POTW's Locate the chlorine diffuser at the influent end of the contact chamber and at the point of maximum turbulence to ensure adequate mixing. Provide a mixing chamber prior to the contact tank. Existing POTW's Method: Relocate the chlorine diffuser at the point of maximum turbulence to ensure adequate mixing. If relocation is not possible, add a mechanical mixing device just downstream of the diffuser. If necessary, relocate the chlorine residual analyzer so that it is 30 to 45 seconds downstream of the chlorine diffuser.
7.2.4 Inadequate provision for sump to facilitate solids removal.	New POTW's Provide a sump and drainline in the chlorine contact chamber so that solids can be hosed to the sump during periodic tank clean-out. Existing POTW's Method: Construct a sump in the contact chamber; a portable pump can be used to dewater the sump during chamber cleaning operations.
7.2.5 Lack of adequate mixing at Cl_2 addition point.	New POTW's Chlorine should be added at the point of maximum turbulence immediately upstream of the chlorine contact tank. The best mixing can be obtained by diffusing the chlorine solution in a hydraulic pump or in a conduit or channel that has been designed to provide turbulent flow. If high-velocity flows cannot be provided by hydraulic pumps, use mechanical mixers, and apply the chlorine solution upstream of the mixer.

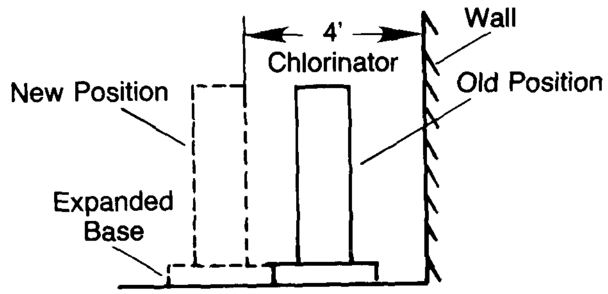
DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 7.2.3.
7.2.6 Insufficient contact time in outfall.	New POTW's Size the chlorine contact chamber to provide a minimum contact time of 15 minutes at peak flow and 30 minutes at average flow. Refer to local standards during design of the chlorination system.
	Existing POTW's Method: The chlorine contact chamber should provide a minimum contact time of 15 minutes at peak flows and 30 minutes at average flow. If these times are not being achieved, an addition to the contact chamber may be required. Installation of a mixer should also be utilized to achieve proper Cl_2 residuals.
7.2.7 Inadequate consideration of possible short-circuiting.	New POTW's Design the chlorine contact chamber to approximate plug flow. Design long, narrow sections with length-to-width ratios of at least 10:1.
	Existing POTW's Method: Provide baffling in the channels to ensure complete mixing and a sufficient contact time.
7.2.8 Inadequate consideration of potential for flooding baffles during high flows.	New POTW's During the design phase, a hydraulic profile should be formulated for all units in the treatment plant, considering both average and peak flow. In this way, the proper elevations for the baffles in the chlorine contact chamber can be determined, and baffle flooding during peak flows can be avoided.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: If possible, raise the height of the baffles; otherwise, install an additional chlorine contact chamber.
7.2.9 Inadequate consideration of present and future flows in equipment sizing.	New and Existing POTW's Refer to 7.1.5.
7.2.10 Inadequate safety equipment.	New and Existing POTW's Refer to 7.1.6.
7.2.11 Improper selection of construction materials to minimize corrosion.	New and Existing POTW's Refer to Water Pollution Control Federation Manual of Practice No. 4 (Chlorination of Wastewater), Chapter 6, Table X, for suggested materials of construction for use in chlorination facilities. Refer to 7.2.2.

Unit Operation/Component: 7.3 Chlorinator

7.3.1 Lack of adequate working space behind chlorinators.	New POTW's For maintenance purposes, it is important to provide adequate working space behind each chlorinator when sizing the chlorine room. It is recommended that a minimum of 4 feet be allowed between the wall and the back of each chlorinator. Existing POTW's Method: Move the chlorinator a minimum of 4 feet from the chlorine room wall. Materials: Concrete to enlarge the chlorinator base and PVC pipe to lengthen water and chlorine gas lines. Cost: If accomplished by the POTW staff, less than $100 per chlorinator.

DEFICIENCY	CONSIDERATIONS
	Sketch:



7.3.2 Lack of stand-by equipment.	New and Existing POTW's To ensure reliable disinfection of the POTW effluent, it is imperative that a stand-by chlorinator be provided.
7.3.3 Inadequate consideration of present and future flows in equipment sizing.	New and Existing POTW's Refer to 7.1.5.
7.3.4 Inadequate feedback for control of chlorine/ozone feed rate.	New and Existing POTW's For POTWs with a capacity greater than 1 mgd, the utilization of an online chlorine analyzer should be considered. This would allow the plant operator to continuously monitor the chlorine residual in the plant effluent and help minimize both over- and under-dosing chlorine. The flexibility to pace the plant chlorinators based on effluent flow and/or chlorine residual should also be provided.
7.3.5 Inadequate safety equipment.	New and Existing POTW's Refer to 7.1.6.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 7.4 Chlorine Control	
7.4.1 Inadequate consideration of potential flow ranges during selection of automatic control equipment.	New and Existing POTW's The most effective method of chlorination control is the compound loop system. This arrangement uses two separate and independent signals to the chlorination device: a flow-proportional signal to the chlorine metering orifice, and a chlorine residual signal to the vacuum regulating valve (the dosage control device). The chlorination mechanism compounds these two signals to achieve a wide range of operation in excess of 100 to 1.
7.4.2 Inadequate feedback for control of chlorine/ozone feed rate.	New and Existing POTW's Refer to 7.3.4.
Unit Operation/Component: 7.5 Dechlorinator	
7.5.1 Lack of stand-by equipment.	New and Existing POTW's To ensure reliable dechlorination of the POTW effluent, it is imperative that a stand-by dechlorinator be provided.
7.5.2 Inadequate consideration of present and future flows in equipment sizing.	New and Existing POTW's Both present and future maximum and minimum flows must be considered when sizing equipment. If dechlorination is accomplished by means of sulfur dioxide (SO_2), the equipment should be sized to feed 1 mg/L SO_2 to dechlorinate 1 mg/L of chlorine residual (free or combined) based on the expected range of chlor-

DEFICIENCY	CONSIDERATIONS
	ine residuals. The SO_2 feed rate can be paced on the basis of chlorine residual. SO_2 can be added by means of a diffuser, and, since the dechlorination reaction is instantaneous, no SO_2 contact chamber is required.
	If sodium metabisulfate ($Na_2S_2O_5$) is used for dechlorination, the equipment should be sized to feed 1.5 parts metabisulfite per part chlorine.
	Size activated carbon dechlorination beds for a wastewater application rate of 3 gpm/sq ft and contact time of 15 to 20 minutes.

Unit Operation/Component: 7.6 Ozone Contact Vessel

7.6.1 Inadequate consideration of present and future flows in equipment sizing.	New and Existing POTW's The ozone contact vessel should be sized to provide 10 minutes contact time at peak flows.
7.6.2 Inadequate safety equipment.	New and Existing POTW's Refer to 7.1.6.

Unit Operation/Component: 7.7 Ozone Generator

7.7.1 Inadequate consideration of present and future flows in equipment sizing.	New POTW's Ozone dosage equipment sizing should be based on ozone demand tests for the wastewater. The range of dosages should be based on the expected flow rate range and on the range of ozone demands expected. Existing POTW's Method: Modify or replace the existing unit(s) to ensure adequate ozone generation capacity is available. Refer to 7.1.5.

DEFICIENCY	CONSIDERATIONS
7.7.2 Inadequate feedback for control of chlorine/ozone feed rate.	New and Existing POTW's The ozone feed rate can be controlled by the output signal from the effluent flow meter. Ozone feed rate control by an on-line ozone residual meter is technically feasible, but not widely used.
7.7.3 Inadequate safety equipment.	New and Existing POTW's Refer to 7.1.6.

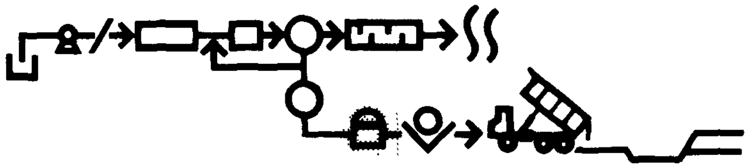
Unit Operation/Component: 7.8 Ozone Controller

7.8.1 Inadequate feedback for control of chlorine/ozone feed rate.	New and Existing POTW's Refer to 7.7.2.

Unit Operation/Component: 7.9 Safety

7.9.1 Inadequate consideration of emergency alarms, controls, and ventilation.	New and Existing POTW's For detailed guidelines on safety in disinfection systems, consult the following: • WPCF MOP No. 1 (Safety in Wastewater Works) -- Sections 3.28 and 6.15. • WPCF MOP No. 4 (Chlorination of Wastewater) -- Chapter 6 (Chlorination Safety).
7.9.2 Floor drains from chlorine room are connected to floor drains from other rooms.	New and Existing POTW's In order to prevent chlorine leaks from penetrating other areas through the floor drains, the chlorine room floor drains should not be connected to any other floor drains in the plant.

DEFICIENCY	CONSIDERATIONS
7.9.3 Inadequate safety equipment.	New and Existing POTW's Refer to 7.1.6.
7.9.4 Improper temperature control in chlorine tank storage area.	New POTW's The chlorine storage area temperature should not be allowed to drop below 10°C (50°F) to prevent liquefaction of chlorine gas in the header. The temperature should be kept below 70°C (158°F) in the storage area to keep the tank from bursting. Existing POTW's Method: Space heaters and ventilation fans should be installed in chlorine tank storage area to maintain room temperature between 60°F and 80°F.

Design Considerations Category: 8.0 Anaerobic Digestion	
Unit Operation/Component: 8.1 General	

DEFICIENCY	CONSIDERATIONS
8.1.1 Inadequate consideration of the impact of the supernatant sidestream on other unit operations.	New POTW's Consider the additional pollutant loading due to sidestream return. The major pollutants to be considered are BOD and suspended solids, with pH and odor problems also of concern. Existing POTW's Method: Provide pumps and piping necessary to route digester supernatant to multiple points in the plant.
8.1.2 Inadequate provision for sampling.	New and Existing POTW's Provide sampling locations such that samples can be obtained from: • Raw sludge. • Digester (active) sludge. • Digested sludge. • Supernatant. • Digester gas.
8.1.3 Inadequate treatment of digester gas before utilization in plant.	New and Existing POTW's If gas is to be burned as a fuel, install a wet or dry gas scrubber to remove impurities (mainly hydrogen sulfide).

DEFICIENCY	CONSIDERATIONS
8.1.4 Inadequate provision for digester cleaning.	New and Existing POTW's Provide facilities for grit and debris collection and removal from the digester tank. Provide an access way and high pressure water supply as a minimum. Considerations include grit and debris disposal, sludge storage during cleaning, tank draining, and disposal of rinse waters.
8.1.5 Insufficient capacity at peak loads.	New and Existing POTW's Ensure digester pumps and pipes are sized for both maximum expected sludge production rate and maximum sludge removal rate.
8.1.6 No provision for cleaning sludge heating lines.	New POTW's Ensure that access for cleaning of the heat exchange equipment is provided. Existing POTW's Method: Install flushing taps in heating lines to allow proper cleaning.
8.1.7 Lack of pH and temperature control facilities.	New POTW's Provide pH and temperature probes within the active portion of the digester. Existing POTW's Method: Retrofit digester with pH and temperature probes within the active portion of the digester.
8.1.8 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Provide insulation, heat tracing, and/or a shelter for pressure relief valves to minimize environmental effects.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 8.2 Single-Stage Digester	
8.2.1 Inadequate consideration of the impact of the supernatant sidestream on other unit operations.	New and Existing POTW's Refer to 8.1.1.
8.2.2 Lack of sludge thickening ahead of digester.	New and Existing POTW's During the design phase, the economics of feeding a concentrated sludge versus a diluted sludge to the digester should be evaluated. Generally, sludge thickening prior to digestion is desirable.
8.2.3 Inadequate location of supernatant withdrawal.	New POTW's Provide the flexibility for supernatant removal at various levels in the upper portion of the digester. This may be extremely important at small plants with variable operating schedules. Existing POTW's Method: Install a telescopic swing valve to allow draw-off of supernatant at varying levels.
8.2.4 Inadequate provision for sampling.	New and Existing POTW's Refer to 8.1.2.
8.2.5 Inability to feed chemicals during process upset.	New POTW's Provide the capability to add chemicals to the digester, including facilities to mix the digester contents and chemicals following addition. Existing POTW's Method: Install a hatch in the digester cover to allow chemical addition.

DEFICIENCY	CONSIDERATIONS
8.2.6 Inadequate treatment of digester gas before utilization in plant.	New and Existing POTW's Refer to 8.1.3.
8.2.7 Inadequate provision for digester cleaning.	New and Existing POTW's Refer to 8.1.4.
8.2.8 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Refer to 8.1.8.

Unit Operation/Component: 8.3 Two-Stage Digester

8.3.1 Inadequate consideration of the impact of the supernatant sidestream on other unit operations.	New and Existing POTW's Refer to 8.1.1. Method: Refer to 8.1.1.
8.3.2 Lack of sludge thickening ahead of digester.	New and Existing POTW's Refer to 8.2.2.
8.3.3 Inadequate location of supernatant withdrawal.	New and Existing POTW's Refer to 8.2.3.
8.3.4. Inability to isolate and feed sludge to all digesters.	New POTW's Provide pumps and piping arrangements such that sludge can be fed to all digesters, both first- and second-stage. Existing POTW's Method: Provide piping and valves necessary to route raw sludge to any one of multiple digesters.

DEFICIENCY	CONSIDERATIONS
8.3.5 Inadequate provision for sampling.	New and Existing POTW's Refer to 8.1.2.
8.3.6. Inability to feed chemicals during process upset.	New and Existing POTW's Refer to 8.2.5.
8.3.7 Inadequate mixing.	New and Existing POTW's Provide external (i.e., mechanical) mixers or internal (gas circulation) mixers to agitate the digester contents. Select the proper velocity gradient for design (typically 50 to 80 sec^{-1}). Take into consideration the temperature, solids concentration, and volatile content of the sludge at which the digester is to be operated.
8.3.8 Inadequate treatment of digester gas before utilization in plant.	New and Existing POTW's Refer to 8.1.3.
8.3.9 Inadequate provision for digester cleaning.	New and Existing POTW's Refer to 8.1.4.
8.3.10 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Refer to 8.1.8.

Unit Operation/Component: 8.4 Gas Collection

DEFICIENCY	CONSIDERATIONS
8.4.1 Inadequate provision for sampling.	New and Existing POTW's Provide sampling ports to allow for sampling of digester gas. Refer to 8.1.2.
8.4.2 Inadequate placement of condensate traps on gas lines.	New and Existing POTW's Ensure that traps are placed at the lowest points in the gas collection system.

DEFICIENCY	CONSIDERATIONS
8.4.3 Inadequate treatment of digester gas before utilization in plant.	New and Existing POTW's Refer to 8.1.3.
8.4.4 Inadequate provision for high/low gas pressure alarms.	New and Existing POTW's Provide high/low pressure alarms in the digesters, the gas collection/cleaning equipment, and the gas storage facilities.
8.4.5 Lack of condensate and flame traps in lines.	New and Existing POTW's Provide condensate and flame traps in gas lines and at pressure relief valves. Install flame traps as close as possible upstream of all sources of ignition.
8.4.6 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Refer to 8.1.8.

Unit Operation/Component: 8.5 Gas Measurement

DEFICIENCY	CONSIDERATIONS
8.5.1 Individual gas measurement not provided on multiple digesters.	New and Existing POTW's Provide gas measurement equipment (such as rotometers, venturi meters, or rotary displacement type meters) on all digesters.
8.5.2 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Refer to 8.1.8.

Unit Operation/Component: 8.6 Supernatant Withdrawal

DEFICIENCY	CONSIDERATIONS
8.6.1 No provision for changing supernatant withdrawal point within tank.	New and Existing POTW's Provide digester with variable level supernatant removal mechanism such as a telescopic valve or floating mechanism. Refer to 8.2.3.

DEFICIENCY	CONSIDERATIONS
8.6.2 Inadequate consideration of the impact of the supernatant sidestream on other unit operations.	New and Existing POTW's Refer to 8.1.1.
8.6.3 Inadequate location of supernatant withdrawal.	New and Existing POTW's Refer to 8.2.3.
8.6.4 Inadequate provision for sampling.	New and Existing POTW's Refer to 8.1.2.
8.6.5 Improper use of water seals on pumps.	New and Existing POTW's Utilize mechanical seals on digester pumps. Provide an air break in seal water lines if potable water is used. Specify proper seal water pressure to minimize pumpage and excessive loss of seal water.

Unit Operation/Component: 8.7 Supernatant Disposal

8.7.1 No provision for changing supernatant disposal point within plant.	New and Existing POTW's Provide piping to allow disposal of supernatant liquor at a minimum of two points in the plant (i.e., thickener and primary tanks) to provide operational flexibility.
8.7.2 Inadequate consideration of the impact of the supernatant sidestreams on other unit operations.	New and Existing POTW's Refer to 8.1.1.

Unit Operation/Component: 8.8 Heating

8.8.1 Inadequate insulation of heating pipes.	New and Existing POTW's Provide insulation on all pipes exposed to the environment to prevent heat loss.

DEFICIENCY	CONSIDERATIONS
8.8.2 Inadequate sizing of heat exchanger.	New POTW's When sizing heat exchangers, heat losses through the top, bottom, and sides of the digester must be considered. It is noted that the heat transfer coefficients for the three are different. Existing POTW's Method: If exchanger is undersized, try insulating system to minimize losses and retain heat within system. If this fails, replace exchanger.
8.8.3 No provision for cleaning sludge heating lines.	New and Existing POTW's Refer to 8.1.6.
8.8.4 Improper use of water seals on pumps around digester.	New and Existing POTW's Refer to 8.6.5.

Unit Operation/Component: 8.9 Maintenance

8.9.1 Inadequate provision for digester cleaning.	New and Existing POTW's Refer to 8.1.4.

Unit Operation/Component: 8.10 Safety

8.10.1 Inadequate provision for digester cleaning.	New and Existing POTW's Refer to 8.1.4.
8.10.2 Inadequate provision for high/low gas pressure alarms.	New and Existing POTW's Refer to 8.4.4.
8.10.3 Lack of condensate and flame traps in gas lines.	New and Existing POTW's Refer to 8.4.5.

DEFICIENCY	CONSIDERATIONS
8.10.4 Pressure relief valves are exposed to cold weather, resulting in freezing.	New and Existing POTW's Refer to 8.1.8.

Unit Operation/Component: 8.11 Sludge Withdrawal

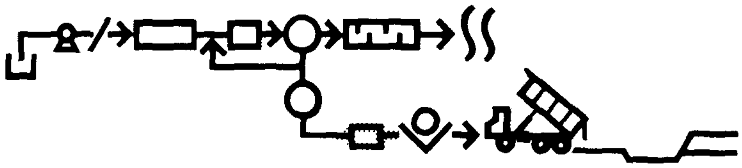
8.11.1 Inadequate provision for sampling.	New and Existing POTW's Refer to 8.1.2.
8.11.2 Inadequate sizing of sludge lines prevents passage of concentrated sludge.	New and Existing POTW's As a minimum, provide 4-inch diameter sludge lines. Install flush-out connections in the sludge piping.
8.11.3 Sludge line from digester to sludge draw-off pump too long, resulting in plugging problems.	New and Existing POTW's Minimize distance between digester and sludge draw-off pump as much as possible.
8.11.4 Lack of multiple sludge withdrawal and return points.	New and Existing POTW's It is particularly desirable for unmixed digesters to provide multiple sludge withdrawal and return points. Arrange pumps and piping such that both the sludge removal pipe at the bottom of the tank and the sludge recirculation line can be utilized for either task.
8.11.5 Improper use of water seals on pumps around digester.	New and Existing POTW's Refer to 8.6.5.
8.11.6 Sludge metering system inaccurate or unreliable.	New and Existing POTW's Utilize non-constructing, non-contact flowmeters (i.e., magnetic, ultrasonic).

