DOCUMENT RESUME

ED 210 167 SE 035 848

AUTHOR Stoltzfus, Lorna Chr., Ed.
TITLE Working for Clean Water, 1: Citizen Handbooks. An Information Program for Advisory Groups.
INSTITUTION Ohio State Univ., Columbus, Ohio. Information Reference Center for Science, Mathematics, and Environmental Education.; Pennsylvania State Univ., Middletown. Capitol Campus.
SPONS AGENCY Office of Water Program Operations (EPA), Cincinnati, Ohio. National Training and Operational Technology Center.
PUB DATE 81
CONTRACT EPA-CT-900980-01
NOTE 111p.; For related documents, see SE 035 849-850. Contains photographs which may not reproduce well.
AVAILABLE FROM Information Reference Center (ERIC/IRC), The Ohio State Univ., 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212 ($6.00).

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Advisory Committees; *Citizen Participation; Citizen Role; Community Planning; *Facility Planning; Municipalities; *Water Pollution; Water Resources
IDENTIFIERS Construction Grants; Waste Water Treatment; *Water Quality

ABSTRACT

Presented is material from an information program designed to help citizen advisory groups and local officials improve decision-making in water quality planning. This program is aimed at helping people focus on essential issues and questions by providing materials suitable for persons with non-technical backgrounds. The following chapters are included: (1) Role of Advisory Groups; (2) Public Participation; (3) Facility Planning in the Construction Grants Program; (4) Municipal Wastewater Processes, An Overview; (5) Municipal Wastewater Processes, Detail; and (6) Small Systems. The volume contains reading material and selected references. (CO)

An Information Program for Advisory Groups

Working for Clean Water

1

Citizen Handbooks

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Published by
SMEAC Information Reference Center
College of Education
The Ohio State University
1200 Chambers Road, Room 310
COLUMBUS, OH 43212

Photo Credits
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U S Forest Service
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U S Department of Interior
City of Miamisburg Parks and Recreation Dept
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This information program was financed with federal funds from the U S Environmental Protection Agency under Cooperative Agreement No CT900980 01 The information program has been reviewed by the Environmental Protection Agency and approved for publication Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency nor does mention of trade names or commercial products constitute endorsement or recommendation for use

Materials in this publication were prepared pursuant to a grant by the U S Environmental Protection Agency to The Pennsylvania State University Materials cited are not endorsed by the U S Environmental Protection Agency nor The Ohio State University

The EPA Information Dissemination Project is sponsored by the U S Environmental Protection Agency, Office of Water Program Operations, National Training and Operational Technology Center, Cincinnati, Ohio, and the College of Education and the School of Natural Resources, The Ohio State University

3

Preface

This information program is based on the assumption that the reader already has a basic knowledge and awareness of the important life-sustaining role that water plays in the biological, chemical, and physical cycles on the planet Earth. If the reader desires this kind of information, your local reference librarian can recommend books that discuss the topic.

* * * * * * * * * * * * * *

Working for Clean Water is an information program designed to help citizen advisory groups and local officials improve decision-making in water quality planning. The idea is simple—the more people know about a subject, the better prepared they are to make workable and practical decisions in meeting community needs. This program is aimed at helping people focus on essential issues and questions by providing materials suitable for persons with nontechnical backgrounds. Although this material was conceived and developed with the advisory group member in mind, it is useful for many other training situations. Persons benefiting from these water quality management educational materials will be local, state, and federal employees, public school and college students, and wastewater treatment authority members. The materials have already been used for these groups and were found to provide an excellent introduction to the subject.

These materials include handbooks, audiovisual presentations (slide/tape or 16 mm film), and instructor guides. The audiovisual presentations highlight major issues and important aspects of each topic. The handbooks elaborate on these points, provide additional detailed information, and include examples of how other communities have dealt with water quality and wastewater treatment issues. The instructor guides give suggestions on how to hold an information session including guided discussions on local topics of concern and some problem-solving exercises.

This volume is one of a series of three which contain the citizen handbook materials. The eighteen topics discussed in the individual handbooks are chapters in this three-volume set. The chapter topics are:

- Role of Advisory Groups
- Public Participation
- Facility Planning in the Construction Grants Program
- Municipal Wastewater Processes: Overview
- Municipal Wastewater Processes: Details
- Small Systems
- Innovative and Alternative Technologies
- Water Conservation and Reuse
- Land Treatment
- Cost-Effectiveness Analysis
- Environmental Assessment
- Financial Management
- Multiple Use
- Industrial Pretreatment
- Wastewater Facilities Operation and Management
- Urban Stormwater Runoff
- Nonpoint Source Pollution: Agriculture, Forestry and Mining
- Groundwater Contamination

The material in each chapter is not designed to make technical experts out of the readers. However, the chapters do contain essential facts, questions to consider, advice on how to deal with issues, and clearly-written technical background material. In short, each chapter provides information that will help advisory group members and local officials to better fulfill their roles.

Each chapter contains material addressed specifically to advisory group members; this information is printed in boldface type. There are often boxed-in sections of material containing examples, lists of advantages and disadvantages, questions addressed to local community needs, and other useful information. Two sections of material common to all chapters are case studies which are found on pages tinted gray and a "Need More Information?" section containing annotated resource materials with information on how to obtain them. In addition, a glossary of terms is provided at the end of each volume

If you would like more information about the program, copies of handbooks, instructor materials, or audiovisual aids, contact the EPA Information Dissemination Project for price lists and rental information.

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Acknowledgements

Of course a project of this magnitude cannot be completed without the help of many people. Those persons helpful in various phases of writing this publication, presenting instructor training workshops across the country, and/or developing the audiovisual presentations include Dr David A Long and Dr John B Nesbitt, College of Engineering, Penn State University; Prof Irving Hand and Dennis W Auker, Institute of State and Regional Planning, Penn State University; Dr Robert A Simko and Dr John H Joseph, Penn State University, Capitol Campus. A special thanks to Dr Thaddeus W Fowler, Dr Glenn C Markle, and Dr J Howard Johnston of the Teachers College, University of Cincinnati, who coordinated the instructor training workshops in the ten EPA regions.

The following persons have contributed numerous ideas and suggestions that are reflected in this final publication: Barry Jordan, EPA Project Officer, Office of Water Programs Operations, and members of the advisory team for this project: David Elkinton, State of West Virginia; Steve Frishman, Michele Frome, and John Hammond, private citizens; Joan Jurancich, State of California; Richard Heatherington, EPA Region 10; Rosemary Henderson, EPA Region 6; George Hoessel, EPA Region 3; George Neiss, EPA Region 5; Ray Pfortner, EPA Region 2; Paul Pinault, EPA Region 1; Earlene Wilson, EPA 7; Dan Burrows, Ben Gryctko, Robert Hardaker, and Steve Maier, EPA Headquarters.

Much appreciation is extended to Donna Kasaniwsky and Bob Flanagan of the EPA Office of Public Awareness for the invaluable graphics design and support they provided for this project. Also it was a pleasure to work with Charles Speers, who provided most of the artwork.

Other persons who played important roles in this project include Tess Startoni, Ann Kirsch, Jan Russ, Pat Rodkey, and Sandra Robbins, typists; Corinne Berti, Dave Brinjac, Fran Costanzi, Kathy DeBatt, Michael Lapano, Bert Marinko, Mike Moulds, and Terry Switzer, student assistants; Martin McGann-Smith and Design Associates, illustrators; Mitzi Dell, printing services; James F Lukens, photographer and A/V coordinator; George W Hughes, sound specialist; George Otto, graphic artist; James Canelos, instructional technologist. Special thanks also to the Gettysburg Advisory Group, the Pennypack Watershed Association, and the Swatara Water Pollution Control Authority. The type was set by Batsch Company; thanks to Bob Hillegas and Carol Young for courteous, efficient service. And, most important, thanks to our families (Sandy and Shari Cole, Carol and Martha Buskirk, and Gary Lake) for their patience, support, and inspiration.

The three-volume series was completed and published by the SMEAC Information Reference Center at The Ohio State University. Robert W. Howe and Chester E Ball coordinated publication activities.

Table of Contents

VOLUME 1

CHAPTER 1 **ROLE OF ADVISORY GROUPS** 1
Irving Hand and Dennis W. Auker
This chapter discusses the role of advisory groups in public participation. Basic issues concerning why advisory groups exist, who should be the members, what they should do, how they should organize, and how they can assess their effectiveness are included.

CHAPTER 2 **PUBLIC PARTICIPATION** 13
E. Drannon Baskirk, Jr., Dennis W. Auker and Irving Hand
What is public participation and why is it important, are addressed in this chapter. Principles, as well as techniques, for successful public participation programs are presented. The role of advisory groups in helping to develop successful programs is stressed.

CHAPTER 3 **FACILITY PLANNING IN THE CONSTRUCTION GRANTS PROGRAM** 29
Charles A. Cole and E. Drannon Buskirk, Jr.
An overview of construction grants process is given. Citizen involvement in the six major steps of facility planning is discussed in detail. Suggestions on areas of possible concern for local communities are noted.

CHAPTER 4 **MUNICIPAL WASTEWATER PROCESSES OVERVIEW** 45
Lorna Chr. Stoltzfus, E. Drannon Buskirk, Jr. and John B. Nesbitt
An overview of "what sewage is and how it is treated to remove various pollutants" is presented in this chapter. The discussions include the collection and transportation of sewage and the disposal of effluent and sludge. Information is given on how to plan and evaluate possible treatment process choices.

CHAPTER 5 **MUNICIPAL WASTEWATER PROCESSES DETAILS** 61
John B. Nesbitt and Charles A. Cole
This chapter describes in detail the various sewage and solids treatment processes. The sewage processes include preliminary, primary, secondary, and advanced stages. Treatment of the solids includes thickening, stabilization, dewatering, and ultimate disposal. The advantages and disadvantages for various processes are listed throughout the text.

CHAPTER 6 **SMALL SYSTEMS** 85
Charles A. Cole
This chapter addresses the various options available for disposal of wastewater from low-density housing areas. The types of small wastewater systems for onsite and cluster treatment include the septic tank as well as many conventional and innovative variations. Options for sewage collection and transport for small communities are also discussed.

VOLUME 2

CHAPTER 7 **INNOVATIVE AND ALTERNATIVE TECHNOLOGIES** 101
Charles A. Cole
Guidelines for identifying innovative and alternative technologies as defined by the EPA are presented. The criteria used for classification are discussed in detail. Several lists of examples are included.

CHAPTER 8 **WATER CONSERVATION AND REUSE** 117
Charles A. Cole
Reasons for conserving water, water usage, and wastewater production are discussed. Various aspects of water conservation plans, such as pricing strategies, public education, and water-saving devices, are presented along with things to consider when implementing the plan. Suggestions for reuse and recycling of water are mentioned.

CHAPTER 9 LAND TREATMENT 133
David A. Long
This chapter addresses, "What is land treatment? When should it be considered? What are the advantages?" Three categories of land treatment are discussed in detail. slow-rate irrigation. overland flow. and rapid infiltration Siting factors and cost-effectiveness of land treatment are included in this discussion

CHAPTER 10 COST-EFFECTIVENESS ANALYSIS 145
E Drannon Buskirk, Jr
This chapter deals with cost-effectiveness analysis and its objectives The following procedures are discussed: preliminary analyses, monetary and nonmonetary evaluation of alternatives, mitigation of potential problems, and plan selection

CHAPTER 11 ENVIRONMENTAL ASSESSMENT 161
E Drannon Buskirk, Jr
Environmental considerations in facility and water quality management planning is the focus of this chapter Types of environmental information included are the description of the current and future environment, evaluation of alternatives, discussion of environmental consequences, and ways to minimize adverse environmental effects Public input into environmental assessment at various stages in the planning process are cited

CHAPTER 12 FINANCIAL MANAGEMENT 177
Dennis W Aukerand Irving Hand
Financial management, such as the analysis and administration of the financial aspects of water quality planning, construction. and operations, is discussed A section concerned with how to pay for clean water includes discussions on federal grant eligibility, funding sources, and community and equity issues The impact of various institutional arrangements and secondary impacts of financial management are addressed

VOLUME 3

CHAPTER 13 MULTIPLE USE 193
E Drannon Buskirk, Jr
Opportunities in the multiple use of water and wastewater treatment plant grounds, buildings, and rights of way are discussed Planning strategies, implementation considerations, and funding sources are also presented

CHAPTER 14 INDUSTRIAL PRETREATMENT 209
John B Nesbitt
This chapter discusses the three major options industry has in treatment and disposal of industrial wastewaters One option is dealt with in detail pretreatment of industrial wastes which are then discharged to a municipal plant for final processing Pretreatment regulations and program requirements are discussed An example of an industrial pretreatment ordinance is included

CHAPTER 15 WASTEWATER FACILITIES OPERATIONS AND MANAGEMENT 221
David A Long
This chapter discusses the costs for operation and management (O & M) of wastewater treatment facilities, who pays for it, and why O & M of wastewater treatment facilities must be considered There is mention of what indicates good O & M practices and a more detailed section on factors found to cause poor plant performance

CHAPTER 16 URBAN STORMWATER RUNOFF 229
Robert A Simko
Urban stormwater runoff is defined, examples are given, its transportation is discussed, and the seriousness of the problem is addressed How to plan for control of urban nonpoint source pollution using structural and nonstructural Best Management Practices and how to implement the plan through voluntary or regulatory control programs are the major topics in this chapter

CHAPTER 17 NONPOINT SOURCE POLLUTION: 241
Agriculture, Forestry and Mining
E Drannon Buskirk, Jr
Nonpoint source pollution is defined and examples are listed. A six-step planning sequence is suggested for prevention and abatement of nonpoint source pollution. Separate discussions regarding plan implementation and Best Management Practices are presented for agriculture, mining, and forestry

