

DOCUMENT RESUME

ED 151 219

SE 024 030

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TITLE Advanced Trickling Filters. Training Module
2.112.4.77.
SPONS AGENCY Department of Labor, Washington, D.C.; Iowa State
Dept. of Environmental Quality, Des Moines.
PUB DATE Sep 77
NOTE 64p.; For related documents, see SE 024 025-047;
Contains occasional light and broken type; Charts
marginally legible; Removed EPA Forms 7500-5 pages 1,
2, 4, 5, 6 due to marginal legibility

EDRS PRICE MF-\$0.83 HC-\$3.50 Plus Postage.
DESCRIPTORS *Instructional Materials; *Post Secondary Education;
Secondary Education; *Teaching Guides; *Units of
Study; *Water Pollution Control
IDENTIFIERS Operations (Wastewater); *Trickling Filters; *Waste
Water Treatment

ABSTRACT

This document is an instructional module package prepared in objective form for use by an instructor familiar with operation and maintenance of a trickling filter wastewater treatment plant. Included are objectives, instructor guides, student handouts and transparency masters. This is the third level of a three module series and considers troubleshooting, operation and maintenance, manpower needs, laboratory equipment needs, secondary sedimentation and sludge disposal problems. (Author/RH)

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ADVANCED TRICKLING FILTERS

Training Module 2.112.4.77

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The publication of these training materials was financially aided through a contract between the Iowa Department of Environmental Quality and the Office of Planning and Programming, using funds available under the Comprehensive Employment and Training Act of 1973. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Department of Labor, and no official endorsement by the U. S. Department of Labor should be inferred.

September, 1977

024 030

SUMMARY

Module Number Module Title:
114MWW Advanced Trickling Filters:

Apx. Time Submodule Titles:
16 Hours

1. Troubleshooting Trickling Filter Problems And Records Keeping
2. Field Experience in Troubleshooting
3. Manpower Needs for Trickling Filter O&M
4. Laboratory Process Control- Cause vs. Effect
5. Observations for Trickling Filter Sedimentation Units
6. Sludge Disposal Problems for Trickling Filter Humus

Overall Objectives: This module is intended for advanced operators and managers of Trickling Filter Systems. The trainee will identify various Trickling Filter problems and solutions in actual plant visits. Manpower estimates, lab, process control, and sludge disposal problems will also be identified (70%) as part of the examination at the end of module.

Instructional Aids: Lesson outlines and Objectives
Overhead Transparencies and Projector
Student Handout Material

Instructor Approach: Lecture and Discussion
Field Plant Inspection and Tour
Stimulate Student Input

References:

- 1) WPCF - MOP 11, 1977. "Operation of Wastewater Treatment Plants".
- 2) EPA - Course 17.9.2 - Instructor Packets. "Troubleshooting O&M Problems at Wastewater Treatment Plants".
- 3) EPA - Technology Transfer Series - "Land Disposal of Sludge, Estimating Laboratory Needs for Wastewater Treatment Plants".
- 4) R. Layton. - Personal Notes and Teaching Outlines, 1970-1977.
- 5) EPA - 1972. "Orientation to Wastewater Treatment Operation", A Training Manual.

SUMMARY

Module Number 114MWW	Module Title Advanced Trickling Filters
Apx. Time 7 hours (Hours 1-7)	Submodule Title Troubleshooting Trickling Filter Problems

Objectives

The Trainee will:

- Describe the process of troubleshooting as described.
- List the characteristics of a troubleshooter.
- Recognize the cause, effect, and recommended solutions for trickling filter problems involving:
 - a. media problems
 - b. nuisance conditions
 - c. organic & shock loads
 - d. hydraulic overloads
 - e. vent & aeration problems
 - f. laboratory control & reporting

Instructional Aids:

Detailed lesson plans
audio visual aids

Instructor Approach:

Stimulate discussion
Lecture, as required

ADVANCED TRICKLING FILTER - 114MWW MODULE
 Instructor Lesson Guide
 Hours 1&2 of 16

Item #	Instructor Discussion	Instructor Key Points of Emphasis
1	<p>What is troubleshooting? Troubleshooting uses technical and human skills</p> <p><u>Technical Skills:</u></p> <p>Recirculation, loadings, etc.</p> <p><u>Human Skills:</u></p> <p>Budget, people problems, etc.</p> <p>Problem Solving</p>	<p>1) Ask Question</p> <p>2) Ask for examples of each</p>
2	<p>What would you consider the ideal traits of a good troubleshooter?</p> <p>Some suggested are as follows:</p> <p><u>Technical Skills:</u></p> <ol style="list-style-type: none"> 1) experience 2) knowledge - mechanical & equipment 3) Scientific knowledge - chemistry, biology & math 4) Solving problem ability - analytical mind 5) other - like knows where & when to get help 6) Common Sense <p><u>Human Skills:</u></p> <ol style="list-style-type: none"> 1) Empathy for operators & operations 2) Ability to listen & understand 3) Honest & sincere (wants to help) 4) Respect for operator ideas 5) Mutual participation with operator in problem solving 	<p>1) Ask question</p> <p>2) Develop on board, write trainee comments - 15 minutes</p> <p>2) Emphasize key points of a good troubleshooter</p> <p>3) Have each trainee write down the name of the "best troubleshooter" they know and BRIEFLY tell why they think that person is good (allow 10-15 minutes)</p>

3 Define troubleshooting as problem-solving

Show overhead #3

Over-head Review "The Process of Troubleshooting Chart (from EPA course, 179.2) 15 minutes

4 Start with Problem - must first identify (abnormal trickling filter performance).

Then list on board, information available (ask for first) (step 6)

Sources of Information for Troubleshooters. (from EPA course 179.2):

1. In-plant information:
 - a. plant log and records
 - b. NPDES
 - c. plant O&M manual
2. EPA Materials:
 - a. inspection and evaluation forms
 - b. performance evaluation manual
 - c. case histories - plant performance
 - d. technology transfer and other technical information
3. Other Technical Materials:
 - a. State manuals and guidelines
 - b. WPCF
4. Other Persons Who Can Be Called for Assistance:
 - a. The operator
 - b. other local people
 - c. state specialists
 - d. federal specialists
 - e. operations consultants
5. Personal Observations:
 - a. plant personnel and operators
 - b. physical conditions of plant
 - c. working conditions
 - d. inter-personal relationships
 - e. management behavior
6. Analyses and Tests:
 - a. compare plant performance to normal operating characteristics
 - b. sampling and testing program
 - c. process modifications and testing