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 8.12 Sludge Recirculation	
8.12.1 Inadequate sizing of sludge lines prevents passage of concentrated sludge.	<u>New and Existing POTW's</u> Refer to 8.11.2.
8.12.2 Lack of multiple sludge withdrawal and return points.	<u>New and Existing POTW's</u> Refer to 8.11.4.
8.12.3 Improper use of water seals on pumps around digester.	<u>New and Existing POTW's</u> Refer to 8.6.5.
8.12.4 Sludge metering system inaccurate or unreliable.	<u>New and Existing POTW's</u> Refer to 8.11.6.
Unit Operation/Component: 8.13 Sludge Feed	
8.13.1 Lack of sludge thickening ahead of digester.	<u>New and Existing POTW's</u> Refer to 8.2.2.
8.13.2 Inability to isolate and feed sludge to all digesters.	<u>New and Existing POTW's</u> Refer to 8.3.4.
8.13.3 Inadequate number of sludge feed lines hinder operation.	<u>New and Existing POTW's</u> Provide multiple feed lines (4-inch minimum diameter) to all digesters. Specify flushing connections on all sludge lines.
8.13.4 Inadequate flow measurement.	<u>New and Existing POTW's</u> Provide non-contract, non-restricting flow measurement devices on sludge feed lines such that flow rates to all digesters can be measured.

DEFICIENCY	CONSIDERATIONS
8.13.5 Inadequate sizing of sludge lines prevents passage of concentrated sludge.	New and Existing POTW's Refer to 8.11.2.
8.13.6 Improper use of water seals on pumps around digester.	New and Existing POTW's Refer to 8.6.5.
8.13.7 Sludge metering system inaccurate or unreliable.	New and Existing POTW's Refer to 8.11.6.

Design Considerations

Category: 9.0 Aerobic Digestion



Unit Operation/Component: 9.1 General

DEFICIENCY	CONSIDERATIONS
9.1.1 Lack of depth gauges provided on basins that operate at varying liquid depths.	<u>New POTW's</u> Provide level meters on digestion tanks, particularly if they are to be operated via the fill and draw method, or if the tanks are covered. <u>Existing POTW's</u> <u>Method</u>: Install level meters on the digester tanks. <u>Materials</u>: Utilize a level meter such as a float, bubbler, capacitance probe, or ultrasonic probe.
9.1.2 Lack of thickening ahead of digestion, and no provision for decanting within the digester.	<u>New POTW's</u> Compare economics and operational flexibility of providing a thickener prior to digestion versus a larger aeration basin and batch operation of the digester with periodic decanting. <u>Existing POTW's</u> <u>Method</u>: Install a swing valve or a telescopic valve to allow supernating the digester (i.e., periodically turn the aeration system off, allow solids to settle, and then supernate.

DEFICIENCY	CONSIDERATIONS
9.1.3 Inadequate consideration of a decrease in operating efficiency due to the temperature drop in winter.	New POTW's Design the digester for operation at the lowest predicted winter temperature. Consider diffused aeration rather than surface aerators. Consider a covered tank or insulation of above-ground tanks. Existing POTW's Method: Insulate existing tank if above ground. Consider replacement of surface aerators with diffused aeration.
9.1.4 Pressure relief valve not provided in area with high groundwater, which prohibits batch operation.	New and Existing POTW's Install pressure relief valves in tanks constructed in high groundwater areas to allow emptying tanks without resultant foundation problems.
9.1.5 Inadequate consideration of pH control.	New POTW's If POTW receives industrial wastes high in Kjeldahl nitrogen, consider need for addition of alkalinity due to pH depression during nitrification. Existing POTW's Method: If pH control is required, install a lime feed system (i.e., slurry tank, mixer, feed pump, etc.).
9.1.6 Inadequate structural design in common wall construction, causing structural failure during batch operation.	New POTW's Ensure that common wall tankage is capable of maintaining structural integrity when one side of the tank is empty.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Brace the existing common wall to allow batch operation (i.e., allow the tank on one side of the wall to be full while the adjacent tank is empty).
9.1.7 Lack of flexibility to dewater small above-ground tanks by gravity.	New POTW's If hydraulics permit, make provisions for gravity dewatering of digestion tanks. Existing POTW's Method: Install a sump in the lowest portion of the tank. If hydraulics dictate that gravity flow is not possible, install a lift pump to drain the sump.
9.1.8 Inability to draw supernatant off at deep enough level.	New POTW's Provide variable level supernatant removal mechanism with ability to withdraw liquid from entire depth of tank, thereby allowing back-up for sludge removal and tank dewatering. Existing POTW's Method: Install a telescopic valve or a swing pipe (with a float) to provide variable-level supernatant removal.
9.1.9 Provisions provided to add defoamer to aeration basin, but not to aerobic digester.	New POTW's Provide a water spray system, as a minimum, or a defoamer addition system for the digester to provide foam control. Existing POTW's Method: Tap into the existing defoamer system and install an additional line and pump (if required) to feed defoamer to the digester.

DEFICIENCY	CONSIDERATIONS
9.1.10 Inadequate freeze protection.	New POTW's If climate dictates, ensure that all above-ground piping and pumping is insulated and/or heat traced. Consider covering tanks and insulating above-ground tanks. Utilize diffused aeration rather than surface aerators. Existing POTW's Method: Install insulation and/or heat tracing around all exposed pipes where freezing is a problem. If an above-ground tank is being used, insulate it by constructing an earthern berm around the tank walls.

Unit Operation/Component: 9.2 Aerobic Digester

9.2.1 Inadequate consideration of denitrification-induced settling problems during decanting.	New POTW's Minimize time required to decant digester by proper sizing of decant pump and/or lines. Existing POTW's Method: Install additional or larger decant pumps and lines to minimize time required to decant.
9.2.2 Pressure relief valve not provided in area with high groundwater, which prohibits batch operation.	New and Existing POTW's Refer to 9.1.4.
9.2.3 Inadequate mixing to prevent solids deposition and provide uniform D.O. concentrations.	New POTW's Ensure that sufficient energy is supplied to the digester to maintain sludge particles in suspension at the design suspended solids level.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install an additional surface aerator or upgrade horsepower of existing aerator. If diffused aeration is being used, increase blower capacity.
9.2.4 Inadequate freeboard for foam containment and spray control.	New and Existing POTW's As a minimum, supply a 3-ft freeboard around digester tanks.
9.2.5 Inadequate ventilation in covered digesters.	New POTW's Review OSHA and state regulations concerning design of ventilation systems for wastewater treatment plants and safety requirements for confined spaces. Existing POTW's Method: Provide a ventilation system (i.e., blower, vents, ducts, etc.) or increase the capacity of the existing system.
9.2.6 Inadequate structural design in common wall construction, causing structural failure during batch operation.	New and Existing POTW's Refer to 9.1.6.
9.2.7 Inadequate freeze protection.	New and Existing POTW's Refer to 9.1.10.

Unit Operation/Component: 9.3 Decanting

DEFICIENCY	CONSIDERATIONS
9.3.1 Inadequate consideration of denitrification-induced settling problems during decanting.	New and Existing POTW's Refer to 9.2.1.

DEFICIENCY	CONSIDERATIONS
9.3.2 Inadequate supernatant flexibility.	New POTW's Provide capability to supernate at varying levels. Existing POTW's Method: Replace existing supernatant withdrawal equipment with variable level equipment. Materials: Utilize either a swing arm or floating decant removal mechanism.
9.3.3 Inability to visually observe the quality of supernatant being drawn off.	New and Existing POTW's Provide bleed-off valve on supernatant line to allow for supernatant quality inspection.
9.3.4 Inability to draw supernatant off at deep enough level.	New and Existing POTW's Refer to 9.1.8.
9.3.5 Lack of spare supernatant pump for both maintenance purposes and to allow rapid dewatering of basin.	New and Existing POTW's If supernatant is pumped from digester, provide spare pump or arrange piping so that an alternate pump can be used.
9.3.6 Inadequate freeze protection.	New and Existing POTW's If climate dictates, ensure that all above-ground piping and pumping is insulated and/or heat traced. Refer to 9.1.10.

Unit Operation/Component: 9.4 Clarification

DEFICIENCY	CONSIDERATIONS
9.4.1 Inadequate consideration of denitrification-induced settling problems during decanting.	New and Existing POTW's Refer to 9.2.1.

DEFICIENCY	CONSIDERATIONS
9.4.2 Inadequate supernatant flexibility.	New and Existing POTW's Refer to 9.1.8 and 9.3.2.
9.4.3 Inability to visually observe the quality of supernatant being drawn off.	New and Existing POTW's Refer to 9.3.3.

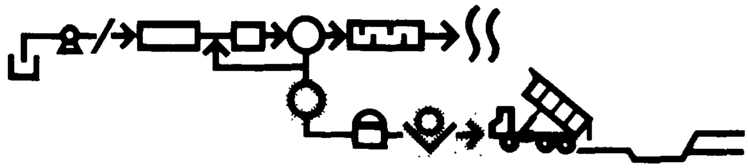
Unit Operation/Component: 9.5 Diffused Aeration

DEFICIENCY	CONSIDERATIONS
9.5.1 Inadequate air supply.	New POTW's Ensure that sufficient oxygen is supplied to meet oxygen demand (including nitrification), and that diffuser spacing will allow adequate mixing. Existing POTW's Method: Determine whether the limiting variable is air supply or number of air diffusers, and then supplement the air supply by increasing blower horsepower or the number of diffusers. Materials: Consistent with existing equipment.
9.5.2 Inadequate consideration of diffuser maintenance problems and clogging tendency.	New and Existing POTW's Provide couplings or swing pipes to allow removal of diffusers from the aeration basin for routine maintenance. For fixed diffusers, provisions must be made for emptying the basin and subsequent diffuser maintenance.
9.5.3 Inadequate mixing to prevent solids deposition and provide uniform D.O. concentrations.	New and Existing POTW's Refer to 9.2.3.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 9.6 Mechanical Aeration	
9.6.1 Inadequate air supply.	New POTW's Supply sufficient horsepower to meet oxygen demand and to maintain suspended solids in suspension. Existing POTW's Method: Install additional mechanical aerators, or replace existing aerators with larger units. Install a diffused aeration system to supplement the existing system. Convert to a pure oxygen system.
9.6.2 Inadequate flexibility in aeration equipment prohibits operation of tank unless full.	New and Existing POTW's Install floating rather than fixed aerators if tank is to be operated partially full.
9.6.3 Inadequate mixing to prevent solids deposition and provide uniform D.O. concentrations.	New and Existing POTW's Refer to 9.2.3.
Unit Operation/Component: 9.7 Sludge Removal	
9.7.1 Inadequate consideration of sludge viscosity during pump selection.	New POTW's Consider sludge solids concentration and temperature when selecting sludge pumps. Existing POTW's Method: Replace centrifugal pump with a plunger-type pump to handle concentrated sludge.

Design Considerations

Category: 10.0 Sludge Dewatering



Unit Operation/Component: 10.1 General

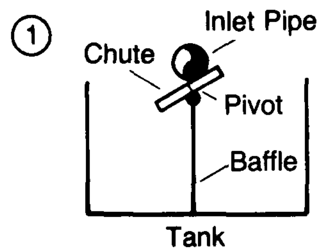
DEFICIENCY	CONSIDERATIONS
10.1.1 Truck loading areas not covered or protected from freezing conditions.	New and Existing POTW's In cold-weather regions, trucks and dumpsters which receive sludges from dewatering equipment should be parked inside a building to prevent the sludge from freezing to the sides and bottom of the transfer vehicle, making it difficult to unload the sludge cake at the final disposal site. In warm-weather regions, the sludge transfer vehicle should be parked under cover to keep the cake dry during wet-weather conditions.
10.1.2 Inability to feed chemicals to both sides of a tank that can be baffled into two separate tanks.	New POTW's Chemical feed lines into splitter boxes and/or chemical mix tanks that can be divided into multiple compartments should be designed to discharge into each compartment rather than into just one side of the tank in case a portion of the tank must be taken out of service or different chemical dosages are required in various compartments. Existing POTW's Method: 1 Provide a central pivoting chute that can be manually rotated to provide discharge into one portion of the tank or the other; or 2 Repipe and valve chemical feed lines to discharge into either side of the tank.

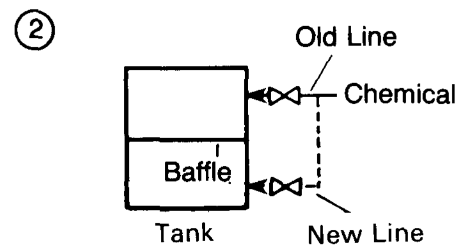
DEFICIENCY | CONSIDERATIONS

Materials: One-eighth inch or greater thickness steel plate and common welding.

Cost: Less than $500.

Sketch:





10.1.3 Excessive cake discharge height results in severe sludge splashing.

New POTW's

Cake discharge heights greater than 15 feet should be avoided if possible. If a long drop from the dewatering unit to the collection vehicle is necessary, consideration should be given to providing portable splash shields that can be set around the vehicle or specify a pliable curtain that hangs from the discharge chute down to the collection vehicle.

Existing POTW's

Method: Provide portable splash shields that can be set around the receiving truck or dumpster, or hang a pliable curtain from the discharge chute down to the collection vehicle.

Materials: Rubber-coated canvas or neoprene.

Cost: Less than $500.

10.1.4 Inadequate access provided to sample filtrate/centrate streams.

New POTW's

Sample taps should be specified for the filtrate/centrate lines from each piece of dewatering equipment. The sample taps should be located in a position that allows sufficient room

DEFICIENCY	CONSIDERATIONS
	for a sample container to collect samples from the tap. Existing POTW's Method: Install sample taps in conveniently accessible locations. Materials: One-half inch diameter nipple and one-half inch gate valve. Cost: Less than $100. Sketch: 
10.1.5 Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosion rates.	New and Existing POTW's Motor control centers for sludge dewatering equipment should be located in a separate room to prevent clean-up water from damaging electrical equipment. The room should have a curb around it to prevent water flowing over the floor and into the room. Local control panels for equipment should be located far enough from the units to allow the operator to hose down the equipment without getting the panels wet. Water-proof (i.e., Nema-4) enclosures should be specified for localized control panels.
10.1.6 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	New POTW's When multiple dewatering units are required, size the units such that, with one out of service, the remaining unit(s) can process the sludge by operating an extra shift or at an increased loading rate. If only one unit is warranted, provide temporary sludge holding capacity (i.e., thickener, digester, holding tank, etc.) in the plant for use when the unit is out-of-service.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install a sludge holding tank to temporarily store sludge while the dewatering unit is out-of-service. The tank should have a mixer and a supernatant line to allow periodic settling (i.e., concentration) of the sludge.
10.1.7 Insufficient provisions for storage of chemicals.	New and Existing POTW's When bagged (versus bulk storage) chemicals such as lime and polymer are used, dry storage space must be provided. The space should be sufficient to store one month's supply of chemicals and be close to the point of use. The storage area should be protected from clean-up waters and high-humidity conditions. Consideration should be given to storage of chemicals on a mezzanine above chemical mix tanks and feeding chemicals to the tanks from the elevated mezzanine rather than storing chemicals on the same floor level as the mix tanks which would require lifting the bags up over the edge of the mix tanks in order to feed chemicals.
10.1.8 Inadequate consideration of storage of dewatered sludge during inclement weather.	New and Existing POTW's Incorporate into the facility's design extra trucks or dumpsters to provide temporary sludge storage capacity during periods of inclement weather when access to the final disposal site is limited (i.e., due to heavy snows) or when the receiving landfill is closed (i.e., due to heavy rainfall). Refer to 10.1.6.
10.1.9 Elevated equipment such as conveyors and chemical	New and Existing POTW's Elevated conveyors should be a minimum of five feet below building

DEFICIENCY	CONSIDERATIONS
storage bins are inaccessible for inspection and maintenance.	ceilings to allow operator access and maintenance work. Stairs and platforms which allow access to equipment (such as blowers, agitators, and instrumentation mounted on the top of chemical storage bins) should be incorporated into the chemical system design.
10.1.10 Inadequate consideration of cyclic peak demands in common air/water supplies results in competition among multiple units.	New and Existing POTW's Peak demands on each unit serviced by a common air/water supply must be considered when sizing utilities and/or auxiliary equipment. Either sufficient capacity to meet equipment peak demands must be provided, or periodic staggered operation of the equipment must be incorporated into planned operating procedures.
10.1.11 Inadequate capability to handle peak loads.	New POTW's Dewatering equipment should be sized to handle peak loads or sufficient storage capacity should be provided in upstream units to equalize peak loadings. This storage capacity could be provided via extra sidewater depth (i.e., sludge holding capacity) in thickeners, aerobic digesters that operate at varying depths, sludge holding tanks, extra capacity in two-stage anaerobic digesters, etc. Existing POTW's Method: Refer to 10.1.6.
10.1.12 Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	New POTW's In-line flow meters or overflow weirs out of flow splitter boxes should be provided to allow measurement of sludge flow to individual pieces of dewatering equipment in order to: properly balance flow

DEFICIENCY	CONSIDERATIONS
	between multiple units, identify loading rates, and/or determine required chemical conditioning feed rates. Existing POTW's Method: For dewatering units fed by gravity flow, provide overflow weirs out of flow splitter boxes; for pressure flow to dewatering equipment, install in-line magnetic flow meters and control valves. Materials: Weirs for gravity flow; magnetic flow meters and pinch valves for pressure flow.
10.1.13 Inadequate scum removal.	New and Existing POTW's Scum removed from clarifiers and thickeners should not be recycled back into the plant treatment system or mixed with waste sludge prior to dewatering, but should be collected and removed separately from the plant. Scum removal capabilities should be provided in all tanks or flow splitter boxes that handle wastewater prior to secondary clarification or that handle sludges.
10.1.14 Inadequate consideration of potential plugging problems in sludge piping.	New and Existing POTW's The minimum size pipe that should be used for sludge handling is four inches. In addition, sludge piping should be equipped with hose bibs to allow flushing the lines to break-up plugs in the lines. Consideration should also be given to periodically using couplings in sludge piping to allow operators to break into lines to fix a plugging problem.

DEFICIENCY	CONSIDERATIONS
10.1.15 Inadequate consideration of corrosive nature of materials to be handled.	New POTW's When selecting piping materials, consideration must be given to the corrosive nature of any sludge conditioning chemicals (i.e., ferric chloride, alum, lime, etc.) that will be utilized. Stainless steel or PVC piping (and tanks) will be required for handling most chemicals. Existing POTW's Method: Replace existing piping with proper type of pipe needed to carry corrosive material.
10.1.16 Insufficient number of floor drains around dewatering equipment.	New and Existing POTW's Provide floor drains on all four sides and underneath dewatering equipment.
10.1.17 Tank drain lines are located 2 to 3 inches off the bottom of tanks, making it difficult to dewater them.	New POTW's Specify that drains on tanks are installed at the very bottom to allow complete dewatering of the tank. Existing POTW's Method: Relocate tank drains to the bottom of the tank to allow complete dewatering.
10.1.18 Chemical feed line and pH probe are located close together, causing erroneous and/or cyclic reading.	New POTW's The pH probe in a complete mix, chemical addition (i.e., pH adjustment) tank should be installed at the opposite end from where chemicals are added. This will ensure the probe is measuring the pH of a completely-mixed solution. This is particularly important when pH readouts are used to control chemical feed rates. Existing POTW's Method: Relocate chemical feed lines to discharge into mixing equipment vortices. Ensure that the pH probe is located at the opposite side of the tank from the chemical inlet.