CHAPTER 18 GROUNDWATER CONTAMINATION 257
Geraghty & Miller, Inc and Charles A Cole
The occurrence, importance, and chemical quality of groundwater are reviewed in this chapter Types, sources, and underground movement of contaminants are discussed How to provide for protection of groundwater from pollution in water quality management and facility planning is the final topic

Glossary

a

Absorption Field (Bed)—type of absorption system which uses a wide trench partially filled with gravel or crushed stone and covered with soil. Piping distributes treated sewage evenly throughout the bed for seepage into the ground

Account Sheet—a table for displaying impact assessment data to facilitate the comparison of alternatives

Acid Mine Drainage—water with an acidic pH which drains from working or abandoned mines

Activated Sludge—waste solids that have been aerated and subjected to bacterial action process for removing organic matter in raw sewage during secondary waste treatment

Adsorption—attraction and accumulation of one substance on the surface of another

Ad Valorem Tax—a tax imposed at a percent of the assessed property value

Advanced Waste Treatment—treatment processes that can increase waste removal beyond the secondary or biological stage. It includes removal of nutrients such as phosphorous and nitrogen and most suspended solids

Aeration—circulation of oxygen through a substance aids in purification

Aeration Tank—tank in which oxygen is circulated through wastewater as an aid in purification

Aerobic Digestion—breakdown of organic material by bacteria in the presence of oxygen

Aerobic Treatment—treatment of wastewater using organisms which are dependent on the presence of oxygen to break down organic matter

Aeroclarifier—settling tank utilizing the circulation of oxygen through the wastewater to aid in purification and sedimentation

Alkaline—wastewater with a pH above 7.0 contains relatively few hydrogen ions as compared to an acid

Alternative Wastewater Treatment Systems—various non-conventional methods of central or community wastewater treatment, sludge treatment, energy recovery and onsite systems that can save energy or cost as compared to conventional treatment systems; they are eligible for an additional 10 percent federal funding over conventional systems

Ammonia Stripping—process in which gaseous ammonia is removed from water by agitating a water gas mixture in the presence of air

Amortize—payment of loans with interest over a period of time

Anaerobic Digestion—breakdown of organic material by bacteria in the absence of oxygen

Aquaculture—growth of plants and animals in water instead of soil

Aquifer—underground bed or layer of earth gravel, or porous stone that serves as a reservoir for groundwater

Aquifer Recharge—adding water to an aquifer either by spreading on the ground surface or direct injection through wells

Artesian—water confined under pressure between impermeable layers such as clay or shale

b

Best Management Practice (BMP)—technique which deals most effectively with a given problem

Biochemical Oxygen Demand (BOD)—amount of dissolved oxygen required by bacteria to decompose organic matter in water measure used to indicate the amount of organic wastes in water

Biodegradable—capable of being decomposed through the action of microorganisms

Biodisc—a large rotating plastic disc which provides a surface area for the attachment and growth of microorganisms

Biological Contactor—a series of closely spaced biodiscs that provide a large surface area for the biological removal of organic pollutants from wastewater

Boundary—geographical area or the degree of study

Buffer Strip (Zone)—area of land which acts as a health and safety barrier between a treatment site and the public

c

Carcinogen—cancer-causing substance

Catch Basin—basin located at the point where a street gutter discharges into a sewer; catches and retains matter that would not pass readily through the sewer

Categorical Standards—effluent standards established for a particular industrial category

Centrifugation—the separation of sludge particles from the liquid by a rapidly rotating drum

Chemical Oxygen Demand—measure of the equivalent amount of oxygen required to break down organic and inorganic compounds in water

Chemical Precipitation—treatment technique that utilizes chemicals known as coagulants to cause solids in the wastewater to clump together and settle

Chlorine Contact Chamber—tank in which chlorine is added to treated wastewater for the purpose of disinfection

Clarifier—settling tank where solids are removed from wastewater

Cluster System—community form of onsite disposal, in which effluent from several individual septic tanks is transported to a central location for disposal

Coagulation—addition of chemicals such as lime or alum to clump together solids in wastewater so that they settle out faster

Coliform Bacteria—bacteria found in the intestinal tracts of humans and other animals; indicator of fecal pollution

Collection Line or Collector Sewer—sewers including laterals, submains, and mains

Combined Sewer—drainage system that carries both sewage and stormwater runoff

Comminutor—device that catches and shreds large objects in the raw wastewater entering sewage treatment plant

Composting—natural biological breakdown of organic material in the presence of air; a humus like material is the end product

Computer Modeling—the programming of a computer to use related input data for analyses or problem solving; such programs can predict events such as stormwater runoff and pollution loading

Conditioning—treatment of sludge with chemicals or heat so that the water may be readily separated

Connection Charge—the one time fee charged to property owners for the privilege of connecting to a central sewer system

Consultation—an exchange of views between governmental agencies and interested or affected persons or organizations; involves communication techniques such as advisory groups and public hearings

Contamination—presence of undesirable substances of biological, inorganic or organic composition

Cost-Effectiveness Analysis—determination of whether a project or technique is worth funding, both monetary and nonmonetary factors are involved

Criteria—guidelines for making decisions

d

Decreasing Block Rate Structure—cost of water to consumer increases as consumption increases, but at a decreasing rate

Deep-Well Injection—pumping high quality treated wastewater into the groundwater table

Delphi Survey—panel of experts independently moving towards consensus through responses to rounds of questions

Demography—statistical study of populations

Denitrification—anaerobic biological conversion of nitrates into nitrogen gas

Depreciation Costs—those costs associated with the loss of value for capital investments over a period of time due primarily to aging

Detention Basin—small basin for collecting stormwater runoff until the particulates picked up by rain water have settled

Dewatering—separation of water from sludge by vacuum pressure or drying processes

Digester—closed tank where wastewater sludge is broken down by intense bacterial action

Direct Discharge—discharge of an industrial waste other than to a publicly-owned treatment works

Disinfectant—chemical such as chlorine that is added to the wastewater to kill bacteria

Dissolved Solids—total amount of extremely small organic and inorganic material contained in water material capable of passing through a filter paper

Dosing Tank—receptacle in septic systems for providing large flow rates for a short time, rather than a trickle all the time. A dosing tank fills to a certain level and then flushes by siphon action

e

Easement—a right of way granting the use of land for a certain period of time

Ecology—study of relationships between organisms and their surroundings

Ecosystem—the interaction of organisms with their environment

Effluent—treated or untreated wastewater discharged into the environment

Electrodialysis—process by which electricity and a membrane separate mineral salts from sewage

Environment—surroundings, including all living and non living factors

Environmental Assessment—a document prepared by the EPA on its assessment of the impacts of proposed projects

Environmental Impact Statement (EIS)—detailed analysis of potential environmental impacts of a proposed project. It is required when the EPA determines that a project may have significant adverse environmental effects or is highly controversial

Environmental Information Document—report done by the grantee describing the environmental effects of proposed wastewater projects

Environmental Review—the process by which the EPA identifies and evaluates impacts upon the environment

Erosion—the wearing away of land surface by wind or water

Eutrophication—nutrient enrichment of a body of water producing excessive growths of aquatic plants that deteriorate the water environment

Evapotranspiration Systems—systems which depend on evaporation and transpiration (loss of water from plants) for wastewater disposal

f

Facility (201) Planning—planning local wastewater collection treatment and disposal facilities, the number refers to section of the Clean Water Act

Filtration—process of passing wastewater through a granular bed or fine screen for removing suspended matter that cannot be removed by sedimentation

Financial Management—the planning and administrative process by which financial resources are used in their most effective manner

Five-Year Frequency Storm—storm of a certain degree of severity that is expected to occur on an average of every five years

Flat Rate Structure—unit price of water is constant no matter how much is consumed

Floodplain—a nearly flat plain along the course of a stream that is naturally subject to flooding at high water

Force Main—sewer pipe under pressure from a pump to maintain the flow of sewage used where gravity flow is not feasible

g

General Obligation Bond—financial bond which is usually paid for by the community by raising taxes

Gravity Sewer—collection system which relies on gravity to transport wastewater from homes to a central treatment or disposal facility

Greenway—another name for "buffer zone"

Greywater—bathing, washing, and kitchen wastewater which is no longer potable, but can be filtered and used for other purposes

Grit Chamber—a tank where sand, cinders, and small stones are removed from wastewater by settling

Grit Removal—a stage of primary treatment during which sand, cinders, and small stones are removed from wastewater by settling out

Groundwater—water lying below the surface of the earth

h

Hardness—property of water that tends to cause scaling and inefficient use of soap, generally caused by the mineral calcium and magnesium

Heavy Metals—metallic elements such as mercury, chromium, cadmium, arsenic, and lead with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain

Holding Tank—tank used for storing wastewater prior to treatment usually used as an alternative for onsite problem areas

Horticulture—science of growing flowers fruits and vegetables

House Connection—sewer that carries wastewater from the house to a collection system

Hydraulic Overload—situation when a wastewater treatment plant is unable to handle the large flow of water entering it

Hydrologic Cycle—the flow of water through the air, land, and liquid environments

Hydrology—the science dealing with the properties, laws, and geographical distribution of water

i

Impact Mitigation—the lessening of the effects of a project on the environment

Implementation Cost—the cost to the community resulting from the use of selected mitigation measures

Incompatible Waste—a waste that will 1) upset a treatment works, 2) pass through a treatment works and cause a pollution problem, 3) be removed in the treatment works, but interfere with the disposal of the sludge from the treatment works

Increasing Block Rate Structure—cost of water to consumer increases as consumption increases, and at an increasing rate, also known as a penalty structure

Industrial Closed Loop—the treatment and reuse of waters used in production within an industrial plant so that no water leaves the plant

Industrial Pretreatment—treatment of industrial wastes before discharge to a municipal sewer system

x

Industrial Waste Ordinance—a common instrument of legal authority for enforcing pretreatment programs

Inequities—injustices or unfairnesses

Infiltration—seepage of effluent through the ground to the water table, *or* groundwater leaking into cracked or broken sewers

Infiltration and Inflow (I/I)—leakage of ground and surface water into sewers

Infiltration-Percolation Land Treatment—the application of treated wastewater onto land to allow it to percolate downward through the soil in order to remove nutrients such as phosphorous and nitrogen

Inflow—surface water that gets into the sewer system from storm drains, downspouts, and sump pumps often during periods of rainfall

Influent—the raw wastewater entering a sewage treatment plant or in more general terms the flow entering some process unit

Innovative and Alternative Treatment—a nonconventional, cost or energy-saving system for treating wastewater, it may qualify for an increase in the federal grant share by 10 percent from 75 to 85 percent

Innovative Waste Treatment Systems—systems that, through new ideas and techniques, significantly reduce costs or use of energy, improve control of toxic materials, improve operational reliability, or result in some other public benefit

Inorganic—substances such as metals or minerals that do not contain carbon

Insoluble—material that cannot be dissolved in a liquid

Interceptor Sewer—central sewer pipe which carries flows from the collector sewers in a drainage basin to the point of treatment or disposal of the wastewater

Intrusion Barrier—practice such as injecting groundwater with effluent in coastal areas to force back intruding salt water

Ion Exchange—exchange of one ion in water for another, specifically, exchanging ammonium nitrogen for sodium or calcium

Irrigation—application of water to vegetation to improve its production

j k l

Joint Treatment—treatment of both municipal and industrial wastes in a publicly-owned treatment works

Lagoon—a pond containing wastewater in which organic wastes are removed under aerobic or anaerobic conditions

Land Reclamation—the reclaiming and reuse of wasteland, swamps, marshes, and other unused or wasted land for useful purposes, such as cultivation or recreation

Land Treatment—process of applying wastewater to the land for removal of pollutants, sludge (the solids removed from wastewater) also may be disposed on land, but it is not called land treatment

Lateral—the small sewer serving individual streets

Leachate—water flowing from the bottom or sides of dumps or landfills that contains material dissolved from the materials stored in the dump

Leaching—process by which substances are dissolved and carried away by water, or are moved into a lower layer of soil

Legal Authority—statutes, ordinances, contracts, or agreements through which a municipality enforces its pretreatment program

Liaison—a go-between to ensure concerted action between parties

Life-Line Rate Structure—schedule providing a minimum basic amount of water at a small cost to all people

Limiting Zone—ground components such as impervious clay, rock, or the water table, which can render an area unsuitable for onsite disposal

Linear Park—a park which is located along a route, such as a sewer right of way or a streamside easement

Loading Rate—rate at which pollutants accumulate in soil or surface waters

Local Pretreatment Program—a procedure for regulating the discharge of industrial waste to a publicly-owned treatment works

m

Main—the intermediate-sized sewers connecting submains to plants or interceptor

Metabolism—process by which food is built up into living protoplasm, and protoplasm is broken down into simpler compounds with the exchange of energy

Methane—a gaseous by-product of the breakdown of organic matter in aerobic digestion

Mitigation Measure—technique for correcting or minimizing adverse environmental impacts

Mitigative Costs—the costs resulting from measures taken to lessen the impacts of a project on the environment

Monetary Costs—costs which can be measured in real dollars

Mound—a type of onsite disposal system utilizing an absorption field built on a bed of sand

Mound System—a type of onsite disposal utilizing an absorption bed of sand that is above the natural grade of the soil surface

Multiple Use—utilization of wastewater treatment facilities for other functions in addition to wastewater treatment, such as for recreational and educational purposes

n

Nitrification—conversion of nitrogen-containing substances such as proteins into nitrates by bacteria

Nitrogenous—containing the element nitrogen

Notification—information flow from the governmental agencies to interested or affected parties, involves communication techniques such as fact sheets, newsletters, and seminars

Nonpoint Source—a contributing factor to water pollution that can't be traced to a specific spot, such as agricultural fertilizer runoff or construction sediment

Nonstructural Management Alternatives—nonphysical approaches to pollution control such as land use controls such as zoning ordinances, improved urban maintenance programs, and construction activity schedules Often more effective and less costly than structural alternatives

NPDES Permit—permit for discharge of a municipal or industrial waste issued by the EPA or state regulatory agency

o

Onsite Disposal—disposal of wastewater on an individual lot, usually by a septic tank