INSPECTION CHECKLISTS*

RE-INSPECTION PREPARATION CHECKLIST

- Review past inspection reports
- Review as-built plant drawings
- Review plant flow diagrams
- Review plant performance records
- Review plant design parameters

VISIT PLANT

Use detailed check list (Instructor Emphasizes trickling filter outline)

ROUTINE INSPECTION CHECKLIST

The following items should be considered during a routine inspection:

- Plant site maintenance, including landscaping, fencing, and buffer zone.
- Plant aesthetics, including odors, building maintenance, and painting requirements of outside visible structures
- Plant operation and maintenance records
- Plant staffing for operation and maintenance
- Plant laboratory, including equipment, test procedures, and staff
- Plant influent
- Plant effluent
- Equipment records
- Safety equipment
- Sampling locations, methods, and frequency
- Solids disposal, both grit and digested sludge
- Plant bypass frequency
- Infiltration inflow

*This check list is reproduced from Appendix B, "Basic Elements of State/Federal Programs on Operations & Maintenance of Municipal Wastewater Treatment Facilities," CH2M HILL, report to the U.S. EPA, 3 February, 1975

Item
5,
cont'd

DETAILED INSPECTION CHECKLIST

The detailed inspection checklist outlined is based on unit operations. For each individual plant, consideration should be given only to those unit operations relevant to that specific plant.

GENERAL

Consider all items outlined on the "Routine Inspection Checklist".

SCREENING AND COMMINATION

- Clean area
- Odors
- Storage of screenings
- Frequency of removal
- Maintenance of mechanical equipment

GRIT REMOVAL

- Amount of grit removed
- Amount of grit in other plant units
- Volatile solids in grit
- Maintenance of mechanical equipment
- Clean area
- Odors
- Adequate venting of grit chambers for enclosed areas; explosive or toxic gases
- Explosion-proof lights and other items in enclosed areas

SEDIMENTATION BASINS

- Clean area
- Safety railings
- Maintenance of mechanical equipment
- Odor problems
- Corrosion on metal and concrete
- Floating sludge or gas bubbles
- Frequency of scum removal and if scum is allowed to accumulate/on scum barrier
- Raw sludge pump maintenance and cycling frequency
- Pressure gauges (are they provided on sludge pumps?) - this gives operation conditions and tells of stoppages in sludge lines
- Plugging in sludge lines and valves
- Raw sludge removal and percent solids content
- Percentage removal of SS and BOD

BIOLOGICAL TREATMENT UNITS

Trickling Filters:

- Dosing performance
- Filter flies and odors
- Corrosion of piping
- Maintenance of equipment
- Clogging of nozzles
- Condition of filter media, that is, ponding
- Cleaning program of underdrains
- Performance of final clarifiers (similar to primary sedimentation outline)
- Frequency of sludge handling from high rate system, as it becomes septic faster than from standard system
- Recirculation volumes
- Condition of biological growth on filter media
- DO of effluent
- Icing of filter surface is inspection is performed in cold climatic regions

Activated Sludge Process:

- Frothing in aeration tank
- Corrosion
- Maintenance of equipment such as blowers, filters, diffusers, air lines, sludge pumps, and scrapers
- MLSS in aeration tank
- Flow and concentration of return sludge
- DO in aeration tank
- Bulking sludge in final clarifiers
- Rising sludge in final clarifier
- Waste sludge flow
- Sludge depths in hoppers and cycling rates of the sludge pumps
- Condition of launders on final clarifier
- Sludge valves and lines for sign of plugging
- Final clarifiers for skimmings removal
- Safety measures, such as guard rails.

CHLORINATION

- Chlorine requirements based on effluent chlorine residual requirements and coliform organisms
- Equipment maintenance and pipe corrosion
- Safety measures such as gas masks (cannister and self-contained breathing), separate ventilation of chlorine feed rooms, explosion-proof electrical fixtures to prevent corrosion, storage of chlorine cylinders, and capped valves on chlorine cylinders
- Check method and frequency of cleaning chlorine contact table

SLUDGE DIGESTION

- Raw sludge solids concentration
- Percent volatile matter in raw sludge
- Temperature ranges of operation
- Sludge pumps for operation and maintenance
- pH control
- Mixing and/or recirculation
- Safety measures
- Gas production
- Percent reduction of volatile matter for digesting process
- Quality of supernatant for volatile acids, alkalinity, BOD, SS
- Supernatant withdrawn and recycled back into plant headworks

SLUDGE CONDITIONING

- Process used, such as gravity, elutriation, pressure flotation, or chemical coagulation
- Proper lab tests conducted, depending on the process
- Equipment operation and maintenance
- Solids uniformity and grit
- Process efficiency
- Odors, oils, and greases
- Clean area

SLUDGE DEWATERING

- Process such as drying beds, vacuum filters, or centrifuges
- Equipment operation and maintenance
- Clean area
- Odors, oils, and greases
- Check that adequate laboratory tests are conducted depending on dewatering process used

SLUDGE DISPOSAL

- Process such as incineration, sanitary landfilling, or soil conditioner
- Equipment operation and maintenance
- Odor and storage area
- Clean area

EQUIPMENT (GENERAL)

- Operation and maintenance records of all major equipment
- Manufacturer's parts and operation and maintenance manuals of all major equipment
- Operation and maintenance of equipment according to manufacturer's recommendation
- Excessive down time
- Preventive maintenance program
- Calibration of instruments
- Operation and maintenance of instruments

Item 5
cont'd

RECORDS (GENERAL)

- Availability at plant of as-built design drawings
- Availability of operational records
- Availability of laboratory records
- Data management procedures

STAFFING (GENERAL)

- Adequate staff available at facility for both the plant and laboratory
 - Certification of plant operators
 - Training programs for staff operators
 - Shift requirements for operators
 - Adequate administrative staff and supervision
 - Adequate salaries for staff
-

ContactWhy

a. The afternoon before the tour of the plant, contact the city manager and/or superintendent. Have him contact the plant that you are there and where you are staying.

b. Early, 7-8 a.m. on the first day of the visit, call the superintendent or meet the city manager and let the plant know you are coming. Either at coffee shop or sitting at the plant, have discussions.

c. Ride with or follow superintendent to the plant

a. (1) To explain the reason for the visit, what they can expect and that you can and will help.
(2) Is the city cooperative?
(3) What particular problems do they have? Such as personnel, budget, industries, etc.

b. (1) Have coffee with the operator or superintendent and let him tell you about the plant. Emphasis on chlorine/disinfection problems.
(2) Get feeling for knowledge of personnel and level of knowledge in treatment.

c. What specific industries and/or unusual problems contribute to the influent quality?