DEFICIENCY	CONSIDERATIONS
10.1.19 Clogging problems in lime piping.	New and Existing POTW's Design techniques that can be employed to minimize clogging problems in lime piping include the following: • Locate lime feeder within a few feet of application point. • Utilize open channel (i.e., gravity) flow in lieu of pumping the lime slurry. • Pre-soften the dilution water with sodium hexametaphosphate. • Discharge the slurry through an air gap into the open pH adjustment tank. • Utilize supernatant from lime slurry settling tanks as dilution water. • Specify heavy-duty flexible rubber hoses or heavy, plastic pipe in lieu of metal pipe; this allows flexing the pipe to break up any scaling inside the pipe. • Provide clean-out/flushing taps on lime piping. • Provide quick-disconnect couplings that allow lime piping to be taken apart for cleaning.
10.1.20 Excessive agitation in chemical conditioning tanks causes floc to shear.	New POTW's For sludge conditioning tanks, utilize turbine impellers that rotate at approximately 150 rpm. If paddle-type mixers are used, the paddles should rotate at 2 to 3 fps.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Do not provide slow-speed mixing by installing oversized impellers or paddles; rather, consult the manufacturer with regard to the use of a step-down transformer to provide slower rotations without damaging the electrical motors.
10.1.21 Inadequate provisions for vibration control in sludge piping design.	New and Existing POTW's Discharge piping from piston pumps should be securely anchored to prevent excessive vibration. Long runs of unbraced piping should be avoided, and thrust blocks should be installed at points where sludge piping changes direction. Piping braces or racks should be specified in lieu of hangers to support elevated runs of sludge piping from plunger pumps.
10.1.22 Lack of moisture removal from instrument air lines results in failure of control equipment.	New POTW's Provide air driers to remove moisture from instrument air supplies since water can collect in automatic control instrumentation and impair operation. The air should be dried to a minus 40°F dew point. Consideration should also be given to insulating the air lines. Existing POTW's Method: Install an air dryer in the instrument air line. Cost: Less than $5,000.
10.1.23 Sludge pumping and dewatering areas not properly ventilated.	New and Existing POTW's Sludge handling areas should be well ventilated to prevent accumulation of gases (i.e., H_2S, ammonia). Approximately 12 room air changes per hour should be provided.

DEFICIENCY	CONSIDERATIONS
10.1.24 Inadequate provisions for lifting equipment for repairs.	New POTW's Architectural and structural designs should include necessary support members for hoists over larger pieces of equipment (i.e., pumps, gates, dewatering equipment, etc.) to allow removal for maintenance purposes. Existing POTW's Method: Consider the use of portable-type gantry cranes. Cost: For portable gantry cranes with up to 2-ton capacity, the cost would be less than $500.

Unit Operation/Component: 10.2 Gravity Thickeners

DEFICIENCY	CONSIDERATIONS
10.2.1 Design satisfies solids loading, but neglects hydraulic loading requirements.	New POTW's Thickeners are generally designed for hydraulic overflow rates of 400 to 800 gpd/sq ft. Overflow rates are a particularly-important consideration if dilution water is to be added to the thickener. Existing POTW's Method: Sample waste sludge concentration to thickener to ensure that excessive pumping is not being performed. Also, reduce or eliminate the use of dilution water to the thickener.
10.2.2 Short-circuiting of flow through tank causes poor solids removal.	New and Existing POTW's Ensure the thickener is properly baffled to prevent short-circuiting across the thickener. Influent and effluent baffles should be used to ensure influent is evenly distributed across the thickener.

DEFICIENCY	CONSIDERATIONS
10.2.3 No provision for chemical addition.	New POTW's Provide flexibility to add a settling aid, such as polymer, to the thickener to enhance performance or for use during up-set periods. Existing POTW's Method: Provide chemical addition facilities. Materials: 55-gallon drum of premixed chemical and metering pump for controlled addition. Cost: Less than $1,000.
10.2.4 Inadequate scum removal.	New and Existing POTW's Provide a scum skimmer with thickeners; the scum should be removed from the plant and not recycled back into the treatment system.
10.2.5 Improper sidewater depth (SWD).	New POTW's Thickeners are generally designed with a SWD depth of 10 to 12 feet. Existing POTW's Method: If hydraulically possible, raise the effluent weirs. Operate thickeners in batch mode. Minimize or eliminate the addition of dilution water, and remove sludge as soon as it has attained a satisfactory concentration in the bottom.
10.2.6 Inadequate freeze protection.	New POTW's In cold-weather climates, in-ground tanks should be used and/or covers should be specified. Operating experience gained at other plants in the vicinity can be used to determine if covers are warranted. Another alternative is to place the units inside buildings.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Construct an insulating earthen berm around above-ground tanks. Install wind breakers around the tank. Insulate and heat trace exposed piping.

Unit Operation/Component: 10.3 DAF Thickeners

DEFICIENCY	CONSIDERATIONS
10.3.1 Inadequate consideration of cyclic peak demands in common air/water supplies results in competition among multiple units.	New POTW's If common air compressors are used for multiple DAF units, the compressors must be designed to supply peak demands for all the DAF units. This could be accomplished by providing a stand-by unit that could be used during peak periods (also when one of the other compressors is out-of-service). Existing POTW's Method: Eliminate other air uses during peak DAF demands, or supply an additional stand-by unit for use during peak periods.
10.3.2 Design satisfies solids loading, but neglects hydraulic loading requirements.	New POTW's Dissolved air flotation units are generally designed for overflow rates of 0.5 to 2 gpm/sq ft. Pilot-plant or laboratory testing should be conducted to develop specific design parameters. Existing POTW's Method: Supply hydraulic load to DAF thickeners as uniformly as possible. Install a sludge holding tank upstream of the DAF units to equalize flows to the thickeners.

DEFICIENCY	CONSIDERATIONS
10.3.3 Insufficient effluent recycle capacity.	New POTW's A maximum recycle capacity of 150 to 200 percent of the influent flow should be provided. However, recycle pumping systems should be designed to allow minimum recycle flows of 30 to 50 percent. Existing POTW's Method: Since effluent is used to convey dissolved air into the system, add air diffusers into the air dissolution tank. If air is pulled into recycle lines through a metered suction, do not exceed four percent by volume to avoid cavitation.
10.3.4 Feed pumps run on an "on-off" cycle, causing uneven feed to DAF unit.	New and Existing POTW's A sludge holding tank (equipped with a mixer) should be provided upstream of DAF thickeners. DAF units should have a continuous and constant influent flow rate with a constant solids concentration in order to consistently maintain an optimum air-to-solids ratio within the unit.
10.3.5 Wide variations in feed solids concentrations occur because DAF is fed directly from final clarifier.	New and Existing POTW's Refer to 10.3.4.
10.3.6 No provision for chemical addition.	New POTW's Refer to 10.2.3. Existing POTW's Method: Provide space for a 55-gallon drum for batch or continuous feed. Provide metering into the feed lines following the dissolved air release.
10.3.7 Improper sidewater depth (SWD).	New POTW's DAF units are generally designed with SWD's from 3 to 10 feet.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Feed DAF unit as uniformly as possible. Remove float as rapidly as possible, consistent with attainment of design concentration. Ensure that settled solids are frequently (at least weekly) drawn off the DAF unit bottoms.
10.3.8 Lack of moisture removal from instrument air lines results in failure of control equipment.	New and Existing POTW's Refer to 10.1.22.
10.3.9 Inadequate freeze protection.	New and Existing POTW's Refer to 10.2.6.

Unit Operation/Component: 10.4 Vacuum Filters

DEFICIENCY	CONSIDERATIONS
10.4.1 Truck loading areas not covered or protected from freezing conditions.	New and Existing POTW's Refer to 10.1.1.
10.4.2 Vacuum valves on equipment are inaccessible.	New and Existing POTW's Avoid unsafe practices such as climbing on equipment to reach valves. If valves are not within reach from floor level, chain-operated valves should be specified and/or stairways and platforms provided.
10.4.3 Excessive cake discharge height results in severe splashing.	New and Existing POTW's Refer to 10.1.3.
10.4.4 Inadequate access provided to sample filtrate/centrate streams.	New and Existing POTW's Refer to 10.1.4.

DEFICIENCY	CONSIDERATIONS
10.4.5 Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosion rates.	<u>New and Existing POTW's</u> Refer to 10.1.5.
10.4.6 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	<u>New and Existing POTW's</u> Refer to 10.1.6.
10.4.7 Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	<u>New and Existing POTW's</u> Refer to 10.1.9.
10.4.8 Sludge feed troughs from chemical conditioning tank to vacuum filter frequently become clogged.	<u>New POTW's</u> Provide troughs that are a minimum of 1 foot wide and sloped at a minimum angle of 30 degrees. <u>Existing POTW's</u> <u>Method</u>: Provide troughs that are a minimum of 1 foot wide and sloped at a minimum angle of 30 degrees. <u>Materials</u>: 1/8 inch steel plate and common welding. <u>Cost</u>: Less than $500 per unit.
10.4.9 Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	<u>New and Existing POTW's</u> Refer to 10.1.12.

DEFICIENCY	CONSIDERATIONS
10.4.10 Top of sludge chute not large enough to accept all the cake that comes off the dewatering equipment, causing some sludge cake to fall on the floor.	New POTW's Provide flared tops on sludge chutes that are approximately 1 foot longer than the dewatering unit and are as a minimum 1 foot wide. Existing POTW's Method: Provide flared tops on sludge chutes that are approximately one foot longer than the dewatering unit and are as a minimum 1 foot wide. Materials: 1/8 inch steel plate and common welding. Cost: Less than $10,000 per unit.
10.4.11 No provision for chemical addition.	New and Existing POTW's Facilities for conditioning sludge prior to dewatering should be provided. This would include chemical storage, mixing and feeding facilities, and a sludge blending (conditioning) tank. A common chemical feed system can often be used to supply sludge conditioning chemicals to multiple application points (i.e., clarifiers, dewatering equipment) in the POTW. Refer to 10.3.6.
10.4.12 Improper cleaning of filter cloth.	New POTW's Specify that spray nozzles be supplied with equipment to wash the filter cloth after the sludge cake has been discharged. The spray nozzles should be located within 1/2 inch of the cloth to ensure adequate cleaning with a minimum nozzle pressure of 50 psig.

DEFICIENCY	CONSIDERATIONS
	Ensure that heavy water use in other parts of the plant will not come off the same main that feeds the spray nozzles. If municipal water is used, provide booster pumping if necessary to ensure a delivery pressure of at least 50 psig at the spray nozzle.

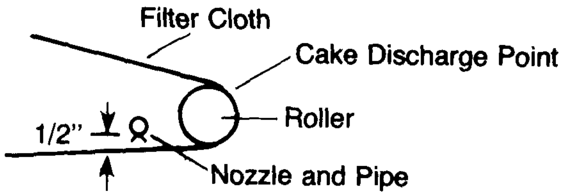
Existing POTW's

Method: Provide spray nozzles to wash off the filter cloth after the sludge cake has been discharged. Locate the spray nozzles within 1/2 inch of the cloth to ensure adequate cleaning with a minimum nozzle pressure of 50 psig.

Materials: Nozzles, 1/2-in. pipe.

Cost: Less than $500 per unit.

Sketch:



10.4.13 Improper selection of filter media.	New and Existing POTW's Conduct laboratory testing to determine the solids retention characteristics of various filter media. Select equipment that allows for simple replacement of filter media in the event that sludge properties and/or conditioning chemicals are changed during operation.
10.4.14 Inadequate sizing of dewatered sludge conveyor.	New and Existing POTW's There are three considerations for design of sludge conveyors. The first is that conveyor capacity

DEFICIENCY	CONSIDERATIONS
	must be adequate to transport the mass flow of sludge which will be produced by the dewatering equipment. Second, the conveyor system must provide adequate freeboard to prevent spillage from uneven placement of the sludge on the conveyor. Third, the conveyor must provide for adequate entrapment of the material as it is released from the dewatering equipment. The latter considerations are best served by making sectional drawings of the relative placement of the dewatering equipment and the conveyor to ensure that adequate freeboard and entrapment are available. Refer to 10.4.3.
10.4.15 Insufficient number of floor drains around dewatering equipment.	<u>New and Existing POTW's</u> Locate floor drains such that, in the event of an overflow of the conditioning tank or vacuum filter feed tank, the flow will be directed to a nearby floor drain. Refer to 10.1.16.
10.4.16 Drain lines from filter vats are too small and become clogged.	<u>New and Existing POTW's</u> Specify all floor drains and drains from filter vats are a minimum of 4 inches in diameter and contain as few bends and connections as possible. Provide clean-outs and flushing taps in the drain lines.
10.4.17 Spray water systems exhibit clogging problems.	<u>New and Existing POTW's</u> If the spray water source is municipal water, measure alkalinity, calcium, and pH to ensure the water is stable. If the water is unstable, recarbonate prior to use to prevent calcium carbonate deposition in the spray water system.

DEFICIENCY	CONSIDERATIONS
	If treatment plant effluent is used for spray water, provide a cartridge filtration system ahead of the spray water system.
10.4.18 Poor cake release.	New and Existing POTW's Poor cake release is usually due to an improper choice of filter media or inadequate sludge conditioning. Refer to 10.4.11 and 10.4.13.
10.4.19 Inadequate provisions for cleaning of filtrate/centrate lines.	New and Existing POTW's Provide for clean-up or access to all parts of filtrate lines and provide for valved crossed connection between spray water system and filtrate lines to allow for high-pressure cleaning of lines when the equipment is not in use.
10.4.20 Inadequate removal of cake from filter media.	New and Existing POTW's Specify that the doctor blade be easily adjustable to the surface of the filter media. Refer to 10.4.12.
10.4.21 Filtrate pumps frequently become air bound.	New and Existing POTW's Provide for recirculation of pump discharge to the filtrate tank to maintain a sufficient level to preclude air binding.
10.4.22 Improper use of needle valves in hydraulic drives, resulting in overheatings.	New POTW's Do not specify needle valves or hydraulic drives. Existing POTW's Method: Replace needle valves or hydraulic drives with ball valves.

DEFICIENCY	CONSIDERATIONS
10.4.23 No provision for remote speed control on sludge pumps, chemical pumps, vacuum filter drive, etc., from a central location.	New and Existing POTW's Consider providing a dewatering equipment layout, such that a single operator may operate and control all components of the dewatering system from one location. Give special consideration to sludge feed pumps from remote thickeners and/or wasting lines.
10.4.24 Inadequate provisions for lifting equipment for repairs.	New POTW's Provide sufficient overhead clearance (at least 20 feet) and sufficient lifting capacity hoists (at least 4 tons) to remove any motors, pumps, and drives that may become damaged and require replacement. Existing POTW's Method: Lease or buy portable gantry equipment.

Unit Operation/Component: 10.5 Centrifuges

10.5.1 Truck loading areas not covered or protected from freezing conditions.	New and Existing POTW's Refer to 10.1.1.
10.5.2 Inadequate access provided to sample filtrate/centrate streams.	New and Existing POTW's Refer to 10.1.4.
10.5.3 Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosion rates.	New and Existing POTW's Refer to 10.1.5.
10.5.4 Lack of preliminary treatment prior to a disc-nozzle centrifuge.	New and Existing POTW's Abrasive solids such as grit and sand must be removed from the sludge generating stream prior to a nozzle

DEFICIENCY	CONSIDERATIONS
	centrifuge to prevent frequent replacement of nozzles. Nozzle centrifuges in general are not suitable for primary sludges nor for secondary sludge unless influent screening, aerated grit removal, and primary sedimentation are provided.
10.5.5 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	New and Existing POTW's Refer to 10.1.6.
10.5.6 Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	New and Existing POTW's Refer to 10.1.9.
10.5.7 Lack of flow meters on sludge feed lines to multiple pieces of equipment.	New and Existing POTW's Refer to 10.1.12.
10.5.8 No provision for chemical addition.	New and Existing POTW's Refer to 10.4.11.
10.5.9 Inadequate sizing of dewatered sludge conveyor.	New and Existing POTW's Refer to 10.4.14.
10.5.10 Inadequate consideration of corrosive nature of materials to be handled.	New and Existing POTW's Refer to 10.1.15.
10.5.11 Insufficient number of floor drains around dewatering equipment.	New and Existing POTW's Refer to 10.4.15.

DEFICIENCY	CONSIDERATIONS
10.5.12 Inadequate provisions for vibration control in sludge piping design.	New and Existing POTW's Isolate centrifuges from rigid piping by a flexible connector to ensure that centrifuge vibration does not cause damage to the pipes. Ensure that the flexible connectors are compatible with the abrasive and corrosive properties of the material to be handled. Refer to 10.1.21.
10.5.13 Inadequate grit removal results in excess corrosion.	New and Existing POTW's Refer to 10.5.4.
10.5.14 Inadequate treatment of flushing water results in plugged nozzles.	New and Existing POTW's Refer to 10.4.17.
10.5.15 Inadequate provisions for cleaning the filtrate/centrate lines.	New and Existing POTW's Refer to 10.4.19.
10.5.16 No provisions for remote speed control on sludge pumps, chemical pumps, vacuum filter drive, etc., from a central location.	New and Existing POTW's Refer to 10.4.23.
10.5.17 Inadequate provisions for lifting equipment for repairs.	New and Existing POTW's Refer to 10.4.24.

Unit Operation/Component: 10.6 Filter Presses

10.6.1 Truck loading area not covered or protected from freezing conditions.	New POTW's Refer to 10.1.1.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 10.4.1.
10.6.2 Excessive cake discharge height results in severe sludge splashing.	New POTW's Refer to 10.1.3.
	Existing POTW's Method: Refer to 10.4.3.
10.6.3 Inadequate access provided to sample filtrate/centrate streams.	New and Existing POTW's Refer to 10.1.4.
10.6.4 Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosive rates.	New and Existing POTW's Refer to 10.1.5.
10.6.5 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	New and Existing POTW's Refer to 10.1.6.
10.6.6 Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	New and Existing POTW's Refer to 10.1.9.
10.6.7 Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	New and Existing POTW's Refer to 10.1.12.

DEFICIENCY	CONSIDERATIONS
10.6.8 Top of sludge chute not large enough to accept all the cake that comes off the dewatering equipment, causing some sludge cake to fall to the floor.	New and Existing POTW's Refer to 10.4.10.
10.6.9 No provision for chemical addition.	New and Existing POTW's Refer to 10.4.11.
10.6.10 Improper cleaning of filter cloth.	New and Existing POTW's Refer to 10.4.12.
10.6.11 Improper selection of filter media.	New and Existing POTW's Refer to 10.4.13.
10.6.12 Inadequate sizing of dewatered sludge conveyor.	New and Existing POTW's Refer to 10.4.14.
10.6.13 Insufficient number of floor drains around dewatering equipment.	New and Existing POTW's Refer to 10.1.16.
10.6.14 Spray water systems exhibit clogging problems.	New and Existing POTW's Refer to 10.4.17.
10.6.15 Poor cake release.	New POTW's Refer to 10.4.18. Existing POTW's Method: Increase mechanical vibration. Manually clear each filter cell as it opens. Refer to 10.4.18.
10.6.16 Inadequate provisions for cleaning of filtrate/centrate lines.	New and Existing POTW's Refer to 10.4.19.