Onsite Recycle—filtered and/or chemically-treated water which flows from a holding tank back to the toilet for subsequent reuse

Onsite System—a self-contained system which provides both treatment and disposal of wastewater on an individual lot

Opportunity Costs—monetary value of potential benefits lost as a result of a water quality action

Organic Matter—carbon-containing substance

Organic Waste Discharge—waste normally containing oxygen-demanding carbon compounds

Overland Flow—land application technique in which wastewater is sprayed onto gently sloping ground planted with vegetation

Oxidation Pond—a natural or man-made pond where wastewater is processed through the interaction of sunlight, wind, aquatic organisms, and oxygen

p q

Pathogen—disease-causing organism

Pathogenic—disease-causing

PCBs—polychlorinated biphenyls, a group of extremely persistent chemicals used in electrical transformers and capacitors

Peak Demand Rate Structure—increases price of water at high consumption periods, effect of leveling out water usage

Per Capita Daily Consumption—amount consumed per person per day

Percolation—downward flow or filtering of water through pores or spaces in rock or soil

Percolation Test—test for measuring the ability of soil to permit downward flow or permeability of water

Permeability—the degree to which a substance is capable of being penetrated by water

Permeable—quality of an aquifer that permits water to move through it

pH—hydrogen ion concentration in a solution

Point Source Pollution—pollution that is discharged from a single location such as a pipe

Pollutant Loading—amount of pollution contributed by a given pollution source over a time period

Polychlorinated Biphenyls (PCBs)—a group of toxic persistent chemicals used in making transformers and capacitors

Polymer—chemical compound consisting of repeating structural units

Ponding (Parking Lot, Rooftop)—occurs when a structure is designed so that rain water will collect within its boundaries and will exist at a specific location at a controlled flowrate, rather than running off uncontrolled

Porosity—open spaces or cracks in rock that might fill with water

Precipitation—process where chemicals combine to produce a compound that can be easily removed from a solution

Present Worth—the sum of money that must be placed on deposit at a given interest rate when the project construction begins to provide funds for the anticipated expenditures

Pressure Sewer—collection system in which wastewater is pumped under pressure from homes into a central treatment or disposal facility

Pretreatment—treatment of an industrial waste before discharge to a municipal sewer system

Pretreatment Effluent Standards—concentrations or amounts of toxic chemicals that may be discharged to publicly-owned treatment works.

Primary Clarifier—sedimentation tank used for removing settleable solids during primary treatment

Primary Impact—an effect directly related to a program or a project such as noise associated with the construction of a wastewater treatment plant

Primary Waste Treatment—first stage of wastewater treatment, removal of floating debris and solids by screening and sedimentation

Prohibited Wastes—wastes not allowed to be discharged to a publicly-owned treatment works

Public Participation—involvement of citizens in the decision making process

Pump Station—facility located along a sewer to maintain the flow of wastewater under pressure

r

Rapid Infiltration—land application technique in which wastewater is applied to land and is allowed to percolate through the soil and enter the groundwater, thereby treating the wastewater

Responsiveness Summary—document prepared by a planning agency indicating briefly to the public how decision makers have dealt with the actions, comments, and opinions of the public

Retrofit Devices—modifications to be installed on existing equipment

Revenue bond—financial bond which the community pays for through fees for the use of a facility

s

Saline—containing chemical salts, such as sodium, potassium, and magnesium

Salt Water Intrusion—the seepage of saltwater into fresh groundwater, often caused by overpumping the groundwater

Sanitary Sewer—collection system which carries wastewater produced in homes and industry, a separate collection system carries stormwater runoff

Sanitary Wastewater—refers to wastewater produced in homes and industry, and separate from stormwater runoff

Saturated Zone—layer below the water table where all cracks and pores are filled with water

Secondary Clarifier—sedimentation tank used for removal of settleable solids and scum created during secondary treatment

Secondary Impact—effect indirectly caused by a program or project, such as community growth induced by wastewater treatment facilities

Secondary Treatment—microbiological treatment of wastewater to consume organic wastes usually in the presence of oxygen Floating and settleable solids, and about 85 percent of oxygen demanding substances and suspended solids are removed Disinfection with chlorine is the final stage of secondary treatment.

Sediment Detention Basin—structural facility for temporarily storing stormwater runoff, during which time sediment is removed by settling

Sedimentation—a nonpoint source of pollution caused when construction disturbs the soil and sediment is washed from the construction site and enters urban stormwater. also more generally, the settling out of solids in wastewater or stormwater by gravity

Seepage Bed—type of absorption system which uses a wide trench partially filled with gravel or crushed stone and covered with soil Piping distributes treated sewage evenly throughout the bed for seepage into the ground

Separate Sewer—collection system which uses a sanitary sewer to carry only wastewater, and a storm sewer to carry runoff from rainwater

Septage—the solids collected in septic tanks over many months of operation

Septage Treatment—treatment of the solids collected in septic tanks over many months of operation

Set Price Rate Structure—each group of customers pays a set amount for any amount of water consumed

Sewer Interceptor—pipe which carries flows from the collector sewers in the drainage basin to the point of treatment or disposal of the wastewater

Sewer Lateral—small sewer pipes in the street to which the individual users connect

Silviculture—a phase of forestry dealing with the establishment, development, and harvesting of trees

Sludge—concentrated solids removed from sewage during wastewater treatment

Sludge Digester—heated tank where wastewater solids can decompose biologically and the odors can be controlled

Soil Profile—a graphic representation of soil components

Soluble—material that can be dissolved in a liquid to form a homogeneous material

Special Assessment Bond—financial bond issued to pay for public improvements where specific and direct benefits exist payments from parties who benefit retire the bonds

Spray Irrigation—the application of treated effluent onto land by spraying to provide irrigation

Stabilization—digestion of the organic solids in sludge so that they may be handled without causing a nuisance or health hazard

Step One Planning—initial planning stage for water pollution control facilities as administered through the Construction Grants Program

Step Two Design Grant—the second stage of planning when a water pollution control alternative is designed as administered under the Construction Grants Program

Stream Divergence—altering and/or dividing the flow course of a stream to reduce the effects of high flows on the land surface

Structural Management Alternatives—involve physical entities for delaying, blocking, or trapping pollutants. As compared to nonstructural approaches, they are often expensive

Structural Methods—construction of physical entities for delaying, blocking or trapping pollutants

Submain—sewer connecting laterals to mains

Subsidence Preventive—use of groundwater injection to prevent soil from subsiding or settling excessively

Supernatant—the relatively clear liquid that forms on the top of the digested sludge in the second tank of a two-stage anaerobic digestion process

Surface Water—accumulations of water on top of the ground, such as lakes, streams, and the oceans

Suspended Solids (SS)—tiny pieces of solid pollutants in sewage that cause cloudiness and require special treatment to remove

t

Thickening—separation of as much water as possible from sludge by gravity or flotation techniques

Total Dissolved Solids—the total amount of dissolved organic and inorganic material contained in water

Toxic Chemical—one [illegible]ber of deadly substances, it appears [illegible] published by the EPA

Transpiration—loss of water from plants

Trickling Filter—a secondary treatment process where wastewater seeps through a film of microorganisms growing on stones or a synthetic medium. As the wastewater trickles through the media, the microorganisms metabolize most of the organic pollutants

Turbidity—cloudy condition in water due to suspended silt or organic matter

201 Plan—local plan for wastewater treatment facilities under the Construction Grants Program of the EPA, the number refers to a section of the Clean Water Act

201 (Facilities) Planning—deals with the planning, designing, and construction of local wastewater treatment facilities

208 Plan—regional, state or areawide plan for water quality management, the number refers to a section of the Clean Water Act

208 (Water Quality Management) Planning—water quality planning with a state, regional, or areawide scope provides guidance for individual 201 facility plans

u

Unit Processes—individual functioning parts of a whole system

Unsaturated Zone—soil layers above the water table, where water adheres to soil particles and will not flow to a well

User Charge (Fee)—prices charged to the consumers of various public services

v

Vacuum Filter—a cylindrical drum filter which uses a vacuum to separate the solids from the water

Vacuum Sewer—collection system in which a central vacuum source maintains a vacuum on small-diameter collection mains

w x y & z

Wasteload Allocation—the maximum pollutant load that a facility is legally permitted to discharge to a water body

Water Quality Management (208) Planning—planning for the maintenance of clean water at the state, regional, and areawide levels

Water Quality Standard—levels of pollution parameters or stream conditions that must be maintained to protect desired uses of water

Water Recharge—adding water to an aquifer either by spreading on the ground surface or by direct injection through wells

Watershed—the land area that drains into a stream or river

Water Table—top surface of the groundwater

Wet Air Oxidation—process of breaking down solids in wastewater under conditions of high temperature and pressure

Wetlands—low lying lands which frequently have standing water on them, such as swamps, marshes, and meadows. Wetlands essentially are pollutant traps in natural environments

Chapter 1

Role of Advisory Groups

Irving Hand and Dennis W. Auker

Will They Listen To Us?

Anyone who participates on an advisory group will ask at some point Who cares about what we say, and will they do anything about it? This is an advisory group's most important concern. It is at the heart of key issues concerning the role of advisory groups

- Why have an advisory group?
- Who should be the members of an advisory group?
- What should an advisory group do?
- How should an advisory group be organized?
- What makes an advisory group worthwhile?

The understanding of these issues [illegible] how they are dealt with will go a long way in determining whether or not an advisory group is effective

There is no absolute guarantee for success in the work of an advisory group. However, the chances for success are better if the advisory group

- Has a balanced membership
- Is interested and willing to devote the necessary time
- Understands what is expected of all participants

This last point is especially important. Advisory groups need to realize their role, and the useful things they can do to help achieve clean water goals. It is essential that there is no confusion about their work.

From the outset the United States Environmental Protection Agency (EPA), the grantee who receives federal funds for planning and constructing wastewater treatment facilities, and the advisory group must understand what is expected of each other There can be no hidden agenda.

Why Have an Advisory Group?

or "What the h am I doing here?"

Public participation is as American as baseball The "association" or "interest group" is one important way Americans participate in making public policy Grassroots organizations, public interest and consumer groups, and voluntary service organizations all seek representation on an equal footing with governmental and economic interests Advisory groups can serve this purpose

The last two decades have shown that the public can play an extremely important role in decision making in both the public and private sectors Public participation is complex and often misunderstood. Not inherently "good" or "bad", it can help things to happen or it can bring projects to a grinding halt.

Through water quality management planning we are now making progress toward meeting our clean water goals. These actions affect everyone in some way taxes or user fees, availability of clean water for recreation, new wastewater treatment facilities, effects on growth patterns, and new political and statutory requirements. The people who will be living with the results should be involved in the planning The advisory group is a useful way to get such involvement

Advisory groups serve three important functions in water quality planning. They can assist in:

- identifying the public's interest in clean water

It's a Good Idea

- making diverse views known to decision makers
- taking local values into account in the decision-making process

Clean water is a necessity of life. We ignore its degradation at our own risk. How we go about achieving clean water in terms of time, responsibilities, and the use of assets (money, manpower, and natural resources) is important to the social, economic, and environmental well-being of the community as well as the nation.

Achieving clean water involves the government, the private sector, the people of an area, and special interests. There are many voices to be heard. The forum provided by the advisory group can help harmonize these voices into actions which will be of the greatest possible benefit.

A plan must fit the needs and conditions of the local area or community. Advisory group members should be knowledgeable about local issues, resources, and potential conflicts.

Resolving conflict, if it can be achieved at all, can often be accomplished through the use of an advisory group. Consensus is an achievable goal in an atmosphere of open communication and understanding.

It's the Law

Section 101 (e) of The Clean Water Act, states

Public participation in the development, revision, and enforcement of any regulation, standard, effluent limitation, plan or program established by the Administrator or any State under this Act shall be provided for, encouraged, and assisted by the Administrator and the States. The Administrator, in cooperation with the States, shall develop and publish regulations specifying minimum guidelines for public participation in such processes.

The 1977 Clean Water Act and EPA regulations implementing the Act require public participation when developing and carrying out water quality management plans. *Each state and agency conducting 208 areawide planning must have an advisory committee.* Advisory committees are required in 201 facilities planning only for large, complex, or controversial projects. The EPA's Rules and Regulations govern the formation and functioning of these advisory groups.

Who Should Be the Members?

There should be a balance of representative interests in the membership of an advisory group. The EPA regulations specify:

- Private citizens
- Public interest groups
- Public officials
- Representatives of organizations with substantial economic interests in the plan or project

Having such interests represented is important if a politically acceptable water quality management system is to be developed.

Size of Membership

There is no magic number for the size of an advisory group. It should not be so small as to be unrepresentative, or so large as to become unmanageable. A dozen like-minded people may make a very congenial group, but their recommendations and advice may be highly suspect because they may not represent a full range of community interests. A group of fifty would have difficulty in setting mutually agreeable meeting dates, in organizing, and even greater difficulty in reaching consensus on an issue.

The size of the group should be determined on a case-by-case basis by the complexity of the job to be done and the number of interested people. Time, interest, and a pertinent agenda are the essential ingredients for an advisory group that expects to function successfully.

Identification of Membership

The grantee is charged with the responsibility of establishing an advisory group. This agency must identify the private citizens, public interest groups, economic interests, and the public officials who are interested in or who might be affected by a project. The agency must make active efforts to inform people in the area, and get suggestions for potential advisory group members. These activities include:

- Announcements to news media
- Written notices to interested organizations

- Public appearances
- Direct contacts.

During its first meeting the advisory group should check to see if its membership is representative. Are any relevant individuals, organizations, or interests missing?

What Should An Advisory Group Do?