7

Review Flow Chart to Finish

Use overhead for Item 3

8

Summarize: Troubleshooter, and what the process consists of. Have students list or comment briefly on their experiences.

END

ADVANCED TRICKLING FILTER - 114MWW MODULE
 Instructor Lesson Guide
 Hour 3 of 7

Slide #	Information	Key Points
1	Trickling Filter Problems: Media related Nuisance Conditions Organic Overloads Distribution & Hydraulic Vent & Oxygen Problems (odors) Laboratory Control Problems	1) Review the 7 basic problem types
2	Media related Problems: Ponding Ice Formation Excessive Growth	1) Ask students to discuss each, have they seen these?
3	Troubleshooting a Problem: Identify Problem identify cause identify solution(s)	1) Stress the three key items in trickling filter troubleshooting
4	Ponding: What is it?	1) Word Slide 2) Ask Question
5	Ponding: What causes it?	1) Ask question, stimulate discussion
6	Right! Ponding - Media clogged and stopped by materials: snails-and/or larvae Media - too small Media - broken (fines) Excessive organic loading without proper recirculation	Word slide
7	Ponding: Methods of Correction?	1) Word slide 2) Ask Question

8

Right!

Ponding can be eliminated by:

- 1) jet surface with high-pressure stream of water.
- 2) stop distributor over ponded area; flush excessive growth from voids.
- 3) Stir or rake filter surface to lessen or remove any accumulations
- 4) dose filter with chlorine at about 5 mg/l for several hours; do during low flow periods to minimize required chlorine dosage (less preferable)
- 5) if possible, flood filter and allow it to stand for 24 hours; don't let water rise high enough to get into distributor bearings; resulting liquid is a mess to dump (less preferable)
- 6) If the problem is caused by snails, Malathion can be used to kill snails

Proposed Methods of Correction:
(for continual ponding)

- 1) For continual ponding, filter must be dismantled to determine what specific cause is: then take necessary corrective action.
- 2) Media too small or non-uniform; screening and/or replacement is in order
- 3) Media deterioration; media must be replaced
- 4) Broken or clogged underdrains; flush out underdrain system or remove media and make necessary repairs. In most cases, media replacement will be necessary.

- 1) Lead discussion with class
- 2) Taken from EPA 179.2

9	<u>Ice Formation - Solution:</u> -regulate recirculation rate (super cooling?) -reduce spray by adjustment of splash plate -cover filter -break up and remove ice -discharge warm flow to filter influent if possible.	1) Word slide, discuss 2) Stimulate discussion
10	<u>Excessive Growth - Solution:</u> -use above procedures, Cl ₂ -adjust recirculation -physically remove -enforce sewer use ordinance	1) Word slide, discuss
11	<u>Fly & Snail Control - Solution:</u> -use Malathion (if approved) -agricultural brand - E-5 (55%) -flood filter just below stone -apply apx. 1 gal/acre foot -leave 4 hours -skim snail & fly carcasses	1) Word slide, discuss pesticides and regulation
12	<u>Snail Control - Mechanical:</u> -snail:pencil-eraser-sized -periwinkle type Joplin, MO (since 1967) Snails, apx. 1½ yd ³ /day! Removed by sedimentation. Basin is 10'x10'x32" high 4"drain, stilling basin weir height - 24" 2 MGD flow Experienced digester "scum" 85-90% removal Cost \$16,000 Located before grit unit.	1) Ref. cited

13	Questions?	
14	Student Problem: Have them work	1) Handout to be given to the student 2) Stress inspection of media and underdrain (safety) 3) Organic loading (too high)* for corresponding recirculation rate

END

STUDENT HANDOUT - PONDING

You have observed trickling filter #2 in your plant -- starting to pond. Inspection of the wastewater influent to the filter shows that it is not septic. What systematic procedure would you perform to identify the cause of and solution for the problem? The filter has a 190 ft. diameter and is 7 feet deep with a recirculation ratio of 1:1. The BOD₅ to the filter is 197 mg/l.

First I would _____

ADVANCED TRICKLING FILTER - 114MWW MODULE
Instructor Lesson Guide
Hour 4 of 7 (Troubleshooting)

Instructor Discussion

Review problem assigned as Homework
in Hour 3

Review: Procedure to:

Identify Problem
Cause/Effect
Solutions

Discuss: Ponding
Systematic Procedure (have students develop)
Calculation of Hydraulic and Organic Loadings
Recirculation Ratio (needs to be increased)

Review Attached Student Handout

STUDENT HANDOUT
TRICKLING FILTER MEDIA RELATED TROUBLESHOOTING
(Ref. EPA Course 179.2)

A. Filter Ponding - occurs when voids between filter media are clogged by biological slimes or inert materials.

B. Likely Causes

1. Excessive organic loading without corresponding high recirculation rate; organic load too heavy in comparison with hydraulic load.
2. media too small or not sufficiently uniform in size.
3. media deterioration due to improper material selection, or freezing.
4. voids becoming clogged by excessive growth of insect larvae or snails (perrywinkle snails quite common on filters)

C. Effect and Symptoms of Problems

1. Ponding on filter surface.
2. Intermittent flooding of filter.

D. Proposed methods of correction

(For intermittent ponding, caused primarily by excessive loading, or by temporary clogging)

Ponding can be eliminated by several methods. In order of least effect on effluent, corrective measures include:

1. jet surface with high-pressure stream of water.
2. stop distributor over ponded area; flush excessive growth from voids.
3. stir or rake filter surface to lessen or remove any accumulations.
4. dose filter with chlorine at about 5 mg/l for several hours; do during low flow periods to minimize required chlorine dosage (less preferable).
5. if possible, flood filter and allow it to stand for 24 hours; don't let water rise high enough to get into distributor bearings; resulting liquid is a mess to dump (less preferable);
6. if the problem is caused by snails, Malathion can be used to kill snails. (Review state regulations)

E. Proposed Methods of Correction (for continued ponding)

For continual ponding, filter must be dismantled to determine what specific cause is; then take necessary corrective action.