DEFICIENCY	CONSIDERATIONS
10.6.17 Inadequate removal of cake from filter media.	New POTW's Provide a safety (electric-eye) curtain to allow operator to manually clean plates with a paddle during the press cake-release cycle. Refer to 10.4.18. Existing POTW's Method: Provide wash water connections to filter feed line and run filter through a cleaning cycle. Manually backwash each cell with high-pressure water. Refer to 10.6.15.
10.6.18 No provision for remote speed control on sludge pumps, chemical pumps, vacuum filter drives, etc., from a central location.	New and Existing POTW's Refer to 10.4.23.
10.6.19 Inadequate provisions for lifting equipment for repairs.	New and Existing POTW's Refer to 10.4.24.

Unit Operation/Component: 10.7 Belt Filters

10.7.1 Truck loading areas not covered or protected from freezing conditions.	New and Existing POTW's Refer to 10.1.1.
10.7.2 Vacuum valves on equipment are inaccessible.	New and Existing POTW's Refer to 10.4.2.
10.7.3 Excessive cake discharge height results in severe sludge splashing.	New and Existing POTW's Refer to 10.1.3.

DEFICIENCY	CONSIDERATIONS
10.7.4 Inadequate access provided to sample filtrate/centrate streams.	New and Existing POTW's Refer to 10.1.4.
10.7.5 Improper placement of control panels in spray/splash areas hampers clean-up and results in abnormally high corrosion rates.	New and Existing POTW's Refer to 10.1.5.
10.7.6 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	New and Existing POTW's Refer to 10.1.6.
10.7.7 Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	New and Existing POTW's Refer to 10.1.9.
10.7.8 Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	New and Existing POTW's Refer to 10.1.12.
10.7.9 Top of sludge chute not large enough to accept all cake that comes off the dewatering equipment, causing some sludge cake to fall on the floor.	New and Existing POTW's Refer to 10.4.10.
10.7.10 No provision for chemical addition.	New and Existing POTW's Refer to 10.4.11.

DEFICIENCY	CONSIDERATIONS
10.7.11 Improper cleaning of filter cloth.	New and Existing POTW's Refer to 10.4.12.
10.7.12 Improper selection of filter media.	New and Existing POTW's Refer to 10.4.13.
10.7.13 Inadequate sizing of dewatered sludge conveyor.	New and Existing POTW's Refer to 10.4.14.
10.7.14 Insufficient number of floor drains around dewatering equipment.	New and Existing POTW's Refer to 10.1.16 and 10.4.15.
10.7.15 Drain lines from filter vats are too small and become clogged.	New and Existing POTW's Refer to 10.4.16.
10.7.16 Spray water systems exhibit clogging problems.	New and Existing POTW's Refer to 10.4.17.
10.7.17 Poor cake release.	New and Existing POTW's Refer to 10.4.18.
10.7.18 Inadequate provisions for cleaning of filtrate/centrate lines.	New and Existing POTW's Refer to 10.4.19.
10.7.19 Inadequate removal of cake from filter media.	New and Existing POTW's Refer to 10.4.20.
10.7.20 Filtrate pumps frequently become air bound.	New and Existing POTW's Refer to 10.4.21.
10.7.21 No provisions for remote speed control on sludge pumps, chemical pumps, vacuum filter drives, etc., from a central location.	New and Existing POTW's Refer to 10.4.23.

DEFICIENCY	CONSIDERATIONS
10.7.22 Inadequate provisions for lifting equipment for repairs.	New and Existing POTW's Refer to 10.4.24.

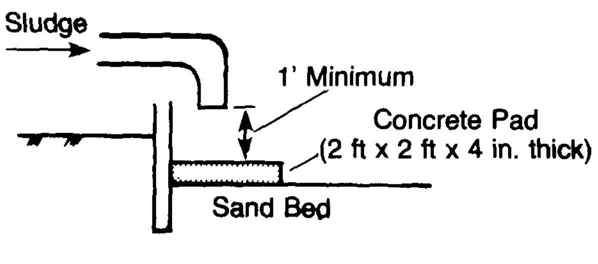
Unit Operation/Component: 10.8 Sludge Drying Beds

10.8.1 Inadequate drainage system.	New and Existing POTW's Provide for minimum of 4-inch diameter drain piping laid at a minimum slope of 1 percent with a maximum spacing of 20 feet between underdrains.
10.8.2 No provisions for cake removal from sand bed.	New and Existing POTW's Provide roadway access along at least one edge of all beds. Also, provide concrete truck tracks at 20-foot centers in all beds.
10.8.3 Inadequate provisions for proper sludge distribution.	New POTW's Specify that bed surfaces are to be level. The influent pipe should terminate at least 1 foot above the surface, and one influent pipe should feed no more than 1,000 square feed of bed.

Existing POTW's

Method: Level bed surfaces. Terminate the influent pipe one foot above the bed surface. Use one influent pipe per 1,000 square feet of bed. Use concrete splash pads under pipe.

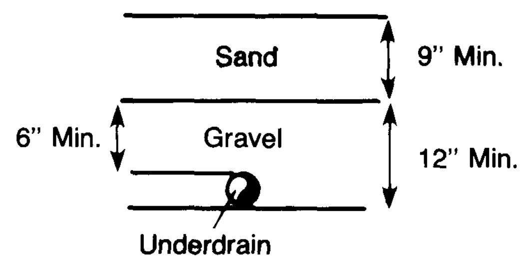
Sketch:



DEFICIENCY	CONSIDERATIONS
10.8.4 Inadequate layout of underdrains.	New and Existing POTW's Refer to 10.8.1.
10.8.5 Improper location of sand bed allows inflow of surface drainage.	New POTW's Outer walls of sand bed should be curbed to prevent soil from washing onto the beds and to divert runoff away from the sand bed area. Existing POTW's Method: Raise the outer walls of the sand bed to prevent soil from washing onto the beds and to divert runoff away from the sand bed area.
10.8.6 Inadequate consideration of potential flooding of sand bed.	New and Existing POTW's Ensure that no portion of the sand bed is within the 100-yr flood plain of nearby waterways. As a minimum, provide adequate diversion channels to prevent bed flooding during the 1-hr, 10-yr storm event.
10.8.7 Lack of operational flexibility and consideration of need for back-up unit during periods of maintenance.	New and Existing POTW's Refer to 10.1.6.
10.8.8 Improper sand gradation.	New POTW's The bed should consist of 6 to 9 inches of sand which has an effective size of 0.3 to 1.2 mil and a uniformity coefficient of less than 0.5. The sand should be placed over 12 to 18 inches of gravel. The top three inches shall consist of 1/8 to 1/4 inch gravel. The gravel shall extend at least 6 inches above the top of the underdrain and be at least 12 inches deep.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Replace existing sand with 9 inches of sand which has an effective size of 0.3 to 1.2 mil and a uniformity coefficient of less than 0.5. Place the sand over 12 to 18 inches of gravel. The top three inches shall consist of 1/8 to 1/4 inch gravel. The gravel shall extend at least six inches above the top of the underdrain and be at least 12 inches deep. Use 1/8 to 1/4 inch gravel.

Sketch:



DEFICIENCY	CONSIDERATIONS
10.8.9 Walls dividing sludge drying beds are made of untreated wood and warp rapidly.	New and Existing POTW's Require pressure-treated lumber for sand drying bed separation barriers.
10.8.10 Inadequate freeze protection.	New POTW's In cold-weather climates, covers should be specified and/or seasonal sludge drying should be considered. In the event seasonal sludge drying is selected, provide adequate sludge storage for at least the 10-yr freezing weather events. Existing POTW's Method: Either install a sludge storage facility for seasonal drying or cover beds.

DEFICIENCY	CONSIDERATIONS
	Materials: Glass, framing members.
10.8.11 Inadequate consideration of local climate on dewatering rate and size requirements for sand beds.	New POTW's Approximately 50 percent of precipitation evaporates from open sand drying beds with the remainder adding to the hydraulic load to the sand bed. The design load to the bed should include consideration of maximum monthly rainfall as an added load. Existing POTW's Method: Expand the bed to include 50 percent of the expected precipitation in design load.

Unit Operation/Component: 10.9 Sludge Transfer

DEFICIENCY	CONSIDERATIONS
10.9.1 Truck loading areas not covered or protected from freezing conditions.	New and Existing POTW's Refer to 10.1.1.
10.9.2 Improper conveyor operating angle.	New POTW's To prevent rolling of the sludge along the conveyor during transfer, ensure that no conveyor angle is greater than 30^{o}. Existing POTW's Method: Reduce the conveyor angle to 30 percent or install a flighted conveyor.
10.9.3 Excessive cake discharge height results in severe sludge splashing.	New and Existing POTW's Refer to 10.1.3.
10.9.4 Inadequate consideration of storage of dewatered sludge during inclement weather.	New and Existing POTW's Refer to 10.1.8.

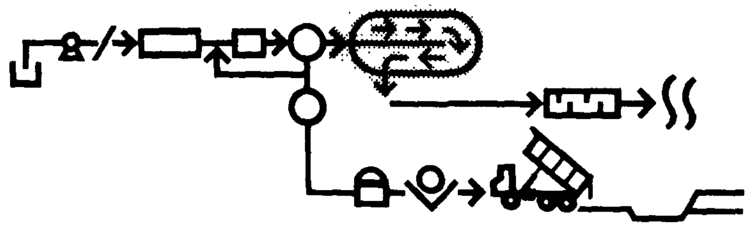
DEFICIENCY	CONSIDERATIONS
10.9.5 Elevated equipment such as conveyors and chemical storage bins are inaccessible for inspection and maintenance.	New and Existing POTW's Refer to 10.1.9.
10.9.6 Lack of flow meters on sludge feed lines to multiple pieces of dewatering equipment.	New and Existing POTW's Refer to 10.1.12.
10.9.7 Top of sludge chute not large enough to accept all the cake that comes off the dewatering equipment, causing some sludge cake to fall on the floor.	New and Existing POTW's Refer to 10.4.10.
10.9.8 Insufficient conveyor skirt length, resulting in severe splashing.	New and Existing POTW's Provide a minimum of one foot of freeboard above the maximum expected sludge level on the conveyor. Refer to 10.1.3 and 10.1.14.
10.9.9 No flushing facilities provided for sludge transfer or feed pumps.	New and Existing POTW's Refer to 10.1.14 and 10.4.19.
10.9.10 No drains provided on elevated sections of conveyor drip pans.	New and Existing POTW's Ensure that all sections of conveyors have drip pans with a minimum of 4-inch drain lines to floor drains.
10.9.11 Inadequate sizing of dewatered sludge conveyor.	New and Existing POTW's Refer to 10.4.14.
10.9.12 Inadequate consideration of potential plugging problems in sludge piping.	New and Existing POTW's Refer to 10.1.14.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 10.10 Sludge Conditioning	
10.10.1 Inability to feed chemicals to both sides of a tank that can be baffled into two separate tanks.	New and Existing POTW's Refer to 10.1.2.
10.10.2 Insufficient provisions for storage of chemicals.	New and Existing POTW's Refer to 10.1.7.
10.10.3 No provision for dust collection when using powdered conditioning agents.	New and Existing POTW's Enclose the conditioning system and provide forced ventilation to an air filtering system with a minimum of six air changes per hour to the conditioning system.
10.10.4 No provision for chemical addition.	New and Existing POTW's Refer to 10.2.3 and 10.4.11.
10.10.5 Tank drain lines are located 2" to 3" off bottom of tanks, making it difficult to dewater them.	New and Existing POTW's Refer to 10.1.17.
10.10.6 Chemical feed line and pH probe are located close together, causing erroneous and/or cyclic readings.	New and Existing POTW's Refer to 10.1.18.
10.10.7 Clogging problems in lime piping.	New and Existing POTW's Refer to 10.1.19.
10.10.8 Excessive agitation in chemical conditioning tanks causes floc to shear.	New and Existing POTW's Refer to 10.1.20.

DEFICIENCY	CONSIDERATIONS
10.10.9 No provision for remote speed control on sludge pumps, chemical pumps, vacuum filter drivers, etc., from a central location.	New and Existing POTW's Refer to 10.4.23.

Design Considerations

Category: 11.0 Lagoons



Unit Operation/Component: 11.1 Facultative Ponds

DEFICIENCY	CONSIDERATIONS
11.1.1 Inability of process to meet effluent requirements in winter.	New POTW's During design, use lagoon temperature prediction techniques to ensure that system is designed to meet effluent requirements at lowest predicted winter temperatures. Existing POTW's Method: Provide additional detention time in lagoons by either increasing depth in pond by raising embankment height and/or raising effluent discharge structure, or installing an additional cell. Materials: Consistent with existing structure.
11.1.2 Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	New POTW's Provide lagoon liner that complies with local code regulations, ensuring that the liner can withstand the expected environmental conditions. Consider the potential effects of industrial wastes discharged to the POTW. Existing POTW's Method: Install (or replace existing) liner with one that complies with state requirements. Materials: Based on local requirements, install synthetic, clay, or pavement liner as required.

DEFICIENCY	CONSIDERATIONS
11.1.3 No provision to vary liquid depth for mosquito control in lagoon.	New POTW's Specify a variable height discharge structure to allow depth adjustments. Existing POTW's Method: Install an adjustable effluent weir to allow control of the pond liquid depth.
11.1.4 Single point entry into pond overloads pond in feed zone.	New and Existing POTW's Provide multiple entry points into pond to reduce the potential for organic overloading in isolated zones of the pond.
11.1.5 Lack of multiple cells for operating flexibility.	New POTW's Provide two or more ponds rather than one large pond to allow the operational flexibility of series versus parallel operation. Existing POTW's Method: Divide existing cell into two basins if construction of earthen dike will not reduce usable lagoon below that required for efficient operation. Alternately, install bulkhead wall or construct an additional cell, particularly if effluent quality is unacceptable or marginally acceptable.
11.1.6 Anaerobic conditions due to organic overloading.	New POTW's Consider the potential effects (i.e., oxygen demand, pH, toxicity, etc.) of industrial discharges to the POTW. Ensure that sufficient oxygen is available from algal production and oxygen transfer at the water surface to sustain aerobic conditions in surface portions. Existing POTW's Method: Enlarge pond volume to reduce organic loading rate.

DEFICIENCY	CONSIDERATIONS
	Materials: Consistent with existing construction.
11.1.7 No drain provided in lagoon.	New POTW's Specify a drain to allow emptying of the pond. Alternately, construct an effluent control mechanism to permit pond dewatering. Existing POTW's Method: Install drain in lagoon. Alternately, install siphon to allow drainage of pond.
11.1.8 Water level gauges not provided.	New and Existing POTW's Provide either float level gauges or noncontact (i.e., ultrasonic) level gauges.
11.1.9 Improper depth between lagoon bottom and groundwater table.	New and Existing POTW's Ensure that an unlined lagoon bottom is above the seasonal high groundwater table; utilize above-ground dikes, if necessary. For a lined lagoon, provide a groundwater interception and collection system.
11.1.10 No groundwater monitoring wells provided.	New and Existing POTW's Specify groundwater monitoring wells be located around the pond.

Unit Operation/Component: 11.2 Aerated Ponds

11.2.1 Inability of process to meet effluent requirements in winter.	New and Existing POTW's Refer to 11.1.1.
11.2.2 Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	New and Existing POTW's Refer to 11.1.2.

DEFICIENCY	CONSIDERATIONS
11.2.3 No provision to vary liquid depth for mosquito control in lagoon.	New and Existing POTW's Refer to 11.1.3.
11.2.4 Single-point entry pond overloads pond in feed zone.	New and Existing POTW's Refer to 11.1.4.
11.2.5 Lack of multiple cells for operating flexibility.	New and Existing POTW's Refer to 11.1.5.
11.2.6 Anaerobic conditions due to organic overloading.	New POTW's Ensure that sufficient oxygen is provided (typically 0.8 to 1.2 lb O_2/lb BOD_5). Refer to 11.1.6. Existing POTW's Method: Increase the capacity (i.e., horsepower) of the existing aeration system. If industrial discharges are contributing to organic overload conditions, formulate pretreatment regulations and implement them.
11.2.7 Complete mixing problems.	New POTW's When sizing aerators, consider the horsepower requirements to keep suspended solids from settling. Also, consider the horsepower requirements for oxygen demand. Existing POTW's Method: For surface mechanical aerators, increase the size of existing units or install additional aerators. For diffused aeration, first determine whether sufficient air supply exists. If so, install additional diffusers. If sufficient air supply does not exist, increase the size or number of blowers.
11.2.8 No drain provided in lagoon.	New and Existing POTW's Refer to 11.1.7.

DEFICIENCY	CONSIDERATIONS
11.2.9 Water level gauges not provided.	New and Existing POTW's Refer to 11.1.8.
11.2.10 Improper depth between lagoon bottom and groundwater table.	New and Existing POTW's Refer to 11.1.9.
11.2.11 No groundwater monitoring wells provided.	New and Existing POTW's Refer to 11.1.10.

Unit Operation/Component: 11.3 Aerobic Ponds

DEFICIENCY	CONSIDERATIONS
11.3.1 Inability of process to meet effluent requirements in winter.	New and Existing POTW's Refer to 11.1.1.
11.3.2 Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	New and Existing POTW's Refer to 11.1.2.
11.3.3 No provision to vary liquid depth for mosquito control in lagoon.	New and Existing POTW's Refer to 11.1.3.
11.3.4 Single-point entry into pond overloads pond in feed zone.	New and Existing POTW's Refer to 11.1.4.
11.3.5 Lack of multiple cells for operating flexibility.	New and Existing POTW's Refer to 11.1.5.
11.3.6 Anaerobic conditions due to organic overloading.	New POTW's Consider the potential effects (i.e., oxygen demand, pH, toxicity, etc.) of industrial waste discharges. Ensure that sufficient oxygen is available from algal production and oxygen transfer at the water surface to sustain aerobic conditions throughout the water column.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Increase usable volume of pond by increasing height of embankments and/or increasing discharge structure height. Alternately, consider addition of increasing oxygenation capacity through pumpage or installation of an aeration system.
11.3.7 No drain provided in lagoon.	New and Existing POTW's Refer to 11.1.7.
11.3.8 Water level gauges not provided.	New and Existing POTW's Refer to 11.1.8.
11.3.9 Improper depth between lagoon bottom and groundwater table.	New and Existing POTW's Refer to 11.1.9.
11.3.10 No groundwater monitoring wells provided.	New and Existing POTW's Refer to 11.1.10.

Unit Operation/Component: 11.4 Polishing Ponds

DEFICIENCY	CONSIDERATIONS
11.4.1 Inability of process to meet effluent requirements in winter.	New and Existing POTW's Refer to 11.1.1.
11.4.2 Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	New and Existing POTW's Refer to 11.1.2.
11.4.3 No provision to vary liquid depth for mosquito control in lagoon.	New and Existing POTW's Refer to 11.1.3.
11.4.4 Single-point entry into pond overloads pond in feed zone.	New and Existing POTW's Refer to 11.1.4.