The advisory group must recognize that the primary responsibility for decision making in water quality management lies with elected officials or their appointees Even so, the role of an advisory group can be extremely useful during the planning process It is essential that early on a well-defined, important role is established for the advisory group

Gives Advice

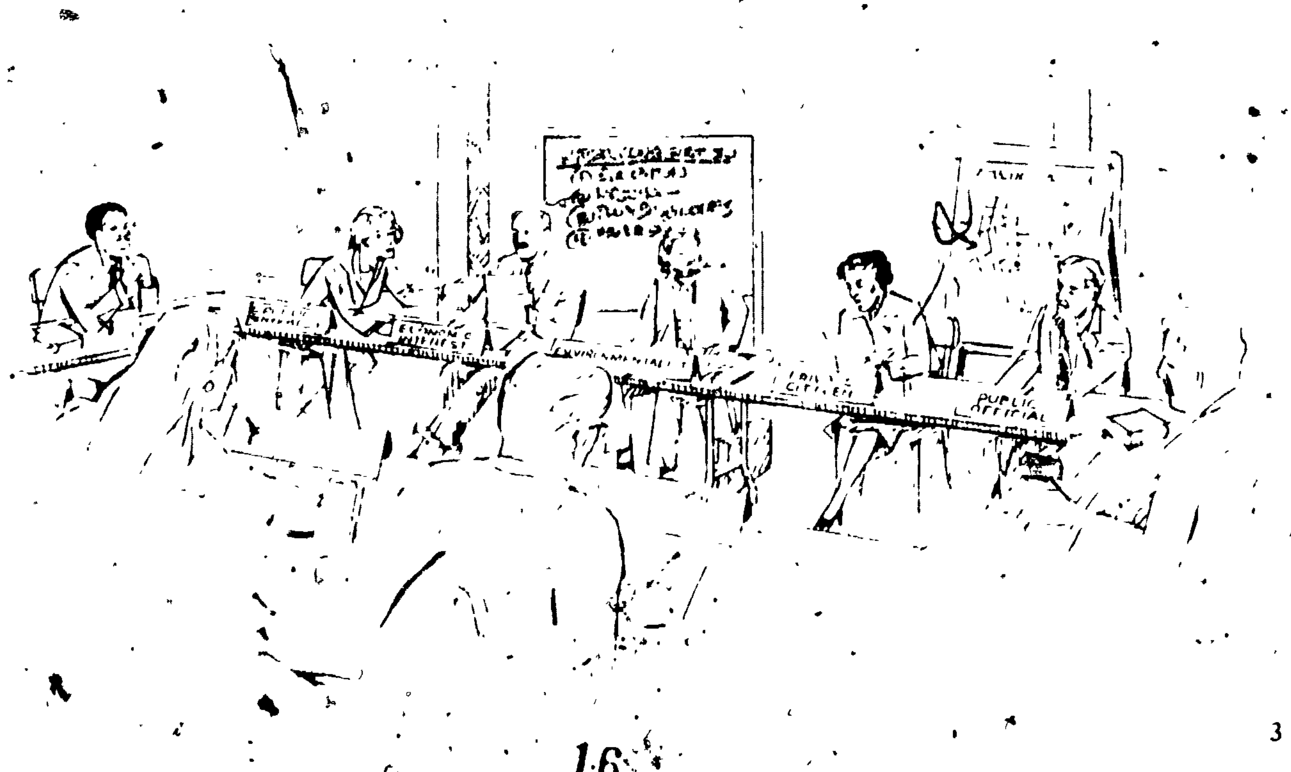
The responsibility of the advisory group is to *advise* This can be an important undertaking if several things happen, including

- The group does its homework in understanding the issues
- The group develops practical, thought-out recommendations.
- The group achieves consensus in support of its recommendations
- The group establishes credibility through its work

Remember, the role is to advise! An advisor is *not* expected to become a professional or a technician in water quality management planning Advisory groups may not be able to offer highly detailed and technical judgments However, they should have enough technical knowledge and an understanding of local conditions to provide credible advice about policy matters Advisory groups should make sure that the public's views and values are communicated to the grantee.

While gaining competence in water quality planning, the advisory group should always remember its responsibility An advisory group represents the public It is not part of the staff Many advisory groups have suffered when they inadvertently have become working extensions of the grantees and their staffs

Water quality planning is done at several levels 208 planning has a state, regional, and areawide scope The 201 deals with planning, designing, and constructing local wastewater treatment facilities Although these plans sometimes overlap, they are basically compatible Local 201 facility planning issues are often addressed in 208 planning State 208 planning documents are correspondingly used as an informational resource in 201 facility planning



201 Issues

- What are the water quality problems?
- Are the existing control facilities adequate?
- What unique resources does the area have that are worth protecting?
- How large should a new facility be if it is to be cost-effective?
- How much wastewater will the population produce?
- Where does industry fit into the facility-sizing picture?
- What about commercial and industrial wastewater flows?
- How is the total wastewater flow estimated?
- Is it better to reduce flows or to plan for growth?
- What geographic areas will the facility serve?
- Are there any small-scale service area options?
- What are the regional options?

208 Issues

- What is the economy of the region, and how will it develop?
- What will be the future population, and how will it be distributed?
- How significant is the rural or urban stormwater runoff?
- What future land uses are projected, and what existing laws and regulations apply?
- How is the state and areawide water quality management plan expected to be implemented and operated?
- What are the nonpoint sources of pollution in the area?
- How does water quality management planning relate to other types of local, county, and areawide planning? How are differences resolved?

From such current and future issues the advisory group will select its agenda of work, always keeping in mind the overall objectives and schedule of the project. This should be done with a clear understanding from the grantee as to where the advisory group can be most helpful. The group should determine if it has the resources to deal with those responsibilities, and then develop a course of action.

Also the progress of the project should be monitored as it relates to the agenda of the advisory group. To do this effectively efforts must be made to increase the understanding and competency of the group members. The training sessions offered by the EPA and the grantee can be of assistance.

Makes Recommendations

The advisory group assists public officials in their final decision-making responsibilities. It offers recommendations to these officials on the important issues involved in water quality planning.

Promotes Dialogue

The workings of the advisory group should encourage constructive communication and understanding among all parties. This kind of "give and take" is extremely important throughout the planning process. It will help to develop

- Mutual respect for various viewpoints
- A willingness to take all considerations into account
- The ability to arrive at recommendations that serve the public interest

In order to promote dialogue, each member has the dual responsibility of representing as clearly and accurately as possible his/her ideas, and of listening carefully to the views of others. Often this key responsibility is overlooked. However effective advisory groups have members who are good talkers and good listeners.

Responsibilities of the Grantee

The grantee is expected to provide support for the activities of advisory groups, and consider their recommendations. The EPA regulations address a number of the responsibilities of the assisted agency

- Establish advisory groups
- Inform people in the affected area
- Receive suggestions as to the make-up of the advisory group
- Provide information, technical skills, and staff support
- Carefully consider advisory group recommendations and requests, and respond to them
- Transmit the advisory group s recommendations to the decision-making officials
- Involve the advisory group in a public participation program

Communication is crucial to effective water quality planning and implementation A liaison often conducts relationships between the grantee and the advisory group The effectiveness of the liaison can be judged through a few questions Is this person comfortable in working with people in an advisory group-agency relationship? Are the activities of the advisory group relevant and mutually agreeable? Are the requests or recommendations of the advisory group receiving reasonably prompt consideration? Is the advisory group receiving sufficient support?

Responsibilities of Advisory Group Members

Become knowledgeable of the needs and values of the community

Listen to the viewpoints of all advisory group members

Attend meetings regularly

Take actions and present findings to the grantee

Help mobilize community support for water quality management decisions

The advisory group interacts with many agencies and interests

How Should An Advisory Group Be Organized?

An advisory group should determine the details of its own organization. Time should not be wasted in establishing an elaborate structure. Time should be spent dealing with activities that the group determines are important

Choose Officers

Minimal organization should include a chairperson and vice-chairperson A temporary leader may be chosen for the first few meetings After the members have become better acquainted with each other. permanent officers may be elected Officers should serve a specified term (one or two years) and be eligible for re-election

The group may also wish to have a secretary and or treasurer Since the grantee may provide recording and support services, this consideration depends upon the given situation

Establish By-Laws

The advisory group may establish its own by-laws and rules of procedure, or may use something which is more formal and generally recognized such as "Robert's Rules of Order" The group should not get bogged down in determining formal or detailed procedures so that the really important matters can be accomplished without delay

Schedule Meetings and Agendas

A regular schedule for meetings should be established as soon as possible However, this determination may be delayed until the membership is relatively certain (perhaps after the first two meetings) It is an important decision where busy people are involved, and conflicting schedules can bring last minute complications

Meetings should be scheduled, as necessary, and have an agenda They should be announced as far in advance as possible and should be open to the public An opportunity for the public to comment should be provided at each meeting

Regular attendance at meetings should be expected A policy concerning the number of acceptable consecutive absences by a member should be established If a member misses more than the accepted number, he/she should be requested to reconsider participation on the advisory group

Set Budget

The financial resources needed for the advisory group activities should be determined jointly by the grantee and the advisory group This could include technical assistance and payment for reasonable out-of-pocket expenses such as educational materials and field trips Provision can be made for these needs in the budget of the grantee with the agreement of the EPA

Appoint Subcommittees

Depending on how the advisory group wishes to proceed, subcommittees may be established to investigate and develop recommendations on specific issues Technical assistance may be provided if the group desires expert advice from someone other than the grantee or its consultant

Similarly, information should be sought from reputable people and interests in the community This will help to insure that advice to the grantee takes into account every appropriate resource and consideration

Recommendations made to the decision makers should be made through the advisory group, not subcommittees of the group Subcommittees should make recommendations only to the advisory group as a whole

Take Action

As fully as possible advisory group actions should express the consensus of the members Depending on the situation, unanimous actions may or may not be achievable. Gaining a significant consensus, not just a simple majority, should be a general objective

The advisory group is a forum It provides an opportunity for the presentation of wide-ranging views and judgments It provides the opportunity for argument, debate, and the resolution of conflicts It provides the opportunity to hear the facts, to become aware of individual concerns, and to appreciate the emotional climate that may bear on an issue

Present Findings

The preparation of various memoranda and short reports presenting the views and findings are part of the group's responsibilities. Just as important, these activities should be visible to all parties involved through meetings, press releases, and other efforts. This will help the community to gain an understanding about water quality issues, and how the community might best deal with them. The work of the advisory group should help provide a sound basis for taking actions.

What Makes An Advisory Group Worthwhile?

What happens to the recommendations of advisory groups? The answers given to this question reflect the usefulness of the group.

Are the recommendations simply ignored? Are they listened to and then rationalized away? Do they generate questions which require further consideration and response, perhaps including a modification of the recommendations? Are the recommendations followed? Every advisory group should periodically answer these questions. Simply put, the group's recommendations should be monitored. If the recommendations of the advisory group are being ignored or are not being followed in any significant way, members should determine why this is happening. The immediate reaction should not be one of hurt feelings and rejection.

Attention should be directed to whether or not the advisory group is dealing with the right issues. Perhaps the issues simply are not important to the community or to the decision makers. If this is the case the advisory group must decide whether to convince the community and decision makers of the importance of the issues, or modify the work program to address different issues.

Additionally, the advisory group should attempt to determine its credibility: does it have credibility? if not, why not? does the membership reflect the community? is the work regarded as meaningless? is the group perceived as being under someone's thumb, and therefore highly suspect?

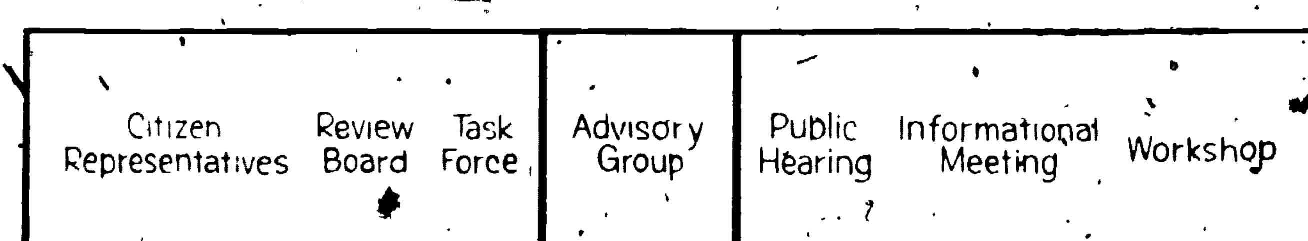
The group can strive to make its efforts worthwhile by:

- Developing a program that is important to the community and decision makers
- Being certain that recommendations are well thought out
- Being persistent in following up on recommendations
- Being protective of the reputation of the advisory group

For its part the grantee should:

- See that the advisory group has staff support and access to information
- See that the advisory group plays a role in the overall public participation program
- See that advice and recommendations of the advisory group are carefully considered

Remember, the advisory group is just one element of a larger public participation effort. The time and effort undertaken in advising the grantee can make a big difference in realizing the maximum benefit from water quality management planning.



The advisory group is one of many public participation opportunities

Case Study

Can an Advisory Group Make A Difference?

Gettysburg, Pennsylvania

Introduction

In the summer of 1979 the Gettysburg Municipal Authority's Advisory Group held its first meeting—three years *after* the Gettysburg 201 Wastewater Management Facilities Plan had been completed and approved by the Pennsylvania Department of Environmental Resources.

The complexities of designing a water quality management system which meets with public approval had again become a seemingly impossible task. The uncoordinated and sometimes contrary goals of state, local, and federal agencies became apparent. The result was the halt of facilities planning, with the process returning to preliminary planning in Step One[1] and preparation of an environmental impact statement.[2]

The specific circumstances surrounding this case are indeed unique. The basic problems, however, are repeated in similar situations across the nation. The question is, of course:

Can an advisory group make a difference?