1. media too small or non-uniform - screening and/or replacement is in order.
2. media deterioration - media must be replaced!
3. broken or clogged underdrains - flush out underdrain system or remove media and make necessary repairs. In most cases, media replacement will be necessary.

ADVANCED TRICKLING FILTER - 114 MWW MODULE
Instructor Lesson Guide
Hour 5 of 7 (Troubleshooting)

Give the following problems to the class and ask them to write solutions. - allow approximately 25 minutes of student work. Use groups of 3 or 4 to stimulate group interactions.

Problem: You are visiting a wastewater treatment plant and you detect the odor of septic conditions near the trickling filters. Describe what you would look for and how you would evaluate the causes, effects (symptoms), and solution to correcting this problem.

Instructor: Stimulate group solution to the problem - follow student handout as attached - Answer questions about proper recirculation rate and organic loading, if required.

STUDENT HANDOUT
TRICKLING FILTER - TROUBLESHOOTING NUISANCE & ODOR PROBLEMS
(Ref. EPA Course 179.2)

LESSON OUTLINE

1. Troubleshooting Guide to Problem 1. (10 Minutes)

A. Identity of Problem

As stated, this was an odor problem.

B. Likely Causes

1. Since the plant inflows are not septic, the most likely cause is inadequate ventilation within the filter. This would be caused if air and water temperatures are equal and no thermal exchange takes place.
2. During hot weather, odors may develop from a filter in good operating condition.

C. Effect and symptoms of Problem

1. Black slimes are likely to develop on the media surface.
2. Hydrogen sulfide odors develop in the vicinity of the filters.
3. Nitrification is not occurring - no breakdown: NH_3 Nitrite Nitrate

D. Proposed Methods of Correction

1. Maintain aerobic conditions in and properly operate sewer system and settling tanks.
2. Examine underdrain system and ventilation facilities; stoppages in either of these will cut down natural flow of air; natural ventilation occurs if vents are open and difference in air and water temperature is greater than 3°F .
3. Increase recirculation rate to provide more oxygen and to increase sloughing of surface slime.
4. Practice good housekeeping around filter; keep slime growths, resulting from wastewater splashing, off sidewalks and other surfaces.
5. In extreme cases it may be necessary to provide forced air ventilation.

ADVANCED TRICKLING FILTER - 114 MWW MODULE
Instructor Lesson Guide
Hour 6 of 7 (Troubleshooting)

Give the following assignment and ask the class to work in small groups writing down response.

Problem: How would you troubleshoot uneven distribution problems in a trickling filter operation? List the likely causes, symptoms, and solution to this problem. Why is it worth considering?

Instructor: Encourage small group discussion and after 25 minutes, review the problem using attached student hand-out. Also review hydraulic overload, if time permits.

STUDENT HANDOUT
TRICKLING FILTERS TROUBLESHOOTING DISTRIBUTION PROBLEMS
(Ref. EPA Course 179.2)

- A. The problem of poor and uneven distribution of waste over the filter, including clogged nozzles and leaking seals.
- B. Likely Causes
 - 1. Poor spray pattern on filter
 - 2. Nozzle clogging
 - 3. Leakage of seals
 - 4. Continued or frequent clogging indicates solids carry-over from primaries; may be due to abnormal loadings to plant of grease or suspended solids. During fall of year sewer clogging due to leaves is a possible problem.
- C. Effects and Symptoms of Problems.
 - 1. Less efficient waste removal by filter due to uneven loading.
 - 2. Sloughing of filter growths.
 - 3. Ponding on certain areas of filter media and drying on others.
 - 4. Valleys or ridges on the filter stone.
- D. Proposed Methods of Correction
 - 1. Adjust splash plates, clean slime growths of plates; replace missing plates.
 - 2. Clean nozzles regularly with small wire or brush, and thoroughly flush distributor piping.
 - 3. Attempt to correct seal leakage problems - which are common. Some seal leakage may be normal.

ADVANCED TRICKLING FILTER - 114MWW MODULE
Instructor Lesson Guide
Hour 7 of 7 (Troubleshooting)
Overall Hour 7 of 16

Instructor: Leads a discussion about the required testing (type of tests), equipment used and common problems encountered in laboratory support for trickling filters.

Review "Sampling and Testing" with class from EPA Manual "Procedural Manual for Evaluating the Performance of Wastewater Treatment Plants". Also cover points on student handout regarding Troubleshooting Lab Equipment.

Answer questions.

STUDENT HANDOUT

TRICKLING FILTER TROUBLESHOOTING - LABORATORY PROCEDURES AND EQUIPMENT (Ref. EPA Course 179.2)

Evaluation of equipment adequacy may readily be performed by comparing existing equipment capabilities to generally accepted listings of minimum and optimum equipment requirements found in Chapter III, "Estimating Laboratory Needs for Municipal Wastewater Treatment Facilities."

Should equipment deficiencies be uncovered, the inspector may advise the proper municipal official of the apparent need and recommend they discuss the matter with their consulting engineer.

1. Analytical Balance

- a. Purpose:
precision weighing
- b. Application:
preparation of standards, gravimetric analysis of:
total solids, suspended solids,
sludge moisture, oils and
grease, etc.

- c. Troubleshooting Signs:
mounted on heavy shock-proof table
level adjusted as necessary

2. Trip Balance

- a. Purpose:
coarse weighing
- b. Application:
weighing samples for MLSS, sludge wet weights, grit analysis, filter cake moisture content, preparation of chemical solutions

- c. Troubleshooting Signs:
maintained and used in accordance with manufacturer's instructions.