DEFICIENCY	CONSIDERATIONS
11.4.5 Lack of multiple cells for operating flexibility.	New and Existing POTW's Refer to 11.1.5.
11.4.6 Anaerobic conditions due to organic overloading.	New and Existing POTW's Refer to 11.1.6.
11.4.7 No drain provided in lagoon.	New and Existing POTW's Refer to 11.1.7.
11.4.8 Water level gauges not provided.	New and Existing POTW's Refer to 11.1.8.
11.4.9 Improper depth between lagoon bottom and groundwater table.	New and Existing POTW's Refer to 11.1.9.
11.4.10 No groundwater monitoring wells provided.	New and Existing POTW's Refer to 11.1.10.

Unit Operation/Component: 11.5 Anaerobic Ponds

DEFICIENCY	CONSIDERATIONS
11.5.1 Inability of process to meet effluent requirements in winter.	New and Existing POTW's Refer to 11.1.1.
11.5.2 Inadequate (or lack of) liner to meet state requirements, and to prevent groundwater pollution.	New and Existing POTW's Refer to 11.1.2.
11.5.3 No provision to vary liquid depth for mosquito control in lagoon.	New and Existing POTW's Refer to 11.1.3.
11.5.4 Single-point entry into pond overloads pond in feed zone.	New and Existing POTW's Refer to 11.1.4.

DEFICIENCY	CONSIDERATIONS
11.5.5 Lack of multiple cells for operating flexibility.	New and Existing POTW's Refer to 11.1.5.
11.5.6 No drain provided in lagoon.	New and Existing POTW's Refer to 11.1.7.
11.5.7 Water level gauges not provided.	New and Existing POTW's Refer to 11.1.8.
11.5.8 Improper depth between lagoon bottom and groundwater table.	New and Existing POTW's Refer to 11.1.9.
11.5.9 No groundwater monitoring wells provided.	New and Existing POTW's Refer to 11.1.10.

Unit Operation/Component: 11.6 Baffles

11.6.1 No provision to vary liquid depth for mosquito control in lagoon.	New and Existing POTW's Ensure that baffles will be effective regardless of liquid level. Refer to 11.1.3.
11.6.2 Short circuiting.	New POTW's In small unmixed ponds, consider barrier walls with orifices. In larger unmixed tanks, consider parallel baffles for end-around (plug) flow. Existing POTW's Method: Perform dye tests to first determine type of short circuiting present. Next, install baffles in proper locations to minimize short circuiting.
11.6.3 Inadequate erosion control measures.	New and Existing POTW's Consider installation of baffles near dikes to dissipate wave energy and to minimize erosion.

DEFICIENCY	CONSIDERATIONS
11.6.4 Inadequate freeze protection.	New and Existing POTW's Provide removable or floating baffles to minimize damage caused by ice cover.

Unit Operation/Component: 11.7 Recirculation Pumps

11.7.1 Control inflexibilities.	New and Existing POTW's Make provisions for parallel and series operation for both intercellular recirculation for maximum operator flexibility.
11.7.2 Inadequate dissolved oxygen control.	New and Existing POTW's Connect recirculation pumps to dissolved oxygen meter/controller to allow automatic cycling of pump.
11.7.3 Anaerobic conditions due to organic overloading.	New and Existing POTW's Provide intercellular recirculation to reduce organic overloading in the overloaded cell.
11.7.4 Complete mixing problems.	New and Existing POTW's Provide a recirculation rate up to eight times the forward flow.
11.7.5 Inability to control and adjust recirculation rate.	New and Existing POTW's Where possible, install flow control valves on discharge side of recirculation pump to allow decreased flow. Alternately, install a time system to allow automatic on/off operation or provide variable speed pumps.

Unit Operation/Component: 11.8 Pond Configuration

11.8.1 Lack of multiple cells for operating flexibility.	New and Existing POTW's Refer to 11.1.5.

DEFICIENCY	CONSIDERATIONS
11.8.2 Control inflexibilities.	New and Existing POTW's Provide multiple cells with provisions for depth control and recirculation control. Refer to 11.7.1.
11.8.3 Anaerobic conditions due to organic overloading.	New and Existing POTW's Provide sufficient area, multiple cells, and intercellular recirculation to minimize anaerobic conditions.
11.8.4 Inadequate sludge storage.	New and Existing POTW's Include provisions for periodic sludge removal in facultative and anaerobic ponds. In aerated ponds, provide additional sludge storage if adequate storage is not provided in clarifier.
11.8.5 Short circuiting.	New and Existing POTW's Refer to 11.6.2.
11.8.6 Odor problems.	New and Existing POTW's Provide grass sod or asphalt slope protection. Ease of cleaning will lower odor potential. Provide rounded corners to minimize scum and grease accumulation.
11.8.7 Inadequate freeze protection.	New and Existing POTW's For aerated ponds, increase depth to minimize heat loss. Provide at least a 3-ft freeboard to act as a wind barrier.

Unit Operation/Component: 11.9 Aerators

DEFICIENCY	CONSIDERATIONS
11.9.1 Inadequate D.O. control.	New and Existing POTW's Utilize D.O. meter/controller in conjunction with aerators to maximize aerator and removal efficiencies.
11.9.2 Complete mixing problems.	New POTW's Refer to 11.2.7.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: First, perform dye tests to isolate dead zones. Then, install additional aerators in dead spots in tanks to ensure complete mixing. Refer to 11.2.7.
11.9.3 Inadequate freeze protection.	New and Existing POTW's For floating aerators, specify aerators with ice shields. For fixed aerators, specify spray shields and ensure that support structures can withstand ice-induced loads.

Unit Operation/Component: 11.10 Dikes

DEFICIENCY	CONSIDERATIONS
11.10.1 Dike widths too small for maintenance vehicles.	New and Existing POTW's Size dike roads according to the maintenance requirements expected. For pickups, trucks, backhoes, bucket cranes, tank/pump trucks, etc., a 10-ft minimum width is recommended.
11.10.2 Inadequate erosion control measures.	New and Existing POTW's Utilize 4 to 5:1 grassed outer embankment slopes. Utilize 2 to 3:1 inner dike slopes. For side slopes, utilize rip-rap, lining, or pavement to minimize erosion. If the pond is aerated, provide concrete pads or crushed stone beneath aerators to minimize erosion. Make provisions for erosion control at influent and effluent ends of ponds.
11.10.3 Improper seeding of dikes (long root plants used that eventually damage the dike).	New and Existing POTW's Plant perennial grasses on the dike embankments. Ensure that grasses selected are not deep-rooted to minimize root damage to the embankment.
11.10.4 Rodent problems.	New and Existing POTW's Provide means for altering lagoon level rapidly and long term to discourage muskrat tunneling. Provide

DEFICIENCY	CONSIDERATIONS
	4 to 5:1 outer embankment slopes to allow for mowing.

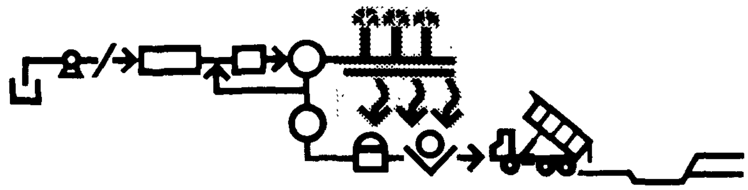
Unit Operation/Component: 11.11 Primary Cell

DEFICIENCY	CONSIDERATIONS
11.11.1 No provision to vary liquid depth for mosquito control in lagoon.	<u>New and Existing POTW's</u> Refer to 11.1.3.
11.11.2 Anaerobic conditions due to organic overloading.	<u>New and Existing POTW's</u> Consider potential effects (i.e., oxygen demand, pH, toxicity, etc.) of industrial waste discharge. Ensure that oxygen generated by algae and oxygen transferred at the surface are sufficient to supply oxygen to bacteria degrading wastes and to supply oxygen caused by degrading sludge on tank bottom. Refer to 11.1.6.
11.11.3 Inadequate sludge storage.	<u>New and Existing POTW's</u> Provide adjustable discharge weir and sufficient pond depth to increase water level and, hence, sludge storage capacity. Refer to 11.8.4.

Unit Operation/Component: 11.12 General

DEFICIENCY	CONSIDERATIONS
11.12.1 Pond located too close to residential areas.	<u>New POTW's</u> Review site plan for a location better situated in relation to residential areas. Consider distance, wind direction, groundwater flow direction, altitude, etc. <u>Existing POTW's</u> <u>Method</u>: Make the following provisions in design to overcome nuisance factors: • Install yard hydrants to increase clean-up capability.

DEFICIENCY	CONSIDERATIONS
	• Increase aeration if anaerobic conditions are a problem. • Install/upgrade recirculation pumps. • Provide additional cell volume. • Provide odor masking agent.
11.12.2 Inadequate erosion control measures.	New and Existing POTW's Refer to 11.10.2.
11.12.3 Water level gauges not provided.	New and Existing POTW's Refer to 11.1.8.
11.12.4 No groundwater monitoring wells provided.	New and Existing POTW's Refer to 11.1.10.
11.12.5 No fence or all-weather road provided.	New and Existing POTW's Unless plant is inaccessible, provide fencing. Provide all-weather road capable of supporting the largest vehicle expected at the site.

Design Considerations **Category:** 12.0 Land Application	
Unit Operation/Component: 12.1 Overland Flow Slope Design	

DEFICIENCY	CONSIDERATIONS
12.1.1 Improper slope construction.	New POTW's Specify slopes be within the range of 2 to 8 percent, with 2 to 6 percent the preferred range. Existing POTW's Method: Regrade slope to within 2 to 6 pecent of grade if the existing grade does not allow for suitable operation.
12.1.2 Inadequate detention time on slope to achieve desired level of treatment.	New and Existing POTW's Provide 150- to 300-foot long slopes to allow for sufficient detention time. In addition, make provisions for series operation of slopes.
12.1.3 Inappropriate location of land treatment plots.	New POTW's Overland flow technique requires slowly-permeable soils, such as clays and clay loams. Existing POTW's Method: If soil types are incorrect, consider excavation and/or soil importation.
12.1.4 Inadequate soil depth for suitable land treatment.	New POTW's Although soil depth is not an extremely-important variable in overland flow design, ensure a minimum 2-foot depth to groundwater level so

DEFICIENCY	CONSIDERATIONS
	that the root zone is not waterlogged. Existing POTW's Method: If more soil depth is required, bring soil in (if hydraulics permit) or consider underdraining of site.
12.1.5 Inadequate site loading for optimum treatment.	New and Existing POTW's Ensure that sufficient organic loading is imparted to the site to maintain a healthy, biological community. A loading range from 14 to 100 lb BOD_5/acre/day is typically used.
12.1.6 Inadequate shaping of drainage channels for efficient system operation.	New and Existing POTW's Shape drainage channels to provide sufficient velocity (1 to 2 fps) to maintain solids in suspension under normal operation, but do not impart excessive velocity that causes scour and erosion problems during rainfall runoff events.
12.1.7 Improper selection of maintenance equipment to minimize soil compaction.	New POTW's Select maintenance equipment with flotation tires to minimize soil compaction. Existing POTW's Method: If existing equipment does not have flotation tires, install flotation tires. Alternatively, consider utilizing dual wheels on equipment.

Unit Operation/Component: 12.2 Buffer Zone

DEFICIENCY	CONSIDERATIONS
12.2.1 Inadequate location of service roads.	New and Existing POTW's Consider installation of all-weather service roads within the buffer zone, thereby reducing the entire land area requirement.

DEFICIENCY	CONSIDERATIONS
12.2.2 Inadequate perimeter fencing for public safety.	New and Existing POTW's Unless the land application site is located in a remote area away from population centers, provide perimeter fencing to limit access to site.
12.2.3 Inadequate posting of signs identifying hazards.	New and Existing POTW's Place signs along perimeter of site to notify the public of hazards associated with entry into the site.
12.2.4 Aerosol drift to neighboring land.	New and Existing POTW's Aerosols may drift 100 to 600 feet off the site. Minimize health risks by: • Limiting public access to a site. • Properly sizing the irrigated area in relation to surrounding communities and lands. • Providing buffer zones and/or plantings around the site. • Considering local climatic conditions such as prevailing wind directions when siting a land application facility.

Unit Operation/Component: 12.3 Cover Crop

12.3.1 Inadequate detention time on slope to achieve desired level of treatment.	New and Existing POTW's Refer to 12.1.2.
12.3.2 Inadequate site loading for optimum treatment.	New and Existing POTW's Liquid loading rates for the overland flow method vary from 2 to 9 inches per week. Liquid loading rates for

DEFICIENCY	CONSIDERATIONS
	the irrigation method vary from 0.5 to 4.0 inches per week. Refer to 12.1.5.
12.3.3 Improper selection of maintenance equipment to minimize soil compaction.	New and Existing POTW's Refer to 12.1.7.

Unit Operation/Component: 12.4 Hydraulic Acceptance

DEFICIENCY	CONSIDERATIONS
12.4.1 Improper slope construction.	New POTW's Consider both the vertical and horizontal permeability to ensure that, at the given slope (i.e., detention time), the soil can infiltrate the desired volume. Existing POTW's Method: If the soil cannot accept the applied water, consider enlarging the site.
12.4.2 Inadequate soil depth for suitable land treatment.	New POTW's For slow rate infiltration systems, provide a minimum 2 to 3 foot soil depth to the water table. For rapid infiltration, allow 10 feet (lesser depths acceptable if underdrains are provided). Existing POTW's Method: Refer to 12.1.4.
12.4.3 Inadequate site loading for optimum treatment.	New and Existing POTW's Ensure that percolation rates are great enough to supply sufficient organic carbon to the soil microorganism to maintain healthy populations. Typical organic loading rates (lb BOD_5/acre-day) are as follows:

DEFICIENCY	CONSIDERATIONS
	• Slow rate - 10 to 25. • Rapid infiltration - 9 to 57. • Overland flow systems - 14 to 20.
12.4.4 Inadequate knowledge of subsurface drainage alternatives to alleviate drainage problems.	New and Existing POTW's For infiltration systems, ensure that the lower soil horizons have a permeability equal to or greater than the surface horizon. Alternately, install an underdrain collection system.
12.4.5 Improper selection of maintenance equipment to minimize soil compaction.	New and Existing POTW's Refer to 12.1.7.
12.4.6 Inadequate use of data telemetry for efficient operation of the treatment system.	New and Existing POTW's Install instrumentation to monitor liquid levels throughout the land treatment system.
12.4.7 Inadequate type and interaction of soil consideration given to soil with sodium in the wastewater.	New POTW's To minimize clay-bearing soils from dispersing, apply wastewaters with sodium adsorption ratios (SAR) of less than 9 to fine-textured soils. Existing POTW's Method: Have soil and wastewater analyzed for sodium, magnesium, and calcium to determine if sodium is causing problems.

Unit Operation/Component: 12.5 Pretreatment

12.5.1 Spray nozzles plug due to solids in wastewater.	New POTW's Provide for a pretreatment system that will minimize the problem of solids plugging the spray nozzles. The required minimum nozzle size

DEFICIENCY	CONSIDERATIONS
	should be a function of the degree of pretreatment, with increasing treatment for smaller nozzles, if desired.
	Existing POTW's Method: Replace nozzles with larger diameter nozzles able to pass largest solids found in treated wastewater. Ensure that sufficient pressure is available in the system to utilize larger nozzle and still get good wastewater distribution.
12.5.2 Excessive wear on pumps due to sand in wastewater.	New and Existing POTW's Provide for degritting as a minimum and possibly primary clarification as part of the pretreatment process.
12.5.3 Inappropriate location of storage facilities for optimum energy utilization.	New POTW's If possible, storage facilities should be located down-gradient from the pretreatment system to eliminate any unnecessary pumping.
	Existing POTW's Method: If any subsequent expansion of land application site or storage lagoons is required, consider the possibility of gravity flow.
12.5.4 Inadequate provisions for by-passing flow during maintenance.	New and Existing POTW's Provide for parallel treatment units so that flow can be temporarily diverted to one while the other is down for maintenance.
12.5.5 Inadequate construction of lagoons for maintenance and sludge removal.	New POTW's As a minimum, provide an eight-foot wide embankment for maintenance vehicles. Provide inner slopes of 4 or 5:1 for accessibility by maintenance vehicles and sludge removal equipment. If a steeper grade is used, provide an access ramp.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Consider installation of an access ramp to the lagoon to facilitate sludge removal.
12.5.6 Inadequate storage for local weather and its impact on the functioning of the system.	New POTW's Provide adequate storage, especially in cold northern states, for wastewater used for irrigation of annual crops. This may require as much as 4 to 7 months of storage. Take into consideration the annual average temperatures, rainfall, and evaporation. Existing POTW's Method: If existing storage is inadequate, install additional lagoon capacity. Alternately, if hydraulics permit, decrease lagoon freeboard by piping changes and, subsequently, increase sidewater depth.
12.5.7 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Provide pumping facilities for a minimum velocity of 2 fps. Avoid sharp bends and unnecessary valves and fittings. Eliminate low points in system.
12.5.8 Inadequate selection of protective coatings to minimize corrosion.	New and Existing POTW's When specifying paint, be sure to include surface preparation, a good primer coat, and a top coat to be compatible with the primer coat. Consider the use of stainless steel, aluminum, zinc, and plastics. Also, consider a sacrificial anode for cathodic protection.
12.5.9 Insufficient ventilation of pump houses to minimize corrosion potential.	New and Existing POTW's Provide sufficient ventilation to purge wet wells and dry wells of the accumulation of hydrogen sulfide gas and water vapor. Use forced air ventilation for systems over 30 feet below ground.

DEFICIENCY	CONSIDERATIONS
12.5.10 Inadequate methods for servicing lagoon aerators.	New and Existing POTW's Provide cable clamps on mooring lines that can be easily removed. The aerator should be pulled to the near shore, and serviced at that location.
12.5.11 Inadequate design for back-up pumping equipment.	New and Existing POTW's Provide a minimum of one spare pump at all essential pumping locations within the plant.
12.5.12 Improper selection of electrical contacts and machinery for corrosive environments.	New and Existing POTW's Provide an enclosure that is hermetically sealed or continuously purged to keep corrosive gases from reaching electrical contacts.
12.5.13 Inadequate construction of underground wiring.	New and Existing POTW's Provide separate conduits for power and signal wiring. Prevent water from entering electrical manholes or entering into conduits.
12.5.14 Inadequate protection of electrical hardware from voltage surges.	New and Existing POTW's Provide surge protectors.
12.5.15 Inadequate posting of signs identifying hazards.	New and Existing POTW's Provide signs around perimeter of plant to identify the area as a wastewater treatment plant. In addition, place signs near all potentially-dangerous equipment and potentially-dangerous chemical handling areas (e.g., chlorine, ferric chloride, etc). Place "no smoking" signs in areas where explosive gases may accumulate.

Unit Operation/Component: 12.6 Storage

12.6.1 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's Refer to 12.5.3.

DEFICIENCY	CONSIDERATIONS
12.6.2 Inadequate consideration for needs of pre-chlorination or preaeration.	New and Existing POTW's Where long detention times and/or high temperatures are expected, pre-chlorination and/or aeration should be used to minimize odor problems and algae growth.
12.6.3 Inadequate construction of lagoons for maintenance and sludge removal.	New and Existing POTW's Refer to 12.5.5.
12.6.4 Inadequate protection of equipment from freezing conditions.	New POTW's During design, ensure that provisions have been made for protection of pumps, aerators, gates, etc. due to freezing and ice accumulation. Existing POTW's Method: Isolate equipment which is subject to damage by freezing. Next, provide either shelter or, if possible, reinstall equipment so as to make it removable during the cold months of the year.
12.6.5 Inadequate storage for local weather and its impact on the functioning of the system.	New and Existing POTW's Refer to 12.5.6.
12.6.6 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.5.7.
12.6.7 Inadequate methods for servicing lagoon aerators.	New and Existing POTW's Refer to 12.5.10.
12.6.8 Inadequate design for back-up pumping equipment.	New and Existing POTW's Refer to 12.5.11.