Background

Located in southcentral Pennsylvania, Gettysburg is most commonly recognized for the Civil War battlefield surrounding the town. The wastewater treatment plant at Gettysburg became inadequate for the treatment of wastes in the 1960's. In 1969 the Pennsylvania Department of Environmental Resources (DER) informed the municipal authority that the plant was in violation of the state's Clean Streams Law, and that corrections had to be made. By 1973 the additional pollution load placed on the system by increased development and excessive stormwater infiltration prompted the DER to order a construction ban on new development until the situation could be improved. During this period it became obvious that a new treatment plant was needed. A consultant was hired to begin Step One planning for a new facility. During the facility planning period flow controls and water conservation corrected the infiltration and overload problem to the degree that the ban could be temporarily lifted. A schedule was developed for constructing new facilities, but opposition to the plan mounted.

The Arrangement

In the early 1970's regional facilities were favored by planners. Accordingly, the Gettysburg Plan called for a regional plant what would serve not only Gettysburg but also four townships surrounding Gettysburg. Between 1976 and 1978 the task of developing a mutual agreement between the townships and the Gettysburg Municipal Authority for service and financial arrangements was undertaken. It was finally secured in 1978. During the same period, the Authority worked with the National Park Service to resolve the concern that future development permitted or prompted by the sewage system would intrude on the beautiful historic surroundings of the park.

A Delay

The Authority was prepared in 1978 to apply for a Step Two design grant.[3] However, yet to be signed was a memorandum of agreement between six groups: The Municipal Authority, the DER, the U.S. Environmental Protection Agency (EPA), the Pennsylvania Historical and Museum Commission, the National Park Service, and the Council on Historic Preservation.

The Council on Historic Preservation in its draft memorandum of agreement called for zoning to prevent unsightly development in townships adjacent to the service area. However, such zoning in the conservative farm areas of southcentral Pennsylvania was impossible to achieve. The Council documented that a significant adverse cultural impact could occur without such restrictions on development. A full-scale environmental impact statement was ordered.

A New Beginning and an Advisory Group

What essentially happened at Gettysburg was that the goals of one agency conflicted with the goals of other interests. Regional treatment plants often spur development. In some areas this pattern may be desirable, but in Gettysburg such development would intrude on the national park. This plan conflicted with the goals of the Council on Historic Preservation. Thus, the planning returned to the beginning of the Step One planning process.

If an advisory group had been in existence throughout the project, could it possibly have made a difference in the final outcome? The answer would appear to be yes! An advisory group would have been integrally involved in the discussions over mutual agreements among the federal, state, and local agencies. An advisory group, representing the community as a whole, could have been a unifying force in these discussions.

The Gettysburg Advisory Group and Its Activities

The Gettysburg advisory group was formed in the summer of 1979 in accordance with the EPA guidelines for public participation. Its task was to advise the Municipal Authority on development of a treatment system which would not only be compatible with the goals of state and federal agencies, but would also meet community goals.

Membership

The Gettysburg advisory group membership, as selected by the Municipal Authority, consists of the following representation:

- Private citizens
- League of Women Voters
- National Park Service
- Taxpayers Association
- Historic Gettysburg Adams County
- Gettysburg Area Chamber of Commerce
- Retail Merchants Association
- Builders Association
- Landlords of Gettysburg
- Four public officials from area municipalities

Concern

The initial meetings of the advisory group developed a dialogue typical of newly formed organizations. Such questions as *Why are we here?* and *What can we possibly achieve?* characterized the feelings of the new group. This is not surprising since the citizens sitting on this advisory group had witnessed the complex history surrounding the previous plan. The proposed project had been controversial due to

- the concern over the ability of the community to afford a regional system
- sharing of costs by the municipalities involved
- the planning and zoning restrictions stipulated by the National Park Service
- the building ban implemented by the DER, and the possibility of future bans if a treatment facility was not built within reasonable time

Organization

At the first monthly meeting of the group, administrative responsibilities, budget, and scheduling were addressed. Informational materials were distributed.

At the second meeting the role of the advisory group was explained by both the chairman of the Municipal Authority and the Public Participation Coordinator of the EPA. A briefing about the history of the project was given. Following this discussion the group considered the role it was expected to play. One of the concerns noted was that the advisory group might find itself in the thankless role of being arbitrators between all the parties involved.

After the first two meetings the group still had not selected permanent officers. However, during the third meeting a permanent chairperson was elected.

Initiatives

After discussion of organizational and procedural matters at the second meeting, the group chose to hear a progress report from the representatives of the consulting firm preparing the environmental impact statement (EIS) for the EPA. It was hoped that this report might help the group better understand its role. Indeed, this did occur. During the presentation it became obvious that the degree of investigation into water supply was inadequate in the eyes of the advisory group. The citizens in the advisory group are acutely aware of water supply problems, as they have seen many of their neighbors' wells go dry. The advisory group suggested that the EIS consultant take a more in-depth look at the water supply problem since it would potentially restrict development in the future, reduce the needed size of the plant, and jeopardize the cost-effectiveness of a regional system.

The advisory group ended its second meeting by requesting the EPA Public Participation Coordinator to delay the public hearing scheduled on the EIS until the advisory group could analyze and comment publicly on the information being developed by the EIS consultant. They requested that an agenda and pertinent materials be distributed in advance of the third meeting so that they would have better opportunity to prepare.

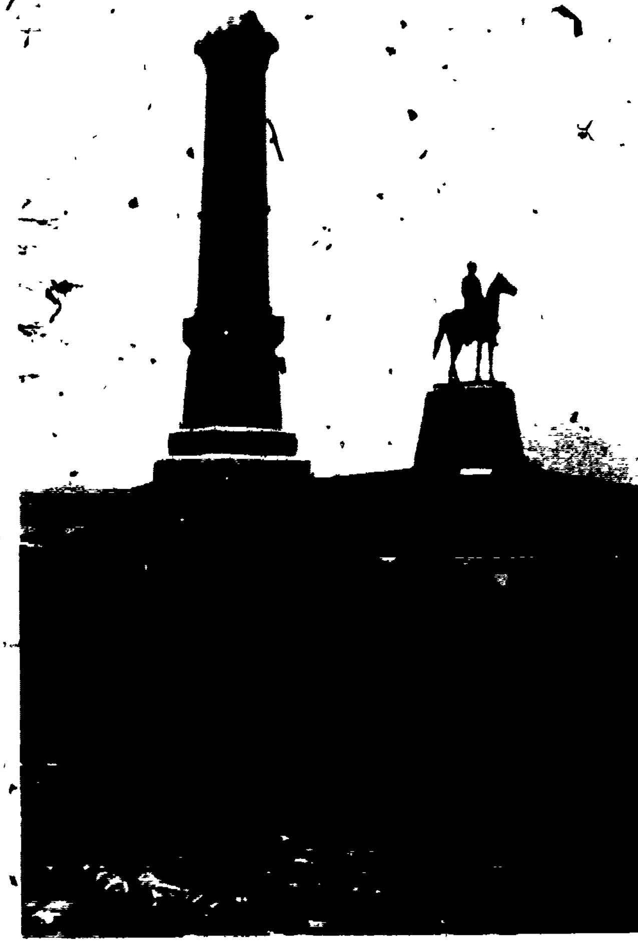
What Does Gettysburg Mean to You?

At the beginning of the second meeting the group was still struggling with "why are we here?" By the end of the meeting, they had made two significant recommendations. This was done even though the group had no officers, and was not sure of the expectations of the federal and state agencies. The group took the initiative and appears to have persuaded those involved to take a closer look at the complexities of overall planning for the municipal wastewater treatment facility. The group also requested an opportunity to analyze and comment on the EIS information being developed before a public hearing was held.

At future meetings the group will be reviewing, evaluating, and commenting on the information being developed for the EIS. Major areas of concern include:

- Where are the focal points of future growth in the Gettysburg area, and what implications will they have in regard to planning this water pollution control project?
- What are the alternatives, including innovative technologies and multiple use options, available for meeting the water quality goals?
- What are the needs of the community and what alternatives will be acceptable to the community?
- How can the concerns of the interested parties be addressed in a fair and equitable way?

During the third meeting the group continued to review the progress of the environmental assessment being developed for the EIS. The group had recommendations as well as many questions for the consultant preparing the document. Although, it is still unknown whether the advisory group can help in achieving a more feasible wastewater treatment system, it is clear that they plan to ask worthwhile, but "sticky" questions. Such actions will likely enchance the coordination among agencies and clarify decisions made during the planning process. This atmosphere, alone, can be beneficial in helping to achieve a solution which is compatible with the goals of various agencies while meeting the needs of the community. It would appear that the group has now established its identity, has a definite idea about its role, and is ready to make a significant contribution to the water quality management planning and decision-making process.



Need More Information?

Municipal Wastewater Management Citizen's Guide to Facility Planning FRD-6, Publication Number EPA-430/0-79-006 Washington, DC U S Environmental Protection Agency, February 1979 263 pp

This handbook is designed to acquaint citizen leaders with important decisions that need to be made in managing municipal wastewater The book lists key decision points throughout the planning process that are critical to the facility plan and the community, identifies environmental, economic and social considerations affecting these decisions; discusses citizen input, and helps citizens understand the legal tools to facilitate their involvement. It is a good reference book It is available from General Services Administration (8FFS), Centralized Mailing Lists Service, Building 41, Denver Federal Center, Denver, CO 80225

Public Participation in Programs Under the Resource Conservation and Recovery Act, the Safe Drinking Water Act and the Clean Water Act. Final Regulations, Title 40, Chapter 1, Part 25 "*Federal Register*, Vol 44, No 34, Part V Washington, DC U S Environmental Protection Agency, February 16, 1979 pp 10286-10297.

This document presents the rules and regulations for public participation including the Clean Water Act of 1977 It deals with advisory groups in detail, including both the responsibilities of the groups and the EPA

State and Local Assistance, Grants for Construction of Treatment Works, Title 40, Chapter 1, Part 35" *Federal Register*, Vol 44, No 23, Part VI, Washington, DC U S Environmental Protection Agency, February 16, 1979 pp 10300-10304

This document presents the rules and regulations for public involvement in the wastewater treatment Construction Grants Program

Chapter 2

Public Participation

E Drannon Buskirk, Jr., Dennis W. Auker, and Irving Hand

Abraham Lincoln said in his Gettysburg Address that government is "of the people, by the people, and for the people" In the early years of this nation, citizens had direct access to government decision making through opportunities such as the town meeting The local government would take no major actions unless approved by persons at the meeting Through time, expanding government and growing population have markedly diminished direct citizen involvement in decision making Democracy by representation has become the major governing mode

An effective representative democracy is dependent upon officials knowing and responding to the needs and views of the citizens Unfortunately, in many areas a communication gap exists between the people and their public servants In an effort to improve the situation, public participation is now mandated in such laws as the Clean Water Act to reduce the gap between citizens and government

This handbook is not an in-depth guide on public participation techniques. The purpose of this handbook is to introduce advisory group members to some general principles about citizen involvement, as well as to outline the things an advisory group can do to help make public participation programs effective.

Public Participation in Planning

In many cases over the years, water quality planning has not generated a great deal of public involvement This fact is not surprising; however, given the widespread cynicism and apathy in our society with regard to government programs In addition, wastewater management does not usually excite most citizens Unfortunately, this lack of interest and involvement often leads to inappropriate plans and facilities In many cases these planning proposals either lack support and are ignored, or they generate "last-minute" controversy and opposition In the end the public pays for the delays and mistakes not only in terms of tax dollars, but also in terms of undesirable environmental, economic, and social impacts

Fortunately, there are good examples of how public involvement has contributed to workable and acceptable solutions to water quality problems These situations show that steps can be taken to improve citizen participation in water quality planning

Public participation is not easy and does not guarantee that the goals of a program will be met However, both the positive and negative experiences with public participation show that if citizen support is needed to implement a proposed project, the citizens must somehow be involved in the project's planning

Good planning can lead to the selection of the most effective and efficient water quality management alternative, but requires more than just professional or technical competence It must provide for an integration of a community's economic, social, environmental, and political values in decision making Such values can only be incorporated through a significant effort to involve the public in all stages of the planning process

be a discussion of the purpose of a particular project and what is to be accomplished The specific objectives of a project will determine the schedule and elements of the public participation program.

Legal Requirements

The Clean Water Act of 1977 in Section 101 states

Public participation in the development, revision, and enforcement of any regulation, standard, effluent limitation, plan or program established by the Administrator or any State under this Act shall be provided for, encouraged, and assisted by the Administrator and the States The Administrator, in cooperation with the States, shall develop and publish regulations specifying minimum guidelines for public participation in such processes

This mandate not only applies to facility planning (Section 201), but also to the Water Quality Management Program (Sections 208 and 106), the Clean Lakes Program (Section 314), and the National Pollution Discharge Elimination System (Section 402).

The term "the public" in a general sense means all of the people. However, there are usually a number of segments of the public which can be identified for specific projects or programs Water quality advisory committees are required to have membership from four broad categories: private citizens, members of public interest groups such as environmental and civic organizations, public officials such as elected representatives and civil servants, and representatives of organizations with substantial economic interests such as developers These four categories can also be used as a guide for the overall public participation program to ensure that a cross section of the public is represented or directly involved.