3. pH Meter

- a. Purpose:
pH measurement
- b. Application:
industrial waste, plant waste streams, electrometric determination of alkalinity, acidity and ammonia endpoints

- c. Troubleshooting Signs:
-frequently calibrated with buffers
-buffer solutions fresh, free of algae
-electrodes immersed in water for storage
-electrode tip unbroken, free of scratches
-electrode reservoir filled
-electrode rinsed between operations
-samples mixed during determinations
-sample temperature noted, meter adjusted

4. Drying Oven

- a. Purpose:
controlled constant temperature drying of samples and glassware
- b. Application:
determination of total, suspended, dissolved solids, sludge drying, drying of primary chemical standard reagents, drying gravimetric glassware
- c. Troubleshooting Signs:
 - oven equipped with thermometer
 - temperature controls functional
 - doors fit properly to minimize heat loss
 - chamber clean and free of scale
 - samples arranged to prevent cross contamination
 - located away from heat sensitive equipment

5. Electric Muffle Furnace

- a. Purpose:
ignition of volatile substances
- b. Application:
determination of volatile and fixed solids of suspended, total, activated, and digester solids/sludges. Ignition of barium sulfate precipitates in sulfate analysis.
- c. Troubleshooting Signs:
 - furnace is equipped with temperature control
 - temperature indicator functional
 - chamber free of ash and residues
 - fumes properly exhausted
 - not located near heat sensitive equipment

6. Desiccator

- a. Purpose:
provide moisture free/absorbent atmosphere for temporary storage of analytical powders and glassware. Ambient drying of oil and grease fractions prior to weight determination
- b. Application:
drying of standard chemical powders, cooling of gravimetric test glassware and specimens prior to weighing. (e.g., total solids oils and grease, sulfates, sludges).
- c. Troubleshooting Signs:
 - desiccator is available to every lab
 - used for all specimen cooling operations prior to reweighing
 - doors and lids properly seal
 - desiccant material is active
 - desiccant replenished when indicated.

7. BOD Incubator

- a. Purpose:
provide constant temperature,
light-free environment for storage
of BOD specimens
- b. Application:
BOD incubation at 20°C
- c. Troubleshooting Signs:
 - temperature controls functional
 - proper temperature maintained
 - door closes and seals properly
 - chamber clean and free of biological growths

8. Water Distillation Unit

- a. Purpose:
provide distilled water having
degree of purity from 0.055 micro-
mhos/cm to 10 micromhos/cm
- b. Application:
product water used in preparation
of chemical solutions, BOD dilu-
tion water, bacteriology, chemical
analyses, rinsing of analytical glass-
ware
- c. Troubleshooting Signs:
Difficulties encountered in
bacteriological and chem-
ical tests often relate to
poor quality distilled
water
 - storage containers have
tight covers and not exposed
to airborne dust, gases,
fumes
 - glass storage vessels of
borosilicate glass
 - boiler and condenser coils
free of scale
 - periodic cleaning to re-
move sediments
 - produce water frequently
tested for pH and conduc-
tivity to assure adequate
purity
 - delivery tubing free of
algae and slimes

9. Deionizer

- a. Purpose:
production of high purity water
by ion exchange rather than dis-
tillation
- b. Application:
same as for water distillation unit.
May be used to supplement distilled
water production
- c. Troubleshooting Signs:
 - ion exchange cartridges
proper type
 - exchange cartridges discard-
ed promptly when exchange
capacity is exhausted
 - recommended water feed
rate not exceeded
 - water product stored prop-
erly to avoid contamination

10. Colorimeter or Spectrophotometer

- a. Purpose:
quantitative measurement of water quality parameters by colorimetric technique
- b. Application:
commonly employed for phosphorus, nitrate, nitrite, hexavalent chrome, color, sulfate by turbidity method, phenols, residual chlorine, etc.
- c. Troubleshooting Signs:
 - colorimeter is delicate precision instrument and must be treated accordingly
 - common replacement parts are in stock
 - instrument properly calibrated prior to transmittance or absorbance readings
 - glass cells kept clean and free of scratches
 - filters used in accordance with operating instructions

11. Refrigerator

- a. Purpose:
low temperature storage unit
- b. Application:
storage and preservation of wastewater and sludge specimens - usually at 4°C. Storage of unstable chemical reagents
- c. Troubleshooting Signs:
 - temperature controls functional
 - proper temperature monitored frequently
 - interior clean and free of biological growths
 - storage capacity adequate for lab demands

12. Autoclave

- a. Purpose:
sterilization by steam of liquids and solids
- b. Application:
sterilization of dilution water, glassware, sample containers, growth media, related supplies necessary for bacteriological tests
- c. Troubleshooting Signs:
 - temperature and pressure controls functional
 - proper time-temperature for materials being sterilized
 - confirmation of adequacy of sterilization by test strips tape indicators, etc.
 - materials sterilized have been properly wrapped and sealed to prevent contamination
 - sterilized materials properly stored to avoid contamination

13. Electric Hotplate and Heater

- a. Purpose:
variable temperature heating of liquids and solids
- b. Application:
preparation of analytical solutions, evaporation, concentration, hydrolysis, digestion, other analytical operation
- c. Troubleshooting Signs:
-number of hotplates and heaters adequate
-temperature controls functional

14. Dissolved Oxygen Analyzer

- a. Purpose:
instrumental analysis of dissolved oxygen in liquids and gases
- b. Application:
analysis of dissolved oxygen, BOD testing sewage, industrial wastes, stream samples
- c. Troubleshooting Signs:
-frequent and proper calibration of instrument by wet chemical or other means
-probe stored in water or moisture saturated atmosphere between testings
-probe surfaces cleaned according to manufacturer's directions
-probe electrolyte and membranes replaced as indicated
-sample velocity at probe tip maintained during determinations
-membrane replacement kit in stock

15. Bacteria Incubator

- a. Purpose:
controlled constant temperature for storage and cultivation of bacteria and biological specimens
- b. Application:
total coliform, fecal streptococci, other bacteriological testing
- c. Troubleshooting Signs:
-temperature controls functional
-thermometer or other temperature monitor system in place and operable
-chamber clean and free of spillage and/or biological growths
-doors close and seal properly
-unit located away from temperature extremes

16. Water-Bath Incubator

- a. Purpose:
controlled constant temperature bath
- b. Application:
fecal coliform bacteria testing, digestion of wastewater specimens, assist color development in nitrate testing
- c. Troubleshooting Signs:
temperature controls functional
-thermometer or other temperature monitor system in place and operable
-chamber and bath water clean, free of rust and sediments
-adequate cover and seal to minimize evaporative losses
-bath water level maintained

17. Conductivity Meter

- a. Purpose:
measurement of solution electrical conductance and resistance
- b. Application:
quality control testing of distilled water, screening of water and waste specimens
- c. Troubleshooting Signs:
-electrode clean and kept in distilled water between determinations
-frequent calibration against known electrolyte references
-sample temperature corrections made