DEFICIENCY	CONSIDERATIONS
12.6.9 Inadequate use of data telemetry for efficient operation of the treatment system.	New POTW's Install level probe on all storage ponds, with a meter/recorder in the control room as a minimum. Consider installation of D.O. and pH probes and recorders. Existing POTW's Method: Following consultation with plant operators, install the desired instrumentation.
12.6.10 Inadequate perimeter fencing for public safety.	New and Existing POTW's Fence the perimeter of storage lagoons, especially if the entire perimeter of the treatment plant is not fenced in. Specify 6-ft high chain-link fence with three-strand barbwire top if the plant is in an area easily accessed by the public.

Unit Operation/Component: 12.7 Crop Harvest

DEFICIENCY	CONSIDERATIONS
12.7.1 Improper slope construction.	New POTW's Limit slopes to 20 percent as a maximum to allow for access by farm machinery and eventual harvesting. Existing POTW's Method: If the slope is too steep to permit access by farm and harvest equipment, regrade and terrace site.
12.7.2 Inadequate site loading for optimum treatment.	New and Existing POTW's Provide for optimum liquid loading, especially on irrigation systems where crops are utilized extensively. The range should be 0.5 to 4.0 inches per week with 1.5 inches as the average. Nitrogen, phosphorus, and organic matter must also be controlled. Stop irrigation prior to harvesting to allow for farm machinery access and traction.

DEFICIENCY	CONSIDERATIONS
12.7.3 Inadequate knowledge of subsurface drainage alternatives to alleviate drainage problems.	New and Existing POTW's Install subsurface drainage in poorly-drained soils or when the groundwater level affects water renovation or crop growth. Design the underdrain system after investigating topography of land and the position, level, and annual fluctuation of the groundwater table. Conduct detailed field investigations prior to final design. Space underdrains based on soil permeability and depth to groundwater.
12.7.4 Improper selection of maintenance equipment to minimize soil compaction.	New and Existing POTW's Refer to 12.1.7.

Unit Operation/Component: 12.8 Surface Drainage

12.8.1 Spray nozzles plug due to solids in wastewater.	New and Existing POTW's Solids in wastewater can cause soil sealing and undesirable runoff characteristics. Refer to 12.5.1.
12.8.2 Improper slope construction.	New POTW's For overland flow, refer to 12.1.1. For a slow-rate system, use 20 percent as a maximum slope. Although not critical for rapid infiltration systems, water must be evenly distributed. Existing POTW's Method: Regrade site if necessary.
12.8.3 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's If surface drainage is collected and stored for future re-application, design a gravity collection system.
12.8.4 Inadequate location of service roads.	New and Existing POTW's Locate service roads so that they do not interfere with surface drainage.

DEFICIENCY	CONSIDERATIONS
12.8.5 Inadequate storage for local weather and its impact on the functioning of the system.	New POTW's When designing storage facilities, ensure sufficient storage capacity exists, not only for wastewater, but also for any runoff which is expected to be generated from the application site. Existing POTW's Method: If the system is a collecting site for non-contaminated stormwater, divert this flow away from the storage pond. If this is not the case, refer to 12.5.6.
12.8.6 Inadequate shaping of drainage channels for efficient system operation.	New and Existing POTW's Refer to 12.1.6.
12.8.7 Improper selection of maintenance equipment to minimize soil compaction.	New and Existing POTW's Refer to 12.1.7.
12.8.8 Inadequate use of data telemetry for efficient operation of the treatment system.	New POTW's Consider the installation of soil moisture measurement equipment to maximize system operation and to minimize the production of surface runoff. Existing POTW's Method: Refer to 12.6.9.

Unit Operation/Component: 12.9 Soil Depth

DEFICIENCY	CONSIDERATIONS
12.9.1 Inadequate soil depth for suitable land treatment.	New POTW's Provide a minimum soil depth of approximately 3 ft for slow-rate systems, and 10 ft for rapid-infiltration systems (unless underdrains are provided). Although not as important, allow 2 ft minimum depth for overland flow systems.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Refer to 12.1.4.
12.9.2 Inadequate site loading for optimum treatment.	New and Existing POTW's Refer to 12.7.2.
12.9.3 Inadequate consideration given to soil type and the interaction of soil with sodium in the wastewater.	New POTW's The sodium adsorption ratio (SAR) should not exceed 9. Values higher than this may adversely affect the permeability of fine-textured soils and be toxic to plants. For a SAR greater than 9, consider chemical addition to adjust the ratio. Existing POTW's Method: Refer to 12.4.7.

Unit Operation/Component: 12.10 Infiltration Beds

DEFICIENCY	CONSIDERATIONS
12.10.1 Improper slope construction.	New and Existing POTW's The slope should be essentially flat to allow for an even distribution of water within the bed; however, sloped land may be acceptable.
12.10.2 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's Where possible, storage facilities should be down-gradient from the pretreatment system, and the infiltration beds should be down-gradient from the storage facilities. This minimizes the need for pumping facilities.
12.10.3 Inadequate soil depth for suitable land treatment.	New and Existing POTW's Provide approximately 10 ft of soil in the bed to allow for sufficient treatment.
12.10.4 Inadequate construction of lagoons for maintenance and sludge removal.	New and Existing POTW's Refer to 12.5.5.

DEFICIENCY	CONSIDERATIONS
12.10.5 Inadequate site loading for optimum treatment.	New and Existing POTW's Utilize a liquid loading rate of 4 inches to 7 ft/week with the rate based on the saturated hydraulic conductivity of the least permeable layer. Allow sufficient resting between application to restore aerobic conditions. Current systems are loaded at a BOD_5 rate of from 9 to 57 lb/acre-day.
12.10.6 Improper selection of maintenance equipment to minimize soil compaction.	New and Existing POTW's Refer to 12.1.7.
12.10.7 Inadequate use of data telemetry for efficient operation of the treatment system.	New and Existing POTW's If desired, provide liquid level sensors and flow controllers.

Unit Operation/Component: 12.11 Subsurface Drainage

DEFICIENCY	CONSIDERATIONS
12.11.1 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's If a subsurface underdrain system is utilized, provide for gravity collection of reclaimed water.
12.11.2 Inadequate soil depth for suitable land treatment.	New and Existing POTW's When groundwater levels affect wastewater renovation or crop growth, underdrains will be required.
12.11.3 Inadequate storage for local weather and its impact on the functioning of the system.	New and Existing POTW's If subsurface drainage is collected for future reuse, release or reapplication, ensure sufficient storage is available, considering groundwater, wastewater applied, and precipitation.

DEFICIENCY	CONSIDERATIONS
12.11.4 Inadequate knowledge of sub-surface drainage alternatives to alleviate drainage problems.	New and Existing POTW's Refer to 12.7.3.

Unit Operation/Component: 12.12 Odor Control

DEFICIENCY	CONSIDERATIONS
12.12.1 Improper slope construction.	New and Existing POTW's For overland and slow rate systems, minimize local surface depressions where wastewater may accumulate and precipitate anaerobic conditions and odors.
12.12.2 Inadequate detention time on slope to achieve desired level of treatment.	New and Existing POTW's Ensure that the hydraulic and organic loadings are proper. Minimize the odor associated with the anaerobic conditions caused by overloading.
12.12.3 Inadequate consideration for needs of pre-chlorination or pre-aeration.	New and Existing POTW's Refer to 12.6.2.
12.12.4 Inadequate construction of lagoons for maintenance and sludge removal.	New and Existing POTW's Provide access to all lagoons to allow for sludge collection and removal, thereby minimizing odor potential. In addition, construct side slopes to allow for access by machinery, especially for grass cutting. Refer to 12.5.5.
12.12.5 Inadequate protection of equipment for freezing conditions.	New and Existing POTW's Refer to 12.6.4.
12.12.6 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.5.7.

DEFICIENCY	CONSIDERATIONS
12.12.7 Inadequate knowledge of subsurface drainage alternatives to alleviate drainage problems.	New and Existing POTW's Avert anaerobic conditions by utilizing subsurface drainage where required. Refer to 12.7.3.
12.12.8 Inadequate methods for servicing lagoon aerators.	New and Existing POTW's Negate odor potential by keeping aerators operational. Refer to 12.5.10.

Unit Operation/Component: 12.13 Center Pivot Sprinkler

12.13.1 Spray nozzles plug due to solids in wastewater.	New and Existing POTW's Provide 50- to 65-psi water pressure at the nozzles. Refer to 12.5.1.
12.13.2 Inadequate protection of equipment for freezing conditions.	New and Existing POTW's Where freezing problems are possible, utilize down nozzles which will drain the sprinkler system, or provide drain plugs. In addition, provide drain plugs for the center pivot section.
12.13.3 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Provide a minimum velocity of two ft/sec in the distribution system.
12.13.4 Inadequate facilities provided for flushing of lateral lines.	New and Existing POTW's Provide sufficient, high-pressure water to flush lateral lines.
12.13.5 Inadequate sprinkler head design to minimize abrasion and aerosolization.	New and Existing POTW's Choose a nozzle with the proper pressure and diameter. For a specific nozzle size, a pressure too high will cause mist and aerosol production. A nozzle too small will easily plug and abrade. Space sprinklers closer together to decrease the required arc of the water, and thereby minimize aerosol production.

DEFICIENCY	CONSIDERATIONS
12.13.6 Inadequate selection of protective coatings to minimize corrosion.	New POTW's Specify the main line and supply line be cast iron, asbestos, cement, plastic, or other corrosive-resistant material. Specify either an aluminum or galvanized steel sprinkler system. Existing POTW's Method: Replace highly-corroded equipment with corrosion-resistant materials. Alternately, apply corrosion-resistant surface finishes.
12.13.7 Improper selection of electrical contacts and machinery for corrosive environments.	New and Existing POTW's Refer to 12.5.12.
12.13.8 Inadequate construction of underground wiring.	New and Existing POTW's Refer to 12.5.13.
12.13.9 Inadequate protection of electrical hardware from voltage surges.	New and Existing POTW's Refer to 12.5.14.
12.13.10 Inadequate use of data telemetry for efficient operation of the treatment system.	New and Existing POTW's Refer to 12.8.8.
12.13.11 Inadequate posting of signs identifying hazards.	New and Existing POTW's Post signs at 100-ft intervals along the perimeter of the site that state wastewater is being used for crop irrigation.
12.13.12 Plastic laterals installed above-ground are breaking because of cold weather.	New and Existing POTW's Refer to 12.13.2.

DEFICIENCY	CONSIDERATIONS
12.13.13 Aerosol drift to neighboring land.	New and Existing POTW's Install properly-designed windbreaks and buffer zones. The design of these control devices is based upon wind speed, spray height, and spray pressure. Also, consideration to neighboring land usage must be given.

Unit Operation/Component: 12.14 Traveling Gun Sprinkler

DEFICIENCY	CONSIDERATIONS
12.14.1 Spray nozzles plug due to solids in wastewater.	New and Existing POTW's Provide a spray nozzle on the gun that has a large-enough bore to minimize clogging. Refer to 12.5.1.
12.14.2 Improper slope construction.	New POTW's The traveling gun should not be limited by the slope of the terrain. Existing POTW's Method: If the traveling gun cannot move within the site due to terrain restrictions, earthwork will be required.
12.14.3 Inadequate protection of equipment from freezing conditions.	New and Existing POTW's Provide drain plugs on both the sprinkler and the supply piping.
12.14.4 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.13.3.
12.14.5 Inadequate facilities provided for flushing of lateral lines.	New and Existing POTW's Refer to 12.13.4.

DEFICIENCY	CONSIDERATIONS
12.14.6 Inadequate sprinkler head design to minimize aerosolization.	<u>New and Existing POTW's</u> Refer to 12.13.5.
12.14.7 Inadequate selection of protective coatings to minimize corrosion.	<u>New and Existing POTW's</u> Refer to 12.13.6.
12.14.8 Improper selection of electrical contacts and machinery for corrosive environments.	<u>New and Existing POTW's</u> Refer to 12.5.12.
12.14.9 Inadequate construction of underground wiring.	<u>New and Existing POTW's</u> Refer to 12.5.13.
12.14.10 Inadequate protection of electrical hardware from voltage surges.	<u>New and Existing POTW's</u> Refer to 12.5.14.
12.14.11 Inadequate use of data telemetry for efficient operation of the treatment system.	<u>New and Existing POTW's</u> Refer to 12.8.8.
12.14.12 Inadequate posting of signs identifying hazards.	<u>New and Existing POTW's</u> Refer to 12.13.11.
12.14.13 Plastic laterals installed above-ground are breaking because of cold weather.	<u>New and Existing POTW's</u> Refer to 12.13.12.
12.14.14 Aerosol drift to neighboring land.	<u>New and Existing POTW's</u> Refer to 12.13.13.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 12.15 Single Set Sprinkler	
12.15.1 Spray nozzles plug due to solids in wastewater.	New and Existing POTW's Refer to 12.14.1.
12.15.2 Inadequate protection of equipment from freezing conditions.	New and Existing POTW's Provide drain plugs on both the sprinkler and the distribution system.
12.15.3 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.13.3.
12.15.4 Inadequate facilities provided for flushing of lateral lines.	New and Existing POTW's Refer to 12.13.4.
12.15.5 Inadequate sprinkler head design to minimize aerosolization.	New and Existing POTW's Refer to 12.13.5.
12.15.6 Inadequate selection of protective coatings to minimize corrosion.	New and Existing POTW's Refer to 12.13.6.
12.15.7 Improper selection of electrical contacts and machinery for corrosive environments.	New and Existing POTW's Refer to 12.5.12.
12.15.8 Inadequate construction of underground wiring.	New and Existing POTW's Refer to 12.5.13.
12.15.9 Inadequate protection of electrical hardware from voltage surges.	New and Existing POTW's Refer to 12.5.14.

DEFICIENCY	CONSIDERATIONS
12.15.10 Inadequate use of data telemetry for efficient operation of the treatment system.	New and Existing POTW's Refer to 12.8.8.
12.15.11 Inadequate posting of signs identifying hazards.	New and Existing POTW's Refer to 12.13.11.
12.15.12 Plastic laterals installed above-ground are breaking because of cold weather.	New and Existing POTW's Refer to 12.13.2.
12.15.13 Aerosol drift to neighboring land.	New and Existing POTW's Refer to 12.13.13.

Unit Operation/Component: 12.16 Lineal Travel Sprinkler

DEFICIENCY	CONSIDERATIONS
12.16.1 Spray nozzles plug due to solids in wastewater.	New and Existing POTW's Refer to 12.14.1.
12.16.2 Improper slope construction.	New POTW's Slope must be such that the traveling sprinkler can negotiate the terrain. Existing POTW's Method: Initiate slope regrading if necessary.
12.16.3 Inadequate protection of equipment from freezing conditions.	New and Existing POTW's Provide drain plugs on the lineal section to allow for drainage.
12.16.4 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.13.3.

DEFICIENCY	CONSIDERATIONS
12.16.5 Inadequate facilities provided for flushing of lateral lines.	New and Existing POTW's Refer to 12.13.4.
12.16.6 Inadequate sprinkler head design to minimize aerosolization.	New and Existing POTW's Refer to 12.13.5.
12.16.7 Inadequate selection of protective coatings to minimize corrosion.	New and Existing POTW's Refer to 12.13.6.
12.16.8 Improper selection of electrical contacts and machinery for corrosive environments.	New and Existing POTW's Refer to 12.5.12.
12.16.9 Inadequate construction of underground wiring.	New and Existing POTW's Refer to 12.5.13.
12.16.10 Inadequate protection of electrical hardware from voltage surges.	New and Existing POTW's Refer to 12.5.14.
12.16.11 Inadequate use of data telemetry for efficient operation of the treatment system.	New and Existing POTW's Refer to 12.8.8.
12.16.12 Inadequate posting of signs identifying hazards.	New and Existing POTW's Refer to 12.13.11.
12.16.13 Plastic laterals installed above-ground are breaking because of cold weather.	New and Existing POTW's Refer to 12.13.12.

DEFICIENCY	CONSIDERATIONS
12.16.14 Aerosol drift to neighboring land.	New and Existing POTW's Refer to 12.13.13.

Unit Operation/Component: 12.17 Grated Pipe Distribution

DEFICIENCY	CONSIDERATIONS
12.17.1 Improper slope construction.	New and Existing POTW's Refer to 12.8.2.
12.17.2 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's Refer to 12.10.2.
12.17.3 Inadequate protection of equipment for freezing conditions.	New and Existing POTW's Design in-ground pipe distribution system to allow for draining water from low points of the system.
12.17.4 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.5.7.
12.17.5 Inadequate facilities provided for flushing of lateral lines.	New and Existing POTW's Refer to 12.13.4.
12.17.6 Inadequate selection of protective coatings to minimize corrosion.	New and Existing POTW's Specify that the main line and supply line be cast iron, asbestos, cement, plastic, or other corrosive-resistant material. Specify an aluminum-grated pipe distribution system.

DEFICIENCY	CONSIDERATIONS

Unit Operation/Component: 12.18 Ridge and Furrow

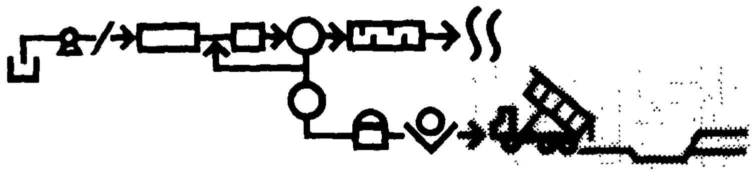
12.18.1 Improper slope construction.	New and Existing POTW's Refer to 12.8.2.
12.18.2 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's Refer to 12.10.2.
12.18.3 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.5.7.

Unit Operation/Component: 12.19 Spreading Basins

12.19.1 Improper slope construction.	New and Existing POTW's Refer to 12.8.2.
12.19.2 Inappropriate location of storage facilities for optimum energy utilization.	New and Existing POTW's Refer to 12.10.2.
12.19.3 Inadequate pumping facilities for control of sedimentation in piping.	New and Existing POTW's Refer to 12.5.7.
12.19.4 Inadequate facilities provided for flushing of lines.	New and Existing POTW's Refer to 12.13.4.

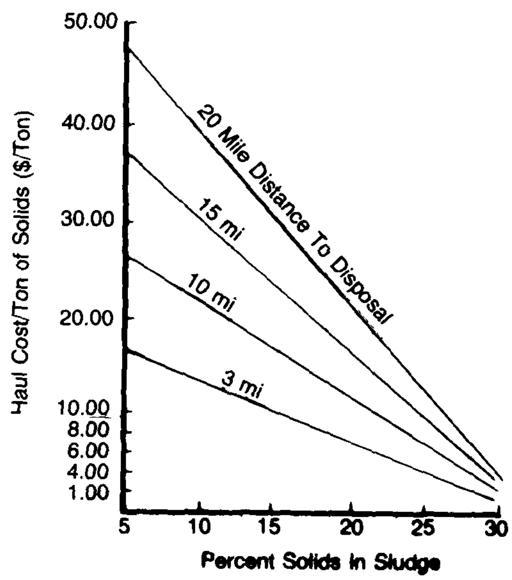
Design Considerations

Category: 13.0 Sludge Disposal



Unit Operation/Component: 13.1 General

DEFICIENCY	CONSIDERATIONS
13.1.1 Inadequate truck tire size for landfill disposal.	New and Existing POTW's Replace tires with 10.00 x 20, 14 ply or equal. Run at 80 lbs. Cost between \$120 and \$150 each, plus tube.
13.1.2 Inadequate consideration of sludge concentration/transportation tradeoffs.	New and Existing POTW's Haulage costs/ton of solids decrease as concentration increases.