As mandated by the Clean Water Act, the United States Environmental Protection Agency (EPA) has issued regulations to further define the public's role in water quality planning These regulations set standards for several EPA programs These general regulations deal with: agency responsibilities, informational materials, time schedules, legal requirements, public hearings, public meetings, advisory groups, and the forms of consultation with the public Individual program regulations implement these general standards by establishing specific requirements The regulations for wastewater treatment facility planning and for water quality management planning are of particular interest to advisory groups

Facility Planning

Facility planning regulations call for either basic or full-scale public participation programs. Facility development in the Construction Grants Program proceed through three stages: Step One (planning), Step Two (design), and Step Three (construction). All projects at the Step One stage must meet basic minimum requirements for public involvement To meet the public participation requirements a grantee must develop a public information program designed to bring about public involvement in the earliest stage of the decision making The agency must also have a program for consulting the public throughout the facilities planning process, including the selection of the professional engineer It must include an outline of the public participation program in the plan of study submitted with a Step One grant A more extensive public participation work plan must be submitted at a later date The work plan and a fact sheet about the project must be distributed to interested groups and individuals The agency must consult with the public when current and future situations are being assessed, and when plan alternatives are being evaluated It must hold a public meeting when alternatives are largely developed, but before a plan is selected. It also must hold a public hearing to discuss the recommended alternatives prior to the adoption of a facility plan Responsiveness summaries which document citizen comments and agency responses to activities such as plan evaluations, public meetings, and public hearings also must be done. Finally, the agency must include an evaluation of the effectiveness of the public participation program in the facility plan submitted for final approval

All projects must meet basic public participation program requirements. A more intensive public involvement effort is justified for complex or significant projects such as those that need advanced waste treatment or require an environmental impact statement In these situations, EPA regulations call for a full-scale program with additional participation elements and responsibilities

The grantee must hire or designate a public participation coordinator who is responsible for carrying out the public participation work plan. The grantee must hold a public meeting early in the facility planning process at the time when current and future situations are being identified (instead of waiting until the alternatives are largely developed). The grantee also is expected to establish an advisory group shortly after acceptance of the Step One grant award, and to provide technical training for advisory group members and local officials. The EPA estimates that approximately 30 percent of Step One projects will trigger a full-scale program.

Water Quality Management Planning

The Water Quality Management (WQM) program was originally set up to develop comprehensive plans for state and regional water quality management; one goal of which was to provide an umbrella under which local facility planning is carried out However, since this initial phase of WQM is mostly complete (most initial WQM plans have been approved by EPA), the focus of the program has changed. Over the years it has become apparent that inadequate attention has been given to the study of nonpoint source pollution problems and solutions Therefore, the WQM program now addresses specific nonpoint source pollution problems in areas such as agricultural runoff, urban stormwater runoff, and groundwater contamination. The concerns of WQM advisory groups are also reflecting this change in emphasis.

Some similarities exist between the facility planning and WQM program requirements for public participation These include general provisions for information, consultation, public participation work programs, responsiveness summaries, and balanced advisory group membership In addition, WQM regulations set public participation requirements which relate more specifically to WQM grantees

All WQM grantees are required to establish and maintain a citizen advisory group, an important part of public participation in WQM planning activities WQM advisory groups advise on goals and priorities, review and comment on grant applications and work programs; assist with public participation, consult with the agency throughout the planning process, submit comments; raise issues, and monitor WQM activities

Additional public involvement actions are also required Early in each stage of the WQM process (which includes the development or revision of WQM plans, state strategies, annual work programs, and State/EPA Agreements) each agency must notify the public about the proposed goals and scope of proposed actions and must schedule opportunities for consultation with the public and the advisory group Each agency must also establish a continuing program of providing information including, where appropriate, fact sheets explaining proposed actions in layman's terms More specifically, WQM agencies are required to hold a public hearing on draft WQM plans or plan revisions and a public meeting on draft annual work programs Responsiveness summaries documenting citizen comments and agency response must be prepared after each meeting or hearing

All public participation activities, including those of the advisory group, should be integrated into WQM planning activities and reflected in the work program for each activity. In addition, a separate public participation work program must be prepared and be made available to the public Work program requirements are discussed in detail later in this handbook

More Than a Set of Requirements

In considering the public participation needs for a project, there is room for flexibility and creativity Each project is different, and every community has resources it can draw upon in carrying out a public involvement program The advisory group is one of these resources

When developing a community involvement program, the following general principles should be kept in mind

- A good program entails careful planning, even before the project formally begins
- As decisions are made, citizens must get feedback on how their concerns and views have influenced these decisions
- Participation activities must be keyed to important decision points in the project

Program Implementation

Regulations of the EPA require that "agencies shall conduct a continuing program for public information and participation in the development and implementation" of water quality plans and programs This continuing program has two main elements information giving (notification) and information receiving (consultation) They are the essence of effective citizen involvement and both are necessary for dialogue between parties

All public participation techniques are either information giving or information receiving For example, fact sheets, newsletters, and seminars basically convey information from the planning agency to the public Other approaches such as public meetings, surveys, and advisory groups facilitate information flow in the other direction

Choice of Appropriate Techniques

Public participation activities are not done for their own sake, or merely to meet the letter of the law They must serve some purpose in the project Choosing appropriate techniques depends upon the objectives of the stage in the planning process. These objectives include tasks such as clarifying project issues, identifying problems, and developing solutions The overall purpose of public participation activities is to improve and support decision making. This can only happen if public participation techniques are linked closely to key decision points and project objectives.

Public participation techniques can help meet program objectives to varying degrees However, some may be counter-productive if they are used at the wrong time The situation is similar to a mechanic using a hammer for a task done better with a wrench As an example, consider the practice of using only public hearings in the public participation process Public hearings are designed to receive formal testimony which will meet legal requirements They normally occur shortly before final decisions are made There is little two-way interaction between the agency holding the hearing, and those who participate. Thus, formal public hearings should not be used if the objective is to have give-and-take discussions with citizens An effective public participation program is likely to require several techniques

The general rule is that no one technique works best all of the time. Advisory groups should make sure that the planning agency doesn't fall victim to limited or over-used techniques.

Choosing appropriate techniques depends upon the objectives at various stages in the planning process, and other considerations. Although WQM and facility planning have their unique aspects, they have similar planning elements. They include

- Identifying problems
- Establishing goals and objectives
- Compiling data
- Developing and evaluating alternatives
- Selecting a plan
- Implementing and revising a plan

Both types of public participation techniques — information giving and information receiving — are used with each planning element, but emphasis may vary because of changing objectives For example, the initial stages involve identifying real needs and problems, and collecting data on existing and future situations Information-giving approaches such as fact sheets and news releases can interest the community about the project, and start to establish on-going support

Other techniques are also available Consultation activities can be used to communicate the opinions and values of the public to the planners In fact, these information-receiving activities are required prior to the selection of alternatives Advisory groups, meetings, and workshops are possible consultation activities

Wisconsin Several public participation techniques were used in facility planning in Milwaukee Faced with a 1 5 billion dollar project, the city initiated a large-scale public information program to make the citizens aware of the wastewater problem and potential solutions. The program involves the extensive use of local newspapers, speaker bureaus, and workshops designed to give people experience in the facility planning process

Later in the planning process, alternatives are developed and evaluated. At this stage, instead of determining needs and problems, clarifying project issues and tradeoffs becomes more important. Information-giving techniques such as briefings, seminars, and responsiveness summaries may prove useful. Consultation or information-receiving techniques such as public meetings, surveys, workshops, and advisory groups can be quite helpful at this planning stage. However, each of these techniques is not suitable for every objective. Therefore, a combination of techniques may be necessary to meet all the objectives.

The problem remains in selecting the best technique at the right time. Objectives, of course, furnish some guidance, but other factors must also be considered. Aspects such as the specific strengths and weaknesses of individual techniques, their requirements in money and time resources, personnel who will have to administer the techniques, and the likely receptivity of the community to certain techniques — are other important considerations.

Resources and Community Attitudes

Financial resources, staff resources, administrative abilities, and attitudes all play an extremely important role in establishing an effective public participation program.

Public Participation Techniques

Notification (Information Giving)	Consultation (Information Receiving)
Newsletters	Advisory Groups
News Releases	Public Meetings
Fact Sheets	Public Hearings
Brochures	Task Forces
Briefings	Surveys
Seminars	Workshops
Radio or TV Announcements	Interviews
Responsiveness Summaries	Review Groups
Telephone Hotlines	Referendums
Summaries of Reports	Phone-in Radio Programs

All public participation programs cost money. If good public involvement is truly desired, adequate funds must be allocated. Of course, available financial resources are seldom plentiful. If funds are scarce it is even more important that the advisory group help the grantee select the techniques for the program that are most cost effective. Local knowledge can help the agency determine the least costly way of getting the public involved. Local resources and existing communication networks should be used wherever possible. It *is* possible to have an effective public participation program without imposing heavy financial burdens on the community.

Staff resources, including availability and technical competence, influence the success of programs. The advisory group should urge the planning agency periodically to assess the public participation program by doing the following:

- **Determine whether public participation needs are being met**
- **Assess the effectiveness of the techniques being used**
- **Ask whether all legal requirements are being met**
- **Determine whether work tasks are being accomplished in an orderly and effective manner**
- **Assess the ability to keep track of management and budgeting for the techniques being used**
- **Determine if there is sufficient supervision of technical staff.**

The advisory group should be continuously informed of developments in the public participation program. In order to play an effective role, the advisory group can designate an individual or subcommittee to work closely with the agency public participation staff.

31

Community attitudes, although less tangible than financial resources or staff abilities, are no less important In this context what is perceived, even if erroneous, is as important as what is real For example, a Delphi survey is a powerful technique for reaching consensus. However, because the technique involves a panel of experts, it may not be supported by community residents who may resent the presence of experts and their inputs

Advisory groups can help the planning agencies stay attuned to what area residents feel about elements of the public participation program.

These matters such as choice of techniques, implementation resources, and community attitudes are best dealt with together through the public participation workplan

Public Participation Workplan

The EPA public participation regulations establish a mechanism through which the planning agency can deliberately plan ahead, and choose public participation techniques to match the schedule and objectives of the project This mechanism is a public participation workplan The workplan is required in both facility planning and water quality management programs. Advisory groups are to be consulted in the development of the workplan The workplan must contain the following information

- A proposed schedule for public participation activities to impact major decisions, including consultation points where responsiveness summaries are required
- An identification of consultation and notification techniques to be used
- The segments of the public targeted for involvement,
- Staff contacts and budget resources to be devoted to public participation
- The coordination of facility and WQM public participation.

The workplan is intended to serve as a public information document on the project Because the workplan links public participation activities to specific decisions and schedules, citizens are able to use the workplan to gain a better understanding of what to expect from a project. The workplan should build public participation activities into the project. In developing a workplan, therefore, the grantee must match objectives at various stages of the process with appropriate techniques The knowledge and experience of the advisory group members should be used to assure that the public participation program outlined in the workplan makes sense for the community

Vermont. In the town of St George it was necessary to involve residents of a trailer park in wastewater facility planning, even though they would not be connected to the new sewage collection system This involvement was necessary because the citizens made up a substantial portion of the voting public, and at some later time the homes of these persons may be connected to the new sewage system However, since the project would not directly affect the homes of these citizens, it was unlikely that public participation techniques such as public hearings and public meetings would be effective Therefore, other techniques were chosen The project workplan for St George calls for the distribution of informational flyers, survey questionnaires, and personal follow-up visits by members of the advisory group

The workplan must be of sufficient scope and detail to serve as a basis for judging the adequacy of proposed public participation activities It also must be a working guide for carrying out the activities For example, rather than simply mentioning that "consultation" will take place at a specific point, the workplan should indicate the kinds of techniques that will be used for informing the public and consulting with the public, the purpose and target audience of each activity, publicity methods, descriptions of products such as fact sheets, approximate completion dates, and plan or project objectives.

Questions for evaluating a public participation program and workplan include

- Do the proposed activities meet the regulatory requirements?
- Is there a good balance between information-giving (notification) techniques and information-receiving (consultation) techniques?
- Do the techniques match project and operational objectives?
- Will the proposed public participation techniques reach all of the target publics?
- Does the program relate to key decision points in the planning process?
- Are sufficient financial and administrative resources allocated to accomplish the public participation objectives?
- Does the workplan provide for adequate feedback to the public about its information and opinions?

Water quality planning agencies have flexibility in developing the workplan contents, and the detail necessary for managing effective public participation. For example, although the regulations do not require it, many WQM agencies will continue to require separate workplans for each problem-solving project involving 208 grants. The key is adaptability. Planners must adjust workplans to fit changing situations. All that is required is that agencies and their advisory groups remain sensitive to the needs of public participation, and strive towards common-sense public participation programs.

Public meetings are a type of public participation.

Main Points

Through citizen involvement, public participation aims at improving water quality plans by reducing costs and avoiding undesirable economic, environmental, and social impacts. Public participation is not a guarantee of resolving conflicts. The goal of public participation is to improve decision making, and to develop solutions that people can live with.

There are three general principles for community involvement: (1) a good public participation program entails careful planning, even before a project formally begins, (2) participation activities must be keyed to important decision points in the project, (3) as decisions are made, citizens must get feedback on how their actions and opinions have influenced the decisions.

Public participation techniques basically accomplish one of two functions: information giving (notification) or information receiving (consultation). Their use depends upon the objectives associated with different stages in the planning process, and other considerations such as resource requirements and probable community receptivity.

The advisory group, itself one type of public participation, should provide information and recommendations which will help a planning agency run a successful public participation program. For 201 facility plans, all full-scale public participation programs have advisory groups. Some basic programs also use informal advisory groups. All water quality management programs have advisory groups.

As mandated by the Clean Water Act, the EPA has established public participation regulations dealing with agency responsibilities, time schedules, information materials, public meetings and hearings, advisory groups, and other forms of citizen involvement. Project workplans are the mechanism for bringing together the diverse aspects of public participation programs. Advisory groups can help develop workplans, and assist in assuring common-sense public participation programs.