18. Total Organic Carbon Analyzer

- a. Purpose:
instrumental analysis of carbon fractions in solutions by combustion/infrared technique
- b. Application:
rapid assay of total, inorganic, and organic carbon fractions in water and waste samples. Data may correlate with BOD and OCD, and (may be) applied accordingly in treatment plant process control
- c. Troubleshooting Signs:
-inspector should refer questions to qualified person due to complexity of instrument and test procedure

19. Atomic Absorption Spectrophotometer

- a. Purpose:
instrumental analysis of metal ions by atomic absorption or emission technique
- b. Application:
analysis of NPDES required heavy metal ions, monitoring industrial wastes for possible toxic metal ions
- c. Troubleshooting Signs:
-determine instrument is properly installed with fume exhaust system
-inspector should refer questions to qualified person due to complexity of instrument and testing procedures

SUMMARY

Module Number
114MWW

Module Title
Advanced Trickling Filters

Apx. Time
4 hours
(Hours 8-11
of 16)

Submodule Title
Field Experience in Troubleshooting

Objectives

The Trainee will:

1. Identify and demonstrate knowledge of common procedures used to troubleshoot a poorly operating trickling filter plant using field observations.
2. Successfully complete EPA Form - for the plant inspected.

Instructional Aids:

Detailed lesson plans
Student Handouts

Instructor Approach:

Stimulate Discussion
Lecture, as required

ADVANCED TRICKLING FILTER - 114MWW MODULE
Instructor Lesson Guide
Hours 8, 9, 10, 11 (Field Trip & Work)

Item # Instructor Discussion

-
1. Instructor should be familiar with the Trickling Filter Plant, plans, problems, etc., and select a plant with poor operations, if possible.
- Travel to the plant - tour the facility, give instruction about EPA Form 7500 and the checklists provided in Hours 1 & 2 of Troubleshooting Section.
- Stress technical and human skills
 - Stress the six areas of Trickling Filter problems (discussed in Hour 3)
-
2. Allow 1 hour at end of tour to have conclusion reached with class as to causes, symptoms, and solutions to plant problems.
-
3. Collect EPA Forms 7500 from students - grade and return at the beginning of Hour 12
-

END

EPA FORMS 7500-5, PAGE 1, 2, 4, 5, 6 REMOVED PRIOR
TO BEING SHIPPED TO EDRS FOR FILMING DUE TO
MARGINAL LEGIBILITY OF THE ORIGINAL.

BEST COPY AVAILABLE.

SUMMARY

Module Number 114MWW	Module Title Advanced Trickling Filters
Apx. Time 1 hour (Hour 12 of 16)	Submodule Title Manpower Needs For Trickling Filter O&M

Objectives: The Trainee will:

1. Demonstrate a familiarity with the EPA publication "Maintenance Management Systems for Municipal Wastewater Systems".

by:

- 1) Estimating the number of manhours estimated for various types of wastewater plant maintenance including trickling filters
- 2) Develop a schedule that utilizes the minimum number of men to perform staffing requirements for around-the-clock work

Instructional Aids:

Detailed lesson plans
Handouts and Manuals

Instructor Approach:

Stimulate student initiative
through working exercises & problems
Minimum lecture time suggested

ADVANCED TRICKLING FILTER - 114MWW MODULE
Instructor Lesson Guide
Hour 12 of 16

Item
#

Instructor Discussion

Manpower Needs for Trickling Filter O & M

The instructor will read and understand:

1

The EPA Publication "Maintenance Management Systems For Municipal Wastewater Systems"

2

The attached work schedule for around-the-clock operation having the student develop this schedule, then providing a copy as attached.

The instructor will:

- 1) Provide a copy of the Manual and introduce this document to the trainee
- 2) Assist the student group in finishing the attached problem:

PROBLEM: As manager of a Trickle Filter Wastewater Treatment Plant that treats apx. 4 mgd with a three shift, 365 day/year operation, you are assigned the task of developing a work schedule to include the following persons:

- 1 supervisor (S)
- 1 chief operator and lab technician (C)
- 1 maintenance man and relief operator (R)
- 4 operators (1, 2, 3, 4)

Total staff (7 people)

AN EXAMPLE WORK SCHEDULE FOR
NEOSHO'S WASTEWATER PLANT

Supervisor = S Maintenance Man Operator = 2
 Chief Oper. & & Relief Oper. = R Operator = 3
 Lab Technician = C Operator = 1 Operator = 4

DAY	First Shift	Second Shift	Third Shift			Off
	Midnight-8 am	8 am - 4 pm	4 pm-Midnight	8 am-5 pm		
Mon 1	1	3	4	S	R	2-C
Tue 2	1	3	4	S	R	2-C
Wed 3	1	2	4	S	C	R-3
Thu 4	1	2	R	S	C	4-3
Fri 5	1	2	3	S	C	4-R
Sat 6	4	2	3	R	C	S-1
Sun 7	4	2	3	R	C	S-1
Mon 8	4	1	3	S	R	2-C
Tue 9	4	1	3	S	R	2-C
Wed 10	4	1	2	S	C	R-3
Thu 11	R	1	2	S	C	4-3
Fri 12	3	1	2	S	C	4-R
Sat 13	3	4	2	R	C	S-1
Sun 14	3	4	2	R	C	S-1
Mon 15	3	4	1	S	R	2-C
Tue 16	3	4	1	S	R	2-C
Wed 17	2	4	1	S	C	R-3
Thu 18	2	R	1	S	C	4-3
Fri 19	2	3	1	S	C	4-R
Sat 20	2	3	4	R	C	S-1
Sun 21	2	3	4	R	C	S-1
Mon 22	1	3	4	S	R	2-C
Tue 23	1	3	4	S	R	2-C
Wed 24	1	2	4	S	C	R-3
Thu 25	1	2	R	S	C	4-3
Fri 26	1	2	3	S	C	4-R
Sat 27	4	2	3	R	C	S-1
Sun 28	4	2	3	R	C	S-1
Mon 29	4	1	3	S	R	2-C
Tue 30	4	1	3	S	R	2-C

SUMMARY

Module Number 114MWW	Module Title Advanced Trickling Filters
Apx. Time 2 Hours (Hours 13 & 14 of 16)	Submodule Title Laboratory Testing - Equipment and Costs

Objectives: The Trainee will

1. Demonstrate a familiarity with the EPA document "Procedural Manual For Evaluating the Performance of Wastewater Treatment Plants" by developing a list for required laboratory testing and equipment used for the testing and estimated cost of the equipment for a 5 mgd Trickling Filter Plant.