DEFICIENCY	CONSIDERATIONS
13.1.3 Inadequate consideration of site geology/topography and climate.	New POTW's Generally, application of sludge should not be made within 100 ft of streams, 300 ft of water supplies, 25 ft of bedrock outcrops, 50 ft of property lines, and 300 ft of occupied dwellings. Refer to local ordinances for site-specific requirements. Soil characteristics should be sandy loam, loam, sandy clay loam, silty clay, or silt loam, and have a well-developed solum with at least 20 in. to bedrock. Slopes should not exceed 30 percent and have no closed depressions on-site. There should be a minimum of 4.5 ft to the groundwater table. Existing POTW's Method: Grade the site to allow rainfall runoff and prevent water infiltrating into the landfill. Provide all-weather roads for wet-weather operation. Install impermeable barriers and/or leachate collection system to prevent groundwater contamination.
13.1.4 Inadequate consideration of equipment utility in all-weather conditions.	New POTW's Make provisions for temporary storage of sludge during wet weather or freezing conditions. Provide special area near entrance for sludge disposal during inclement weather. Provide lighting (portable or permanent) for night operation. Existing POTW's Method: Refer to 13.2.1.
13.1.5 Lack of vector control.	New and Existing POTW's Cover sludge daily with a minimum of 6 inches of cover material.

DEFICIENCY	CONSIDERATIONS
13.1.6 Inadequate consideration of nutrients and public health hazards (metals, bacteria) transport in soil/groundwater.	New POTW's Specify sludge stabilization via digestion or chemical treatment and and sludge dewatering prior to final disposal. Provide collection lines beneath landfills, leachate collection facilities, and/or impermeable barriers to prevent migration of leachate. Existing POTW's Method: Decrease the sludge loading rate, install a leachate collection system, and provide sludge dewatering prior to disposal.
13.1.7 Inadequate buffer zone at disposal site.	New and Existing POTW's A buffer zone of 40 feet should be provided as a minimum. Local ordinances should also be referred to for buffer zone requirements. Refer to 13.1.3.
13.1.8 Lack of odor control/prevention.	New POTW's Specify a daily sludge cover of 6 inches or more. Provide facilities for adding lime to the sludge, when needed, to reduce the potential for odors. Develop a grading plan that prevents ponding. Existing POTW's Method: Add lime to the sludge soil mixture.
13.1.9 Sludge loading delayed due to lack of truck or container capacity.	New POTW's Incorporate into the facility's design provisions for temporary storage (i.e., extra trucks or containers) to provide temporary sludge storage during periods of truck breakdowns or landfill closure. Existing POTW's Method: Purchase an extra truck(s) or container(s) to temporarily store

DEFICIENCY	CONSIDERATIONS
	sludge during periods of equipment breakdown or landfill closure.

Unit Operation/Component: 13.2 Landfill

13.2.1 Inadequate selection of disposal vehicle results in inability to maneuver in landfill.	New POTW's Vehicles should have the following or equal specifications: • Chassis: A 50,000 gross vehicle weight rating (GVWR) chassis to meet GVWR requirements, reinforced high tensile steel frame (1/4-in.) inside channel, heavy duty steel front bumper with dual hooks, 10-wheel tandem rear with 10.00 x 20, 14-ply tires with tubes at 80-lb pressure, hydraulic power steering, full air brakes, front axle 14,000-lb cap. with 14,000-lb aux. springs rear axle 36,000-lb cap. with 4,000-lb aux. springs. • Power: A 200-hp (minimum) diesel with vertical exhaust. • Transmission: An automatic or standard heavy duty rear matched to highway/off-road performance requirements. • Body: Bulk carrier for 20 percent solids; tank for 3 to 5 percent solids. Existing POTW's Method: Contract with private hauler having the proper vehicles and/or upgrade the existing equipment per the specifications presented in 13.1.1.
13.2.2 Inadequate consideration of sludge concentration/transportation tradeoffs.	New and Existing POTW's Refer to 13.1.2.

DEFICIENCY	CONSIDERATIONS
13.2.3 Inadequate consideration of site geology/topography and climate.	New and Existing POTW's Refer to 13.1.3.
13.2.4 Inadequate consideration of equipment utility in all weather conditions.	New and Existing POTW's Make provisions for temporary storage of sludge during wet weather or freezing conditions. Provide special area near landfill entrance for waste disposal during inclement weather. Provide tracked equipment (front-end loaders, bulldozers, backhoes, etc.). Provide paved or all-weather roads at the site. Transfer sludge from haulage vehicles to super-flotation equipment at site. Provide an enclosed truck (or container) in the sludge loading area to prevent the sludge from freezing in the transportation vehicle.
13.2.5 Inadequate consideration of gas migration/accumulation.	New POTW's Provide gas venting and migration control at periphery of fill: 1. Place a barrier of low permeability material, such as compacted clay, around the fill area. 2. Provide a gravel-filled trench outside the clay barrier to intercept migrating gas, and to vent it to the atmosphere. 3. Place vertical perforated pipes into each cell and/or lift to vent each to the atmosphere.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Vent each lift to the next higher lift: 1. By removing 2 to 5 sq ft of low permeability cover material per cell before applying new lift of solid waste/sludge. 2. Vent final lift with vertical perforated pipes (one per cell) before placing final cover. 3. Place a barrier of low permeability material, such as compacted clay, around perimeter of fill area.
13.2.6 Lack of vector control.	New and Existing POTW's Personnel should be trained in controlling vectors. Cover sludge daily with a minimum of 6 inches of cover material.
13.2.7 Inadequate consideration of nutrients and public health hazards (metals, bacteria) transport in soil/groundwater.	New and Existing POTW's Refer to 13.1.6.
13.2.8 Inadequate buffer zone at disposal site.	New and Existing POTW's Refer to 13.1.7.
13.2.9 Lack of odor control/prevention.	New and Existing POTW's Refer to 13.1.8.
13.2.10 Sludge loading ing delayed due to lack of truck or container capacity.	New and Existing POTW's Refer to 13.1.9.

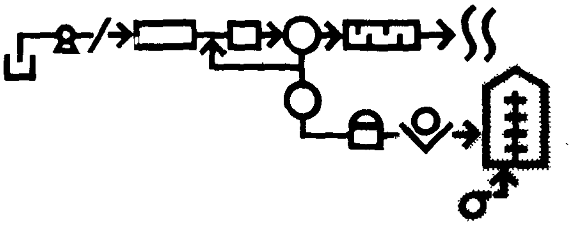
DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 13.3 Spraying	
13.3.1 Inadequate consideration of sludge concentration/transportation/trade-offs.	New and Existing POTW's Refer to 13.1.2.
13.3.2 Inadequate consideration of site geology/topography and climate.	New and Existing POTW's Refer to 13.1.3.
13.3.3 Inadequate consideration of hydraulic transport reduction due to ion exchange.	New POTW's High sodium concentrations in clay-bearing soils disperse soil particles and decrease soil permeability which can cause ponding. Existing POTW's Method: High sodium concentrations in clay-bearing soils disperse soil particles and decrease soil permeability which can cause ponding. Wastes with high sodium concentrations should be segregated and disposed of separately when possible. In addition, add dolomitic lime to the soil to displace Na with Mg and Ca.
13.3.4 Inadequate consideration of equipment utility in all weather conditions.	New and Existing POTW's Make provisions for temporary storage of sludge during wet weather or freezing conditions. Provide flexibility to change from subsurface to surface application during wet or frozen ground conditions. Provide flexibility to transfer sludge from haulage vehicle to superflotation equipment.

DEFICIENCY	CONSIDERATIONS
13.3.5 Lack of vector control.	New and Existing POTW's Provide facilities to apply lime to site after spraying. Provide flexibility to use subsoil injection in lieu of surface spraying.
13.3.6 Inadequate consideration of nutrients and public health hazards (metals, bacteria) transport in soil/groundwater.	New POTW's Refer to 13.1.6. Existing POTW's Method: Decrease the sludge application rate to reduce nutrients and metals loadings. Refer to 13.1.6.
13.3.7 Inadequate buffer zone at disposal site.	New and Existing POTW's Refer to 13.1.7.
13.3.8 Lack of odor control/prevention.	New POTW's Refer to 13.1.8. Existing POTW's Method: Improve the site grading plan to eliminte any ponding of precipitation; however, do not allow direct runoff of sludge into surface waters. Refer to 13.3.5.

Unit Operation/Component: 13.4 Planning

DEFICIENCY	CONSIDERATIONS
13.4.1 Inadequate consideration of sludge concentration/transportation trade-offs.	New and Existing POTW's Refer to 13.1.2.
13.4.2 Inadequate consideration of site geology/topography and climate.	New and Existing POTW's Refer to 13.1.3.

DEFICIENCY	CONSIDERATIONS
13.4.3 Inadequate consideration of hydraulic transport reduction due to ion exchange.	New and Existing POTW's Refer to 13.3.3.
13.4.4 Inadequate consideration of equipment utility in all weather conditions.	New and Existing POTW's Make provisions for temporary storage of sludge during wet weather or freezing conditions. Provide special area near entrance for sludge disposal during inclement weather disposal. Provide tracked equipment (front-end loaders, bulldozers, backhoe, etc.). Provide flexibility to convert from subsurface application during wet or frozen ground conditions. Provide paved or all-weather roads at site.
13.4.5 Lack of vector control.	New and Existing POTW's Cover sludge daily with a minimum of 6 inches of cover material. Provide flexibility to utilize soil injection in lieu of surface spraying, if required.
13.4.6 Inadequate consideration of nutrients and public health hazards (metals, bacteria) transport in soil/groundwater.	New and Existing POTW's Refer to 13.1.6.
13.4.7 Inadequate buffer zone at disposal site.	New and Existing POTW's Refer to 13.1.7.
13.4.8 Lack of odor control/prevention.	New and Existing POTW's Refer to 13.1.8 and 13.3.8.
13.4.9 Sludge loading delayed due to lack of truck or container capacity.	New and Existing POTW's Refer to 13.1.9.

Design Considerations Category: 14.0 Sludge Reduction	
Unit Operation/Component: 14.1 General	

DEFICIENCY	CONSIDERATIONS
14.1.1 Inadequate consideration of equipment arrangement in overall process flow.	New and Existing POTW's All sludge reduction devices require the use of energy to attain and maintain an operating temperature. Any handling of solids prior to sludge reduction which involve dilution or the addition of water should be eliminated; rather, the material should be dried as much as possible prior to sludge reduction.
14.1.2 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Provision must be made to store the sludge in its least putrescible form between the point of wasting and prior to sludge reduction. The storage capacity provided must be compatible with the downtime which is typically reported for the sludge reduction operation to be utilized at the POTW.
14.1.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New POTW's Provide scrubber water pumps that utilize final effluent for air pollution control uses.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Install scrubber water pumps and a sump (if necessary) that utilize POTW effluent for the scrubber. Consider installing larger utility water pumps (or pump impellers, if applicable) and tie the scrubber water system into the plant utility water system.
14.1.4 Inadequate consideration of fresh air supply and overall ventilation requirements.	New POTW's For all sludge reduction units that operate at elevated temperatures, ensure that adequate fresh air supply and ventilation are provided for operator safety in the vicinity of the unit, and to meet current OSHA requirements for maximum temperatures for shift operation. Existing POTW's Method: Refer to OSHA requirements and install appropriately-sized ventilation fans in sludge dewatering area.
14.1.5 Improper feed equipment selection.	New and Existing POTW's The two major characteristics of feed equipment that must be considered for sludge reduction are the ability to deliver the required mass flow of material working against the back pressure of the sludge reduction equipment and the ability to provide a suitably steady flow to the reduction operation. Belt or screw conveyors are typically used to carry sludge into incinerators and for ash handling.
14.1.6 Inadequate consideration of impact of recycle streams on main stream processes.	New POTW's Waste streams generated by sludge reduction processes are generally recycled back to the head end of the

DEFICIENCY	CONSIDERATIONS
	POTW. These waste streams can significantly add to both the organic and hydraulic loading to the POTW and must be considered when sizing main stream unit operations. Existing POTW's Method: Provide pretreatment of sidestreams prior to discharge to head-end of plant. This could include flow equalization and/or solids removal.
14.1.7 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's In oxidative treatment processes that operate at elevated temperatures, sulfides (which may be oxidized to sulfuric acids) and chlorides provide special concerns for corrosion. Equipment specifications should involve consulting the manufacturer as to corrosion resistance under operating conditions.
14.1.8 Improper consideration of reliability of mechanical components.	New and Existing POTW's Minimizing system down-time and providing consistent operation requires consideration of two aspects: provision for adequate sludge storage, and provision for back-up units to maintain reliable operation during equipment maintenance periods. Refer to 14.1.2 and 14.1.9.
14.1.9 Inadequate consideration of back-up equipment requirements.	New and Existing POTW's In general, the degree of duplication of facilities must be proportional to the complexity of the unit operation. For large expensive operations, it is generally more economical to provide greater sludge storage with a single large unit than the duplication of smaller auxiliary equipment.

DEFICIENCY	CONSIDERATIONS
14.1.10 Inadequate instrument monitoring of process flows (flue-gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	New and Existing POTW's Spot sampling analysis at elevated temperatures is extremely difficult and represents a safety problem; therefore, great care must be taken to ensure that maintainable, accessible sample points and instrument locations are provided which fully characterize the design and control parameters for the unit.
14.1.11 No stack sampling ports provided.	New POTW's Stack sampling ports should be included as part of the original POTW design. Local ordinances should be referred to in order to determine sampling requirements. Existing POTW's Method: Install stack sampling ports before and after air pollution control equipment. Refer to EPA guide-lines "Methods for Air Sampling, Volumes I and II" for sampling port specifications. Refer to OSHA regulations for construction specifications related to safety scaffolding and walkways.
14.1.12 Lack of protective insulation on exposed hot piping.	New and Existing POTW's For operator protection, insulation should be wrapped around all exposed hot piping, particularly along walkways and other areas characterized by high operator activity.
14.1.13 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's The flow balance for the sludge reduction unit should include all input streams (that is, fuel, air, water, and residue) and ensure that a proper (i.e., closed) balance is drawn around the sludge reduction system. In particular, ensure that

DEFICIENCY	CONSIDERATIONS
	the ash content of the material going to sludge reduction has been adequately characterized. The flow balance can then be used to identify the characteristics and the quantity of residue that must be ultimately disposed of in some manner. This could include landfilling, reuse as a sludge conditioner prior to dewatering, an additive for concrete, ground cover, etc.

Unit Operation/Component: 14.2 Multiple Hearth Incineration

14.2.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Provide a minimum sludge storage capacity of 30 days.
14.2.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Ensure that the solids loading per unit of hearth area falls within the manufacturer's recommendations.
14.2.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New and Existing POTW's To reduce POTW operating costs, plant effluent should be used as the scrubber water source. Refer to 14.1.3.
14.2.4 No heat exchanger provided to make use of waste heat.	New and Existing POTW's Provide heat exchangers in equipment exhaust air ducts and/or residue quenching exhaust ducts to collect waste heat to the degree economically possible.
14.2.5 Inadequate consideration of fresh air supply and overall ventilation requirements.	New and Existing POTW's Consider locating the incinerator outdoors with the control room in an enclosed and suitably-ventilated building; or, if the incinerator is located within the building, close off or provide sufficient ventilation

DEFICIENCY	CONSIDERATIONS
	to maintain acceptable operating temperatures for the operators in the working area. Refer to 14.1.4.
14.2.6 Improper feed equipment selection.	New and Existing POTW's Refer to 14.1.5.
14.2.7 Inadequate provisions for reliable auxiliary fuel source.	New and Existing POTW's Provide on-site storage of either natural gas or fuel oil with a minimum supply of 60 days.
14.2.8 Inadequate consideration of impact of recycle streams on main stream processes.	New and Existing POTW's Refer to 14.1.6.
14.2.9 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Incinerated materials must be able to resist the reducing environment in the upper portion of the incinerator, as well as high temperature chloride corrosion and sulfuric acid production. Refer to 14.1.7.
14.2.10 Improper consideration of reliability of mechanical components.	New and Existing POTW's Consider the need for spare rabble arms and teeth, which represent the highest wear points. Refer to 14.1.8.
14.2.11 Inadequate consideration of back-up equipment requirements.	New and Existing POTW's It is seldom practicable to provide dual units; therefore, a minimum sludge storage capacity of 60 days is recommended.
14.2.12 Inadequate consideration of impact of excess scale and ash on air pollution equipment and ash removal facilities.	New POTW's In order to properly size air pollution control equipment, sufficient testing must be performed prior to design to ensure that the ash content of the feed material has been adequately characterized so that realistic ash quantities can be predicted.

DEFICIENCY	CONSIDERATIONS
	Existing POTW's Method: Upgrade the air pollution control system to handle increased quantities of ash.
14.2.13 Improper selection of equipment drives for service in high-temperature areas.	New and Existing POTW's Temperature controls and cooling air controls must be provided to ensure that equipment drive temperatures do not exceed the manufacturer's requirements.
14.2.14 No oxygen analyzing equipment provided to monitor burn.	New and Existing POTW's Ensure that oxygen analyzing equipment is provided on intake air and exhaust streams so that ventilation controls may be tied into the oxygen analyzer equipment.
14.2.15 No remote control capability provided for burners to optimize burn.	New and Existing POTW's Provide, where possible, integrated control equipment to analyze and control oxygen, burn temperatures, and fuel supplies.
14.2.16 No remote control capability provided for shaft drive to optimize burn.	New and Existing POTW's Provide remote controls to allow operator to adjust shaft rotation speed (usually 0.5 to 1.5 rpm).
14.2.17 Improper use of mercury manometers for scrubber water flow measurement causes loss of mercury into system during system surges.	New and Existing POTW's Specify closed manometer systems that do not use mercury.
14.2.18 No remote control provided for natural draft and induced draft flow control valves.	New and Existing POTW's Refer to 14.2.14.
14.2.19 Inadequate instrument monitoring of process flows (flue gas temperature, pres-	New and Existing POTW's Numerous parameters should be monitored to properly control the incineration process. These would include

DEFICIENCY	CONSIDERATIONS
sure) and inadequate number of monitoring points (before and after scrubber).	oxygen, carbon dioxide, carbon monoxide, temperature, pressure, etc. of the stack gas. The temperature of the individual hearths must also be monitored. Refer to 14.1.10.
14.2.20 No stack sampling ports provided.	New and Existing POTW's Refer to 14.1.11 and 14.2.19.
14.2.21 Lack of protective insulation on exposed hot piping.	New and Existing POTW's Refer to 14.1.12.
14.2.22 Inadequate access to incinerator ash container.	New and Existing POTW's Provide sufficient and convenient operator access to the ash container at the bottom of the incinerator.
14.2.23 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's The residue from the sludge reduction operation may have a high heavy-metal content. Also, the material may be susceptible to leaching and may well be deemed hazardous under current or future regulations; therefore, care should be taken to ensure that the characteristics of the material to be handled have been accurately identified and that the disposal facility is licensed for handling potentially hazardous material. Refer to 14.1.13.
14.2.24 Inadequate odor control.	New and Existing POTW's For excess-air multiple hearth incineration, either water scrubbing or after burning is necessary in many areas for odor control. For starved-air multiple hearth incineration, pyrolysis or ignition of the fuel gas produced during pyrolysis provides acceptable odor control for most areas.