Case Study

Many Forms of Public Participation

Pennypack Creek, Pennsylvania

This case study involves three municipalities near Philadelphia, Pennsylvania Pennypack Creek, which is a tributary of the Delaware River, runs through a green belt, which is the only undeveloped area left adjacent to Philadelphia

In the early 1970's, the least populous of the municipalities, Bryn Athyn, applied for a grant to build a spray irrigation treatment system About the same time, two neighboring townships (Abington and Lower Moreland) applied for funding to extend an existing sewer interceptor line along the Pennypack, and transport wastewater to a Philadelphia treatment plant The regulatory agency indicated it would not fund two separate systems in the same service-area The three communities would have to agree on one system

Bryn Athyn was adamant on having the other municipalities join its spray irrigation system Bryn Athyn and the Pennypack Watershed Association, a private conservation group, thought the interceptor plan was undesirable for several reasons

- Exportation of water from the central watershed
- Onsite systems and small package plants that were recharging the Pennypack Creek watershed would be phased out
- Lower Moreland treatment plant, which is a principal source of pollution, would become the sole source of flow into the headwaters of the creek

Differing opinions among the three municipalities led the Pennsylvania Department of Environmental Resources to study spray irrigation and other alternatives The studies supported the desirability of spray irrigation, but Bryn Athyn had to get the two townships to agree, or substantiate why the state should force the two townships to join the system

Public Participation Activities

The Pennypack Watershed Association and Bryn Athyn undertook many public participation efforts in order to increase public understanding

- Established a citizen advisory group for responsible sewage planning
- Prepared information leaflets about project facts
- Solicited signatures of local citizens on petitions
- Developed a mailing list and mailed pertinent educational information
- Identified who would be affected directly by the project and contacted them
- Held small public meetings in neighborhoods to discuss the facts
- Brought the wastewater issue into the elections for the Lower Moreland Township Board of Commissioners
- Held a public hearing at which proponents of spray irrigation turned out in large numbers to support the project

Following a public hearing, the state recommended a grant for the spray irrigation system However, the Townships of Lower Moreland and Abington still favor the interceptor, and have appealed the state's decision in the courts

Significance

The Pennypack Watershed Association in conjunction with Bryn Athyn used an extensive public participation process It consisted of many techniques to help them win grassroots support for the alternative

Lessons to Learn

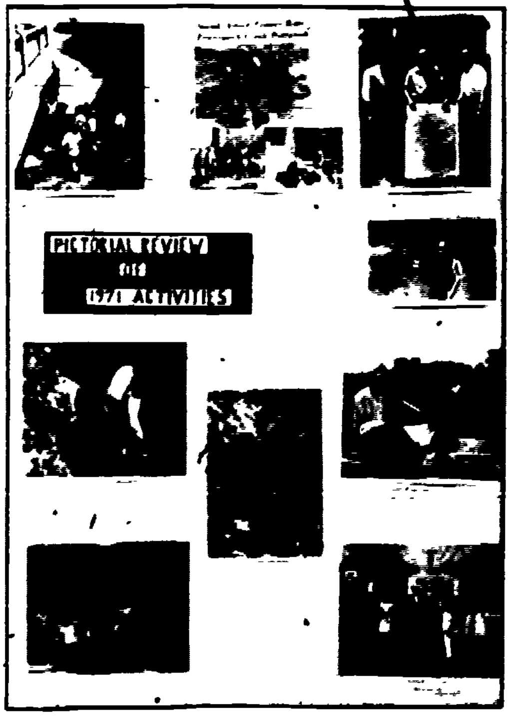
In order for the Pennypack Watershed Association and Bryn Athyn to develop a treatment facility which they thought would be most beneficial to the community, it was necessary to develop public understanding of the issues. Three objectives had to be met

1. Communicating project information to the general public
2. Identifying and informing potentially-affected parties
3. Providing opportunities for the issues to be discussed

Five different public participation techniques were used to meet these objectives

- Citizen advisory group gave visibility to the effort, and brought citizens directly into the planning process
- An information program educated the public about the technology and the real issues
- Personal contacts provided interaction with many citizens
- Neighborhood public meetings helped to inform and involve other citizens
- A well-attended public hearing culminated the effort, and provided a formal opportunity for comment on the project.

The Pennypack Watershed Association and Bryn Athyn, thus, were successful in developing public support for the project by using a combination of public participation techniques. It is very unlikely that they would have been as successful if only one or two techniques had been used.



Case Study

Water Hotline

Bartow, Florida

The Central Florida Regional Planning Council has responsibilities as a water quality management (WQM) agency In an effort to involve the public in the WQM program, this agency installed a telephone alert system called "Waterline " Citizens in a three-county area could bring cases of discharge violations, and health or safety hazards in surface waters to the attention of the WQM staff

The Waterline was a direct telephone line manned by an answering service all the time. Calls received on the Waterline were returned by the staff within twenty-four hours (weekends excepted) Based upon these calls a thorough examination of problems was conducted Out-of-town callers could call collect

The Waterline received about ten calls per week One case concerned a shopping mall next to Lake Parker in the city of Lakeland An anonymous Waterline call reported that the mall maintenance company was dumping parking lot sweepings on the lakeshore The WQM staff reported the situation to the Florida Department of Environmental Regulations (FDER) It took two visits from FDER officials, and the threat of court action to force the company to clean up the dumping pile

Significance

The Waterline had two areas of significance One was the impact of calls from individuals. The dumping case generated city officials' interest in the WQM program for the first time The response to this technique showed Lakeland officials that the water quality management program could help to solve local problems

In general, the Waterline gave citizens a direct line of communication to the WQM staff It also gave the staff a sense of public priorities and issues, and helped to identify new problem areas The Waterline could be maintained indefinitely at small expense

The Central Florida Regional Planning Council, by using the Waterline, met five important public participation needs These needs included

- Increased public awareness
- Identified problems
- Increased agency responsiveness
- Communicated information
- Achieved at relatively low cost

The Waterline technique helped to make the agency directly responsive to public concerns Problems were identified by making it easy for those familiar with water problems to communicate their concerns to the appropriate agency Information was communicated by establishing a direct person-to-person, two-way information flow between the public and the water quality management agency The cost of manning the phones was low compared to the costs of techniques such as public hearings and surveys

The Waterline technique worked well at achieving certain objectives However, it would not be as useful in meeting other objectives, such as clarification of issues or search for consensus

Public Participation Techniques

	Benefits	Drawbacks
Advisory Groups		
An advisory group consists of a group of citizens who give advice to an agency developing a plan	• Transmits information to community and facilitates feedback • Formulates solutions • Clarifies goals, objectives, and issues • Increases access to representatives of varied interests	• Time-consuming participation • Some group members may dominate • Group may feel like a rubber stamp • Group may have difficulty establishing credibility • Group can become relied upon as sole public participation technique
Public Information Programs		
Public information programs are carried out on a continuing basis Press releases, mailings, advertisements, displays, radio and television presentations, films, and legal notices are involved	• Communicates basic information • Reaches a large number of citizens	• One-way communication • Can appear as "public relations" propaganda • Does not by itself constitute a public involvement program
Open Information Meetings		
Open information meetings present technical or programmatic elements to a general audience before or during the life of a project. Audiovisual presentations, briefings, and seminars are types of information meetings	• Conveys information with opportunity for immediate public comment • Identifies problems and recommends courses of action • Presents opportunity to answer citizen questions	• Limitations on time which can be spent discussing issues • Domination of some participants • Often needs experienced and skilled staff to run effective meetings • Difficulty in conveying technical information at a meeting
Public Hearings		
Public hearings include a formal agency presentation, citizen presentation, and an official record of the proceedings Public hearings are required in most governmental decision making	• Provides forum for citizens to gain information or challenge decisions • Gives opportunity for formal, "official" comments	• One-way communication • Vocal minorities may dominate • Technique may appear as a token effort

	Benefits	Drawbacks
Task Forces		
The task force aids in solving specific problems. It is usually linked to a large ongoing participatory body such as an advisory group.	• Focuses attention on specific issues • Can develop recommendations in short time • Promotes group interaction among different interests	• May not represent the public adequately • Sometimes requires a lot of staff time
Surveys		
Surveys can range from personal interviews to telephone and mail questionnaires.	• Provides direct contact with public • Reaches a larger number of people than are usually involved in projects • Can promote interest in a project	• Usually does not give opportunity for in-depth discussion • Personal and telephone interviews use up a lot of staff time • Unless carefully planned, surveys usually do not generate a significant response
Citizen Training		
Training is normally provided through short courses, workshops, and gaming simulations.	• Gives citizens a better understanding of technical issues • Better equips citizens to advise on projects • Enhances perspectives on project objectives, decisions, and constraints	• Reaches only a relatively few citizens • Difficult to plan and run an effective technical training program for citizens • May take on the appearance of "busy work"

Need More Information?

Advisory Commission on Intergovernmental Relations. *Citizen Participation in the American Federal System* Washington, DC. 1980.

This document addresses the importance of public participation and why it will increase in importance in the future. Single copies may be ordered free of charge from the Advisory Commission on Intergovernmental Relations, Washington, DC 20570. The document may be ordered in quantity at cost from the Superintendent of Documents, Government Printing Office, Washington, DC 20402

"Grants for Water Quality Planning, Management, and Implementation" *Federal Register*, Vol. 44, No. 101, Part II, Washington, DC U.S Environmental Protection Agency, May 23, 1979, pp 30016–30042

This document contains the rules and regulations for public participation in the Water Quality Management Program. Copies of the *Federal Register* are available through libraries Contact your local reference librarian

"Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act and the Clean Water Act, Final Regulations, Title 40, Chapter 1, Part 25" *Federal Register*, Vol. 44, No. 34, Part V Washington, DC U S Environmental Protection Agency, February 16, 1979. pp. 10286–10297

The implementing regulations which address the legal responsibilities of the funded agency and the advisory group in relation to public participation Your local reference librarian will be able to tell you how to obtain copies of the *Federal Register*.

Rastatter, Clem L., ed *Municipal Wastewater Management Citizen's Guide to Facility Planning*. FRD-6 Washington, DC U.S Environmental Protection Agency, Office of Water Program Operations, January 1979 263 pp

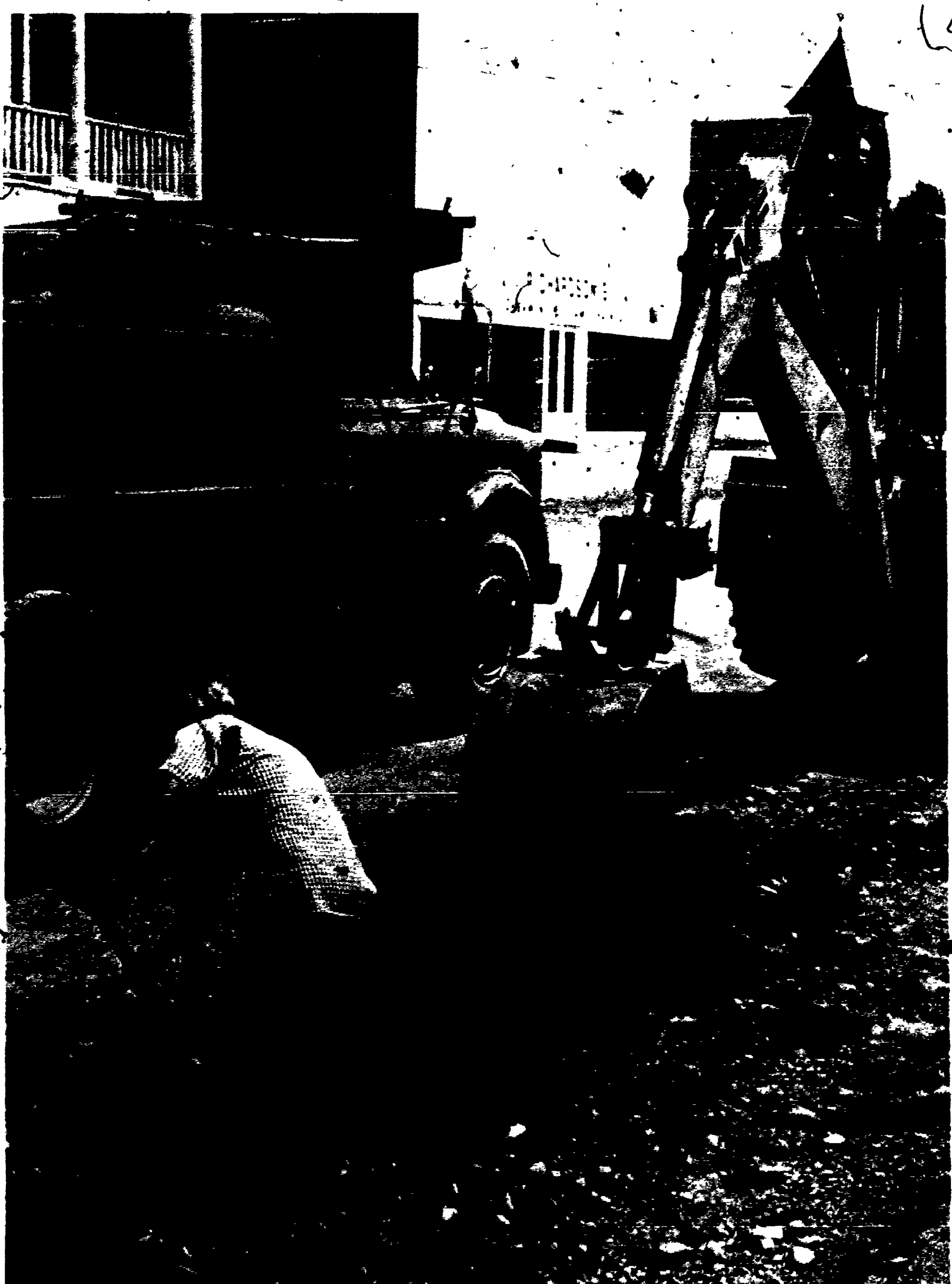
A publication prepared by the Conservation Foundation, Washington, DC, which provides a selected and extended discussion of activities pertinent to the responsibilities and work of advisory groups. It includes discussion on public participation This publication can be obtained by writing to General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225. Be sure to mention the FRD number and the title of the publication

Rastatter, Clem L., ed. *Municipal Wastewater Management. Public Involvement Activities Guide.* FRD-7 Washington, DC U S. Environmental Protection Agency, Office of Water Program Operations, January 1979 125 pp

This document was developed for a training program on citizen involvement in wastewater facilities planning. It consists of several parts facility planning, and public involvement. The latter part consists of public participation requirements under the Clean Water Act, EPA regulations, public participation program elements, public participation tools, implementation issues, and the rewards of public involvement in facilities planning. This publication is available from the General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225 Include the FRD number and the title of the publication

"State and Local Assistance, Grants for Construction of Treatment Works, Title 40, Chapter 1, Part 35" *Federal Register*, Vol. 44, No 23, Part VI, Washington, DC U S. Environmental Protection Agency, February 16, 1979 pp 10300–10304

This document presents the rules and regulations for public involvement in the Wastewater Treatment Construction Grants Program Your local reference librarian will be able to tell you how to obtain copies of the *Federal Register*



Chapter 3

Facility Planning in the Construction Grants Program

Charles A Cole and E Drannon Buskirk, Jr.