Instructional Aids:

- 1) Lesson Plan
- 2) EPA Manual listed above
- 3) Sample laboratory catalogues from equipment suppliers (instructor should obtain)

Instructor Approach:

- Hour 13 - Distribute Manuals and review contents with trainees
- Hour 14 - Have trainees use manuals and catalogues to establish, testing, equipment and cost of equipment

ADVANCED TRICKLING FILTERS - 114MWW MODULE

Instructor Lesson Guide

Hours 13 & 14 of 16

Item

#

Instructor Discussion.

Instructor asks for the class to work in small groups of 3 or 4 and develop a list of tests to be monitored, equipment to be used, and estimated cost to be expected, after reviewing the document:

"Procedural Manual for Evaluating the Performance of Wastewater Treatment Plants"

Hour 13 - (1) The instructor distributes the manuals.
(free from EPA)

(2) Reviews with particular emphasis pages 31-38 - works examples from each page.

(3) Reviews one or two catalogues from major laboratory suppliers, with costs.

Hour 14 - Asks the students to develop the following:

(1) A list of lab tests for a 5 mgd Trickling Filter Plant

(2) A list of equipment required

(3) An estimated cost for this equipment

SUMMARY

Module Number 114MWW	Module Title Advanced Trickling Filters
Apx. Time 1 hour (Hour 15 of 16)	Submodule Title Observations For Trickling Filter Sedimentation Tanks

Objectives:

The Trainee will:

1. Become familiar with WPCF MOP 11, particularly with Chapter 14
2. Be able to list common operational problems with secondary sedimentation tanks.

Instructional Aids:

1. Lesson Plan
2. WPCF MOP 11 - Chapter 14, pages 183-188
3. Checklist in Hours 1 & 2

Instructional Approach:

Lecture and discussion

ADVANCED TRICKLING FILTERS - 114MWW MODULE
Instructor Lesson Guide
Hour 15 of 16

Item
#

Key Lesson Item

Follow MOP 11 - Chapter 14 - Discuss with students
Have them review their copy (Chapter 14, edited by R. Layton).

Key Instruction Points

1. Following MOP topical outline:

Objectives of secondary sedimentation
Factors influencing sedimentation
Process equipment
Normal operation
Operating problems (instructor should emphasize)
pages 185-188
Data collection and laboratory
Planned maintenance program

2. Review inspection checklist for secondary sedimentation
from Hours 1 & 2.

SUMMARY

Module Number 114MWW	Module Title Advanced Trickling Filters.
Apx. Time 1 hour (Hour 16 of 16)	Submodule Title Sludge Disposal Problems For Trickling Filter Humus

- Objectives: The Trainee will:
1. Be able to list the normal disposal techniques utilized for Trickling Filter humus.
 2. Identify the problems with handling this type of sludge

Instructional Aids:

- 1) Lesson Plan
- 2) Student Handout
- 3) EPA Manual - "Procedural Manual For Evaluating Performance of Wastewater Treatment Plants"

Instructor Approach:

Lecture and Discussion

ADVANCED TRICKLING FILTERS - 114MWW MODULE
Instructor Lesson Guide
Hour 16 of 16

Item
#

Key Lesson Item

1 Characteristics of Trickling Filter Humus:

- High water content (often 99%)
- Low solids (1 to 3%)
- Fluffy - large particles (sloughing)
- Hard to settle
- Hard to dewater
- Hard to digest. (already well digested)

2
Slide

Review plant flows and sludge return systems
(Figure)

Discuss problem units

- Secondary sedimentation
- Digestors, etc.

3

Ways to handle Trickling Filter humus

- 1) Return to head of plant - (often done) (added load)
- 2) Take to digester - Poor digestion if good trickling filter operation
- 3) Dispose of separately (seldom done) - Lagoons, etc.
- 4) Coil or vacuum filter (poor cake)
- 5) Incineration

Instructor discusses problems with each of these techniques

4

Instructor discusses volume reduction (dewatering, digestion, incineration, etc.) vs ultimate disposal:

- Landfill
- Lagoons (not just to dry)
- Land application
- Ocean disposal

Lead discussion of advantages and disadvantages of each.

5

Instructor leads discussion of pages 111 to 127 of reference "Procedural Manual For Evaluating Performance of Wastewater Treatment Plants" (as much as time permits)

End Hour 16 of 16

Examination Questions
Advanced Trickling Filters
Module 114MWW (16 Hours)

Name _____ Date _____

1. Troubleshooting is the process of _____ solving.
2. List three technical skills required to troubleshoot a trickling filter plant.
 1. _____
 2. _____
 3. _____
3. List two human skills required to troubleshoot a trickling filter plant.
 1. _____
 2. _____
4. "Empathy" means; _____

5. List five items that you would include on a routine check list for inspection of a trickling filter plant.
 1. _____
 2. _____
 3. _____
 4. _____
 5. _____
6. List five items you would place on an inspection checklist for troubleshooting a trickling filter plant.
 1. _____
 2. _____
 3. _____
 4. _____
 5. _____

7. List three types of records that you would inspect while visiting a trickling filter plant.

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____

8. What are three items concerning staffing of a trickling filter plant that you would evaluate as a troubleshooter.

- 1. _____
- 2. _____
- 3. _____

9. List three media related problems in a trickling filter plant.

- 1. _____
- 2. _____
- 3. _____

10. When troubleshooting you must first identify the _____ then identify the _____ and propose alternate _____

11. List two potential causes of ponding in a trickling filter (excluding snails)

- 1. _____
- 2. _____

12. Describe in detail how you would solve a snail problem in a trickling filter operation.

13, 14, 15. Describe a step by step procedure to investigate and solve a ponding problem. (50 words or less)

16. List the cause of psychoda fly problems in a trickling filter. (25 words or less)

17, 18, 19. Describe a step by step procedure to investigate and solve a psychoda fly problem. (50 words or less)

20. List two sources of organic overloads in trickling filter plants.

- 1. _____
- 2. _____

21, 22, 23. Describe a step by step procedure to investigate and solve an organic overloading problem:

24. If you were to develop a check list for distribution problems in a trickling filter plant operation, list three items that you would place on the list.