DEFICIENCY	CONSIDERATIONS
14.2.25 Inadequate air pollution control.	New and Existing POTW's Prior to specification of air pollution control equipment, care must be taken to determine the regulatory requirements for air pollution control which are highly site-specific, and require careful investigation. Scrubbers and electrostatic precipitators are commonly-used air pollution control devices.

Unit Operation/Component: 14.3 Heat Treatment

DEFICIENCY	CONSIDERATIONS
14.3.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Provide a minimum of 60 days sludge storage.
14.3.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Ensure that feed pumps are capable of handling the high viscosity material to be fed to the sludge reduction unit.
14.3.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New and Existing POTW's Refer to 14.1.3.
14.3.4 No heat exchanger provided to make use of waste heat.	New and Existing POTW's Provide a heat exchanger in the equipment exhaust stream if it is not provided as part of the manufacturer's equipment.
14.3.5 Inadequate consideration of fresh air supply and overall ventilation requirements.	New and Existing POTW's Refer to 14.1.4.
14.3.6 Improper feed equipment selection.	New and Existing POTW's Refer to 14.1.5.

DEFICIENCY	CONSIDERATIONS
14.3.7 Inadequate consideration of impact of recycle streams on main stream processes.	New POTW's The return stream from a heat treatment operation may amount to 30 percent of the design organic load of the main stream treatment plant. Failure to include this in the material balance will have a significant effect upon the operational stability of the plant. Also, where possible, the return stream to the main stream plant should be as constant as possible and should be discharged upstream of the plant grit chambers in order to allow removal of as much solid material as possible prior to providing secondary treatment. Existing POTW's Method: Refer to 14.1.6.
14.3.8 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Ensure that piping used to transfer material to and from the heat treatment area is compatible with the materials of construction in the unit to prevent dissimilar metals corrosion or corrosion due to the materials being handled.
14.3.9 Improper consideration of reliability of mechanical components.	New and Existing POTW's It is seldom practical to provide two heat treatment units; therefore, a minimum sludge storage capacity of 60 days is recommended to allow for equipment downtime.
14.3.10 Inadequate consideration of backup equipment requirements.	New and Existing POTW's Refer to 14.1.9 and 14.3.9.
14.3.11 Improper use of mercury manometers for scrubber water flow measurement causes loss of mercury into system during system surges.	New and Existing POTW's Refer to 14.2.17.

DEFICIENCY	CONSIDERATIONS
14.3.12 Inadequate instrument monitoring of process flows (flue gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	New and Existing POTW's Refer to 14.1.10 and 14.2.19.
14.3.13 Lack of protective insulation on exposed hot piping.	New and Existing POTW's Refer to 14.1.12.
14.3.14 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's The return stream from heat treatment may amount to 30 percent of the designed organic load to the waste treatment plant and, therefore, greatly influence the quantity of solids generated and which must ultimately be disposed of in some manner. Refer to 14.2.23.
14.3.15 Inadequate odor control.	New and Existing POTW's Where possible, provide heat treatment in an enclosed area with forced ventilation exiting through either an activated carbon or ozone odor control system in order to eliminate the characteristic odor generated by heat treatment units.
14.3.16 Inadequate air pollution control.	New and Existing POTW's Refer to 14.3.15.

Unit Operation/Component: 14.4 Fluidized Bed

DEFICIENCY	CONSIDERATIONS
14.4.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's It is seldom practical to provide duplicate equipment for this operation; therefore, a minimum sludge storage capacity of 60 days is recommended.

DEFICIENCY	CONSIDERATIONS
14.4.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Ensure that the pumping equipment is capable of pumping high viscous material through the fluidized bed.
14.4.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New and Existing POTW's Refer to 14.1.3.
14.4.4 No heat exchanger provided to make use of waste heat.	New and Existing POTW's Refer to 14.2.4.
14.4.5 Inadequate consideration of fresh air supply and overall ventilation requirements.	New and Existing POTW's Refer to 14.1.4.
14.4.6 Improper feed equipment selection.	New and Existing POTW's Refer to 14.1.5.
14.4.7 Inadequate provisions for reliable auxiliary fuel source.	New and Existing POTW's Provide a minimum of 60 days storage of either fuel oil or natural gas.
14.4.8 Inadequate consideration of impact of recycle streams on main stream processes.	New and Existing POTW's Refer to 14.1.6.
14.4.9 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Refer to 14.1.7 and 14.2.9.
14.4.10 Improper consideration of reliability of mechanical components.	New and Existing POTW's Refer to 14.2.10.

DEFICIENCY	CONSIDERATIONS
14.4.11 Inadequate consideration of back-up equipment requirements.	New and Existing POTW's Refer to 14.2.11.
14.4.12 Inadequate consideration of impact of excess scale and ash on air pollution equipment and ash removal facilities.	New and Existing POTW's Refer to 14.2.12.
14.4.13 Improper selection of equipment drives for service in high-temperature areas.	New and Existing POTW's Refer to 14.2.13.
14.4.14 No oxygen analyzing equipment provided to monitor burn.	New and Existing POTW's Refer to 14.2.14.
14.4.15 No remote control capability provided for burners to optimize burn.	New and Existing POTW's Refer to 14.2.15.
14.4.16 Improper use of mercury manometers for scrubber water flow measurements causes loss of mercury into system during system surges.	New and Existing POTW's Refer to 14.2.17.
14.4.17 Inadequate instrument monitoring of process flows (flue gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	New and Existing POTW's Refer to 14.1.10.
14.4.18 Lack of protective insulation on exposed hot piping.	New and Existing POTW's Refer to 14.1.12.

DEFICIENCY	CONSIDERATIONS
14.4.19 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's Refer to 14.2.23.
14.4.20 Inadequate odor control.	New and Existing POTW's Refer to 14.2.24.
14.4.21 Inadequate air pollution control.	New and Existing POTW's Refer to 14.2.25.

Unit Operation/Component: 14.5 Flash Drying

14.5.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Refer to 14.3.1.
14.5.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Refer to 14.2.2.
14.5.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New and Existing POTW's Refer to 14.1.3.
14.5.4 No heat exchanger provided to make use of waste heat.	New and Existing POTW's Refer to 14.3.4.
14.5.5 Improper feed equipment selection.	New and Existing POTW's Refer to 14.1.5.
14.5.6 Inadequate provisions for reliable auxiliary fuel source.	New and Existing POTW's Provide 60 days storage capacity for either fuel oil or natural gas.

DEFICIENCY	CONSIDERATIONS
14.5.7 Inadequate consideration of impact of recycle streams on main stream processes.	New and Existing POTW's Refer to 14.1.6.
14.5.8 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Refer to 14.1.7 and 14.2.9.
14.5.9 Improper consideration of reliability of mechanical components.	New and Existing POTW's Provide a back-up piece of equipment as well as a minimum of 30 days of sludge storage capacity.
14.5.10 Improper use of mercury manometers for scrubber water flow measurement causes loss of mercury into system during system surges.	New and Existing POTW's Refer to 14.2.17.
14.5.11 Inadequate instrument monitoring of process flows (flue gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	New and Existing POTW's Refer to 14.1.10.
14.5.12 Lack of protective insulation on exposed hot piping.	New and Existing POTW's Refer to 14.1.12.
14.5.13 Inadequate odor control.	New and Existing POTW's Refer to 14.3.15.
14.5.14 Inadequate air pollution control.	New and Existing POTW's Refer to 14.2.25 and 14.3.16.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 14.6 Composting	
14.6.1 Inadequate space for sludge staging and preparation.	New and Existing POTW's Provide a minimum of 10 acres per ton of dry sludge to be handled.
14.6.2 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Maintenance will be required when the operating area becomes inaccessible due to inclement weather, during personnel strikes, or if filler material becomes unavailable. Provide for a minimum sludge storage capacity of 60 days.
14.6.3 Inadequate consideration of feed solids concentration.	New POTW's Ensure that the feed stream pretreatment provides an acceptable material with regard to moisture content and solids concentration. Existing POTW's Method: Ensure that the feed stream pretreatment provides an acceptable material with regard to moisture content and solids concentration. Provide a chemical conditioning system to improve upstream dewatering operation.
14.6.4 Inadequate consideration of fresh air supply and overall ventilation requirements.	New POTW's Provide for positive control of the air volume entering the composting pile. Existing POTW's Method: Provide for positive control of the air volume entering the composting pile. Install air flow meters and flow control valves.

DEFICIENCY	CONSIDERATIONS
14.6.5 Inadequate provisions for reliable auxiliary fuel source.	New and Existing POTW's Ensure that contracts are available for a minimum of four suppliers of the filler material in the event it becomes unavailable from the preferred supplier.
14.6.6 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Refer to 14.1.7.
14.6.7 Improper consideration of reliability of mechanical components.	New and Existing POTW's Provide back-up equipment for turning the composting pile. Specify that a minimum of 50-percent excess compost handling equipment is available.
14.6.8 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's Care must be taken in drawing up the material balance to ensure that the filler material (for example, wood chips) has been included in the material balance. Refer to 14.2.23.
14.6.9 Inadequate odor control.	New and Existing POTW's Provide for back-up equipment to turn and repress the pile in the event of severe odor problems. Refer to 14.6.4.

Unit Operation/Component: 14.7 Atomized Spray

DEFICIENCY	CONSIDERATIONS
14.7.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Provide a minimum of 30 days sludge storage.
14.7.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Provide sludge density meters to ensure that the feed solids concentration is not excessively high, preferably less than 8 percent for waste activated sludge.

DEFICIENCY	CONSIDERATIONS
14.7.3 Improper consideration of reliability of mechanical components.	New and Existing POTW's The impact of the added ash load to the ash removing equipment must be considered in determining the size and type of equipment to be used. Refer to 14.1.8 and 14.2.10.
14.7.4 Inadequate consideration of impact of excess scale and ash on air pollution equipment and ash removal facilities.	New and Existing POTW's Refer to 14.2.12.
14.7.5 Inadequate consideration of ultimate residue disposal.	New and Existing POTW's The ash produced by burning the atomized spray material must be included in the plant residue handling system. Refer to 14.2.23.
14.7.6 Inadequate air pollution control.	New and Existing POTW's Ensure that consideration of the components of the sludge, notably chlorinated hydrocarbons and metals, has been included in the air pollution control considerations for the burning equipment. Air pollution control requirements are very site specific; therefore, ensure that injection of these materials is an acceptable alternative.

Unit Operation/Component: 14.8 Co-Incineration

14.8.1 Inadequate sludge storage during maintenance periods.	New and Existing POTW's Refer to 14.2.1.
14.8.2 Inadequate consideration of feed solids concentration.	New and Existing POTW's Refer to 14.2.2.

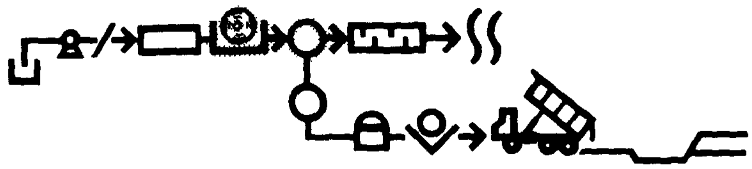
DEFICIENCY	CONSIDERATIONS
14.8.3 Use of high volumes of city water for air scrubbers instead of plant utility water.	New and Existing POTW's Refer to 14.2.3.
14.8.4 No heat exchanger provided to make use of waste heat.	New and Existing POTW's Refer to 14.2.4.
14.8.5 Inadequate consideration of fresh air supply and overall ventilation requirements.	New and Existing POTW's Refer to 14.2.5.
14.8.6 Improper feed equipment selection.	New and Existing POTW's Refer to 14.1.5.
14.8.7 Inadequate provisions for reliable auxiliary fuel source.	New and Existing POTW's Refer to 14.2.7.
14.8.8 Inadequate consideration of impact of recycle streams on main stream processes.	New and Existing POTW's Refer to 14.1.6.
14.8.9 Improper selection of materials of construction results in excessive corrosion.	New and Existing POTW's Refer to 14.2.9.
14.8.10 Improper consideration of reliability of mechanical components.	New and Existing POTW's Refer to 14.2.10.
14.8.11 Inadequate consideration of back-up equipment requirements.	New and Existing POTW's Refer to 14.2.11.

DEFICIENCY	CONSIDERATIONS
14.8.12 Inadequate consideration of impact of excess scale and ash on air pollution equipment and ash removal facilities.	New and Existing POTW's Refer to 14.2.12.
14.8.13 Improper selection of equipment drives for service in high-temperature areas.	New and Existing POTW's Refer to 14.2.13.
14.8.14 No oxygen analyzing equipment provided to monitor burn.	New and Existing POTW's Refer to 14.2.14.
14.8.15 No remote control capability provided for burners to optimize burn.	New and Existing POTW's Refer to 14.2.15.
14.8.16 No remote control capability provided for shaft drive to optimize burn.	New and Existing POTW's Refer to 14.2.16.
14.8.17 Improper use of mercury manometers for scrubber water flow measurement causes loss of mercury into system during system surges.	New and Existing POTW's Refer to 14.2.17.
14.8.18 No remote control provided for natural draft and induced draft flow control valves.	New and Existing POTW's Refer to 14.2.14.

DEFICIENCY	CONSIDERATIONS
14.8.19 Inadequate instrument monitoring of process flows (flue gas temperature, pressure) and inadequate number of monitoring points (before and after scrubber).	<u>New and Existing POTW's</u> Refer to 14.2.19.
14.8.20 No stack sampling ports provided.	<u>New and Existing POTW's</u> Refer to 14.1.11 and 14.2.19.
14.8.21 Lack of protective insulation on exposed hot piping.	<u>New and Existing POTW's</u> Refer to 14.1.12.
14.8.22 Inadequate access to incinerator ash container.	<u>New and Existing POTW's</u> Refer to 14.2.22.
14.8.23 Inadequate consideration of ultimate residue disposal.	<u>New and Existing POTW's</u> The addition of sludges to municipal solid waste may well provide an ultimate residue with a higher ash and metal content than the solid waste by itself. Care must be taken to ensure that the ultimate disposal facility can accept these materials.
14.8.24 Inadequate odor control.	<u>New and Existing POTW's</u> Refer to 14.2.24.
14.8.25 Inadequate air pollution control.	<u>New and Existing POTW's</u> Refer to 14.2.25.

Design Considerations

Category: 15.0 Rotating Biological Contactors



Unit Operation/Component: 15.1 General

DEFICIENCY	CONSIDERATIONS
15.1.1 Bearings located below grade and are susceptible to flooding.	New POTW's Locate RBC unit so that the bearing assembly is out of the tank and at grade level. Existing POTW's Method: Provide pressure lubrication system to minimize effects of flooding on bearings.
15.1.2 Buildings not insulated and facility loses heat in winter, causing wastewater temperature to drop.	New POTW's Provide insulated housing which is designed for the lowest ambient temperature to maintain the wastewater at a minimum of $55^{o}F$. Existing POTW's Method: Provide weather stripping, gaskets, and insulation. Supplemental heat input may be required in the form of portable heaters or permanently-mounted electric heaters.
15.1.3 Primary clarifiers not provided, causing settling and plugging of media.	New and Existing POTW's Provide for primary sedimentation facilities upstream of RBC units.

DEFICIENCY	CONSIDERATIONS
15.1.4 Excessive collection system detention times promote incoming septic waste.	New POTW's The design of the collection system should provide for a minimum wastewater velocity of 2 fps. The effective detention time of the pump station wet well should not exceed 10 minutes for the design average 24-hour flow. Existing POTW's Method: Provide aeration of pump station wet well by use of spargers or diffusers. The detention time should be maximized by setting the controls on the pumps so that the well is not pumped down very far. Materials: Compressor, piping.
15.1.5 Inadequate consideration of possible development of septic conditions in channels.	New POTW's Design channels for a flow velocity of 2 ft/sec at design flow. Provide means to clean out channels (i.e., to remove settled solids and/or scum). Provide the flexibility to aerate channels carrying raw wastewater. Existing POTW's Method: Inject air along the channels to maintain aerobic conditions. The channels could also be partitioned off to reduce their volume and, therefore, increase flow-thru velocities and the time wastewater or sludge is allowed to remain in them.
15.1.6 Sidestreams not accounted for in design of RBC units.	New POTW's Since the RBC units exhibit first-order kinetics at a specific hydraulic loading, a specific percentage removal of BOD will occur independent of the organic loading. The primary design criterion is hydraulic loading

DEFICIENCY	CONSIDERATIONS
	which must include the sidestream from other unit processes.
	Existing POTW's Method: If sidestream is producing an organic overload in the first stage, remove baffle between first and second stage to increase available surface area for first-stage treatment. Implement pretreatment and/or equalization of sidestreams prior to discharge to the RBC system.
15.1.7 Inadequate screening of raw wastes causes plugging of RBC media.	New POTW's Provide preliminary treatment via comminutors and bar screens. Remove rags and screenings from system rather than grinding them up and putting them back into the system. Existing POTW's Method: Construct grit removal and screening devices upstream of influent wet well. Refer to 2.1.3, 2.3.1, and 2.6.1.

Unit Operation/Component: 15.2 RBC

DEFICIENCY	CONSIDERATIONS
15.2.1 Bearings located below grade and are susceptible to flooding.	New and Existing POTW's Refer to 15.1.1.
15.2.2 Buildings not insulated and facility loses heat in winter, causing wastewater temperatures to drop.	New and Existing POTW's Refer to 15.1.2.
15.2.3 Insufficient tank mixing causes dead spots and solids deposition in RBC tank.	New POTW's Rotational velocity affects wastewater treatment in several ways: it provides contact between the biomass and the wastewater, it shears

DEFICIENCY	CONSIDERATIONS
	excess biomass, it aerates the wastewater, and it provides the necessary mixing velocity in each stage. Increasing the rotational velocity increases the effect of each of these factors. The optimum peripheral velocity for domestic wastewater is 60 ft/min. This corresponds to a rotational speed varying from 1.6 to 2.9 rpm, depending on the media size. Existing POTW's Method: Increase sheave size to increase rotational speed of RBC unit. Provide supplemental air for mixing.
15.2.4 Improper design of overflow baffles between stages causes solids deposition.	New POTW's Specify underflow baffle to minimize solids deposition. Existing POTW's Method: Construct wooden baffles with underflow design.
15.2.5 Inadequate screening of raw wastes causes plugging of RBC media.	New POTW's Provide preliminary treatment via comminutors and bar screens. Remove rags and screenings from system rather than grinding them up and putting them back into the system. Existing POTW's Method: Refer to 2.1.3, 2.3.1, 2.6.1, and 15.1.7.

DEFICIENCY	CONSIDERATIONS
Unit Operation/Component: 15.3 Secondary Clarification	
15.3.1 No provision for addition of chemicals to improve settling characteristics.	New POTW's Provide a chemical addition system to enable the operator to feed settling aids, such as alum or polymer, to secondary clarifiers. Existing POTW's Method: Install chemical addition system near effluent trough of RBC system. Allow in-line mixing between effluent trough and center well of clarifier. Materials: Chemical make-up and storage system, piping, and related appurtenances. Building to house equipment and chemicals.
15.3.2 No provision for measuring and sampling waste sludge flow.	New POTW's Provide flow meters on sludge waste lines and specify a flow totalizer as part of the instrumentation package. This allows the POTW operator to compute a solids balance for solids handling purposes. Existing POTW's Method: Install a flow meter in the waste sludge line. Install 1 1/2 to 3 inch sample tees on sludge pump discharge line. Materials: Flow meter, pipe valves, and related appurtenances.

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