- 1. _____
- 2. _____
- 3. _____

25. What are two types of seals used in trickling filters?

- 1. _____
- 2. _____

26. A common trickling filter seal problem is _____

27. What causes a trickling filter to go "septic" (2 reasons)

- 1. _____
- 2. _____



28, 29, 30. Develop a step by step procedure to evaluate and solve a septic condition on a trickling filter. (50 words or less)

31. List three important tests used to evaluate a trickling filter performance.

- 1. _____
- 2. _____
- 3. _____

32, 33, 34. Explain how each of the three tests listed in question 31 are used. (25 words or less for each test)

- 1. _____

- 2. _____

- 3. _____

35. List two common deficiencies often observed in trickling filter laboratories.

1. _____

2. _____

36, 37, 38. How would you correct the problems you listed in question 35?

39. EPA form _____ is often used to evaluate wastewater treatment plants.

40. A useful reference in developing the cost of laboratory needs in a trickling filter plant would be:

41. List two problem areas in secondary settling tanks following a trickling unit.

1. _____

2. _____

42,-43. Discuss how you would prevent these problems as listed in question 41 above from occurring.

44. List 3 techniques to provide ultimate disposal of trickling filter sludge.

1. _____
2. _____
3. _____

45. List three common problems in handling trickling filter sludge.

1. _____
2. _____
3. _____

46, 47, 48. Discuss how you would solve each of these three problems as listed in question 45.

1. _____

2. _____

3. _____

SLIDE 1

TRICKLING FILTER PROBLEMS:

- 1) MEDIA RELATED
- 2) NUISANCE CONDITIONS
- 3) ORGANIC OVERLOADS
- 4) DISTRIBUTION & HYDRAULIC
- 5) VENT & OXYGEN PROBLEMS (ODORS)
- 6) LABORATORY CONTROL PROBLEMS

SLIDE 2

MEDIA RELATED PROBLEMS:

PONDING

ICE FORMATION

EXCESSIVE GROWTH

SLIDE 3

STEPS IN TROUBLESHOOTING A PROBLEM:

- 1) IDENTIFY THE PROBLEM
- 2) IDENTIFY THE CAUSE
- 3) IDENTIFY THE SOLUTION(S)

SLIDE 4

PONDING.

WHAT IS IT?

SLIDE 5

PONDING.

WHAT CAUSES IT?

SLIDE 6

RIGHT.

PONDING - MEDIA CLOGGED AND STOPPED BY MATERIALS:

- 1) SNAILS AND/OR LARVAE.
- 2) MEDIA TOO SMALL
- 3) MEDIA BROKEN (FINES)
- 4) EXCESSIVE ORGANIC LOADING WITHOUT PROPER
RECIRCULATION

SLIDE 7

PONDING.

METHODS OF CORRECTION?

SLIDE 8

PONDING CAN BE ELIMINATED BY:

- 1) JET SURFACE WITH HIGH PRESSURE STREAM OF WATER.
 - 2) STOP DISTRIBUTOR OVER PONDED AREA; FLUSH EXCESSIVE GROWTH FROM VOIDS.
 - 3) STIR OR RAKE FILTER SURFACE TO LESSEN OR REMOVE ANY ACCUMULATIONS
 - 4) DOSE FILTER WITH CHLORINE AT ABOUT 5 MG/L FOR SEVERAL HOURS, DO DURING LOW FLOW PERIODS TO MINIMIZE REQUIRED CHLORINE DOSAGE (LESS PREFERABLE)
 - 5) IF POSSIBLE, FLOOD FILTER AND ALLOW IT TO STAND FOR 24 HOURS; DON'T LET WATER RISE HIGH ENOUGH TO GET INTO DISTRIBUTOR BEARINGS; RESULTING LIQUID IS A MESS TO DUMP (LESS PREFERABLE)
 - 6) IF THE PROBLEM IS CAUSED BY SNAILS, MALATHION CAN BE USED TO KILL.
- PROPOSED METHODS OF CORRECTION: (FOR CONTINUAL PONDING)

FOR CONTINUAL PONDING, FILTER MUST BE DISMANTLED TO DETERMINE WHAT SPECIFIC CAUSE IS; THEN TAKE NECESSARY CORRECTIVE ACTION.

- 1) MEDIA TOO SMALL OR NON-UNIFORM; SCREENING AND/OR REPLACEMENT IS IN ORDER.
- 2) MEDIA DETERIORATED; MEDIA MUST BE REPLACED
- 3) BROKEN OR CLOGGED UNDERDRAINS; FLUSH OUT UNDERDRAIN SYSTEM OR REMOVE MEDIA AND MAKE NECESSARY REPAIRS. IN MOST CASES, MEDIA REPLACEMENT WILL BE NECESSARY

SLIDE 9

ICE FORMATION - SOLUTION:

- 1) REGULATE RECIRCULATION RATE (SUPER COOLING?)
- 2) REDUCE SPRAY BY ADJUSTMENT OF SPLASH PLATE.
- 3) COVER FILTER
- 4) BREAK UP AND REMOVE ICE
- 5) DISCHARGE WARM FLOW TO FILTER INLUENT IF POSSIBLE

SLIDE 10

EXCESSIVE GROWTH SOLUTIONS:

- 1) USE ABOVE PROCEDURES, Cl_2
- 2) ADJUST RECIRCULATION
- 3) PHYSICALLY REMOVE
- 4) ENFORCE SEWER USE ORDINANCE

SLIDE 11

FLY & SNAIL CONTROL - SOLUTIONS:

- 1) USE MALATHION (IF APPROVED)
- 2) AGRICULTURAL BRAND - E-5 (55%)
- 3) FLOOD FILTER JUST BELOW STONE
- 4) APPLY APX. 1 GAL/ACRE FOOT
LEAVE 4 HOURS
- 5) SKIM SNAIL & FLY CARCASSES

SLIDE 12

SNAIL CONTROL - MECHANICAL:

SNAIL; PENCIL - ERASER SIZED

PERIWINKLE TYPE

JOPLIN, MO (SINCE 1967)

SNAILS APX. 1 1/2 YD³/DAY

REMOVED BY SEDIMENTATION

Basin IS 10' x 10' x 32" HIGH

4" DRAIN; STILLING BASIN

WEIR HEIGHT 24"

2 MGD FLOW

EXPERIENCED DIGESTOR "SCUM"

85-90% REMOVAL

COST. \$16,000

LOCATED BEFORE GRIT UNIT