Facility Planning and Construction Grants

Let's face it. A sewage plant lacks the appeal of a new park or public library. Most people have little interest in sewage until it poses a threat to the community or family This concern may be a health problem, a public nuisance, or even higher taxes.

Construction Grants Process: A Summary

Why does a community take the steps to build or improve sewage treatment facilities? There are several possible reasons

- Voluntary community action to develop or improve public facilities
- Voluntary action to remove a public nuisance or community problem.
- Compliance with local or other public health codes
- Compliance with federal pollution control regulations or state water quality standards
- Compliance with a court order.

While local desires or public health considerations may be factors, most communities have to deal with sewage treatment for two reasons The Federal Clean Water Act of 1977, and State Water Quality Standards.

Through the Clean Water Act, Congress and the President have established a national goal of waters suitable for fishing and swimming The Act requires at least secondary treatment for all publicly-owned sewage systems (Secondary treatment generally removes 85 percent of BOD and suspended solids). BOD, called biochemical oxygen demand, and suspended solids are measures of pollution strength. Enforcement of these regulations is ensured through the National Pollution Discharge Elimination System (NPDES) that requires permits for all wastewater discharges.

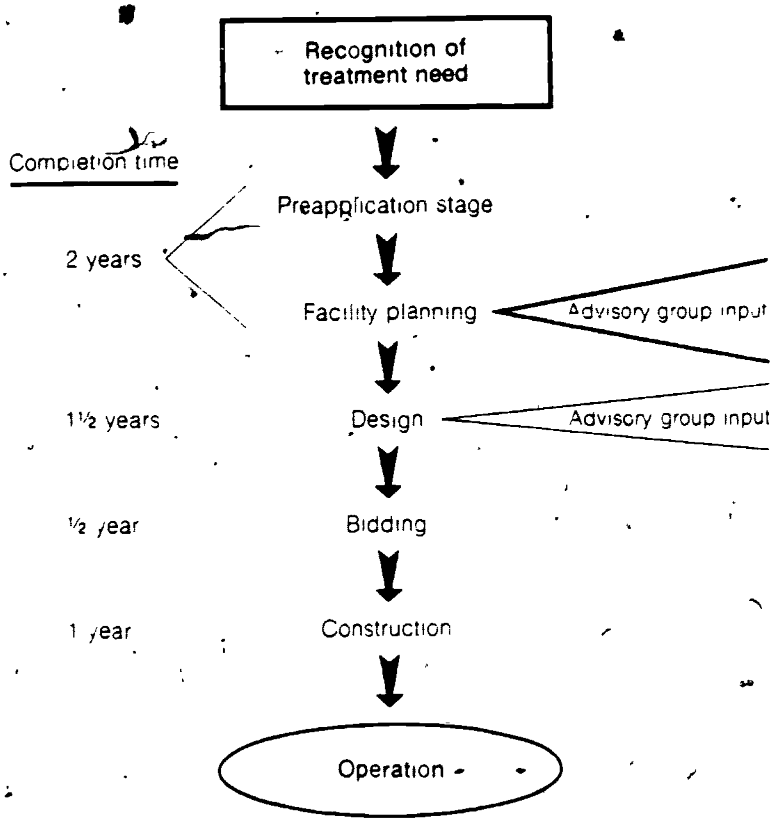
States determine how much pollution can enter a water body by establishing water quality standards These standards are based on the potential uses of the water body. In order to meet and maintain these standards, limitations are placed on industrial and municipal discharges. These limitations often determine the type of treatment facilities which must be built and the level of treatment which must be achieved.

The events or conditions which cause a community to look at its wastewater problems go a long way toward determining the outcome. For this reason, the advisory group should understand from the outset why the community is developing a wastewater facility plan.

The Grants Process

No matter what initiates the planning, most communities want a federal grant to help pay for new or upgraded treatment facilities. These grants are available through the Construction Grants Program.

Three main governmental bodies are involved in the construction grants process. They are the local agency, the state agency, and the United States Environmental Protection Agency (EPA).



The construction grants process can take two to ten years The average is about five years

How does a community get a grant? First comes the *preapplication stage* The municipality seeks to have its project placed on the state "priority list," which is a statewide ranking of proposed projects in order of their importance. In ranking the projects the state follows an approved procedure involving several factors, including

- Severity of the pollution problems
- Number of people affected
- Need to preserve high-quality water bodies
- National priorities
- Availability of federal grants and local funds

If the state agency determines that the project deserves high priority and the EPA approves, the community becomes eligible for federal funding. The next job for most municipalities is to select a qualified engineering-planning consultant, if one is not already involved.

Choosing a qualified consultant is a crucial decision since the firm will conduct most of the planning. In addition to technical competence, the consultant should be able to demonstrate flexibility, and show sensitivity for local concerns

The municipality and consultant meet informally with state and EPA officials in a preapplication conference to review requirements for submitting a grant application. The municipality and consultant then prepare a plan of study describing the nature of pollution problems, the study tasks, and costs for conducting this work The community next submits a plan of study along with an application for a Step 1 planning grant to the state and the EPA. The application contains several items, including

- An explanation of how the community will finance the local share of the project cost
- Name of an authorized representative to act on behalf of the municipality

The state and EPA both review the plan of study and the application Upon approval, the EPA awards a Step 1 grant, which covers 75 percent of the planning cost Some states provide additional assistance The town then enters the *facility planning stage* and becomes a *grantee*.

Planning Stage

Good planning of wastewater treatment facilities means more than just technical expertise. It means taking into account community characteristics, social values, environmental concerns, and financial capabilities People must work together to incorporate these from the beginning.

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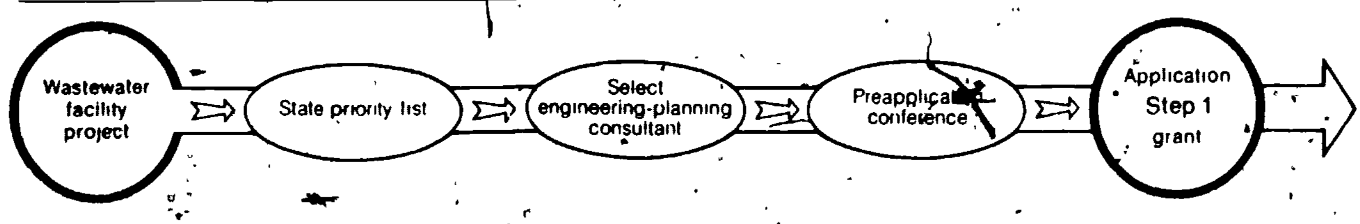


The facility plan is an actual document that is submitted to the state environmental agency and to EPA. Its objective is to develop a cost-effective solution to the pollution control problem. It must balance the desired degree of pollution control against economic, social, and environmental costs. The facility plan has to provide answers to many questions. Some of the more important ones are

- Does the facility plan accurately define and verify the extent of the problem?
- How does the project fit into the water quality management plans for the region or area (i e , 208 planning)?
- *Does the project call for a reasonable sewage collecting and treatment reserve, or is there an excess capacity?*
- How will the reserve capacity affect community growth?
- What are the project's impacts on the environment?
- What is the plan for mitigating adverse environmental impacts?
- Is the project cost-effective? That is, will it achieve the needed degree of pollution control at the least cost in money and adverse environmental effects?
- How will the project be financed? What will be the financial impact on the community and individual households?
- Has a fair user charge system been established to pay for plant operation and maintenance?
- What are the plans for efficient operation and management of the system?

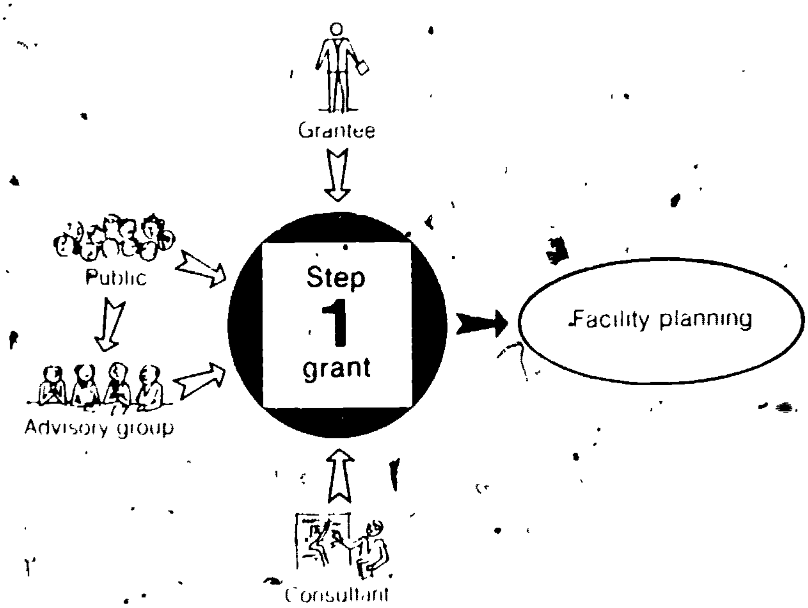
Public Participation

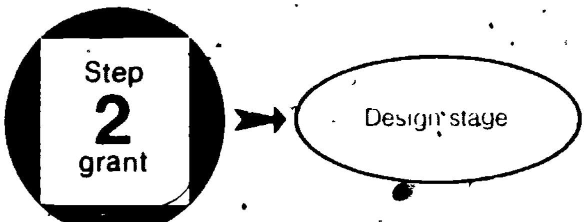
Public involvement early in the project, especially in the planning stage, is the best way of dealing with these questions, and, ultimately, gaining public support for financing any new or rehabilitated facilities

Public participation makes good sense for many reasons

- Incorporating public values
- Resulting in better facility plans
- Ensuring reasonable costs
- Bringing added community benefits
- Resolving controversies
- Gathering public support

Specific public participation requirements for facility planning are covered later in this handbook

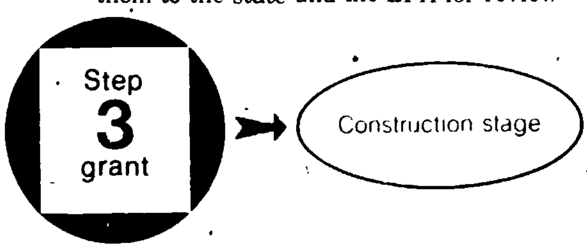




Design Stage

When the facility plan is completed it is sent to the state for approval. It is then submitted to the EPA for a Step 2 grant for *design of the facility* The EPA reviews the facility plan to determine, among other things, whether significant adverse environmental impacts will result from the project If the EPA determines that such impacts exist, an environmental impact statement (EIS) must be prepared If no significant impacts will result, the EPA will issue a finding of no significant impact (FNSI) and will approve the facility plan A Step 2 design grant is then awarded

When the Step 2 grant is awarded, the consultant prepares detailed engineering plans and specifications The community also has several tasks It must establish user charges — a system of fees to pay for the operation, maintenance, and management costs of the facility It must make arrangements for payment of the local share of the construction costs It must prepare plans for the operation of the facility, including, if necessary, industrial pretreatment of wastewater When these plans are complete, the grantee submits them to the state and the EPA for review



Construction Stage

If the designs and specifications receive state and EPA approval, the grantee now enters the *construction stage* A Step 3 federal grant will often pay 75 percent of the eligible construction costs of the project (85 percent if the project qualifies as an innovative or alternative approach). Some states provide additional grant assistance for planning, design, and construction The community then advertises for bids for the construction work in accordance with local ordinances, state laws, and EPA regulations. If the successful bidder's qualifications meet EPA requirements, the contract is awarded

The construction begins on the facility. While construction continues, a manual for the operation and maintenance of the facility is prepared When construction is completed the state and the EPA conduct final inspections *The EPA then makes a final audit*

Finally comes the operation and management of the facility This is possibly the most difficult part of the project and is often overlooked Every measure should be taken to be sure that the community can live with whatever facilities are built Once the construction is completed, EPA grant assistance ends The community must pay 100 percent of all operation and management costs.

These three stages — from the beginning of Step 1 to the end of construction — can require seven years or more Facility planning alone takes 17 to 36 months It all depends upon the size and complexity of the project

Advisory groups should watch that planning proceeds with a minimum of delays. In these inflationary times this is crucial.

Facility Planning and the Advisory Group

The community must seek adequate public involvement throughout the facility planning process.

Public Participation Program

All Step 1 (facility planning) projects must meet certain basic requirements for public involvement. However, small projects involving minor sewer rehabilitation or minor upgrading are exempt from most public participation requirements. Where public participation is necessary, the grantee

- Develops a public information program in the early phases of decision making
- Has a program for consulting the public throughout the facilities planning process, including the selection of the engineering consultant if feasible
- Includes an outline of the public participation program in the plan of study accompanying the Step 1 grant. A more extensive public participation work plan must be submitted no later than 45 days after the Step 1 award
- Distributes the work plan and fact sheets to interested groups and individuals
- Consults with the public when assessment of current and future situations and alternatives are being evaluated
- Holds a public meeting when the cost effectiveness of the alternatives is determined, but before any plan is selected
- Holds a public hearing to discuss the recommended alternatives prior to adoption of a facility plan
- Includes an evaluation of the effectiveness of the public participation program in the facility plan.

Complex, controversial, or significant projects justify more intensive public involvement. The EPA Regional Administrator orders a full-scale public participation program when the project warrants an environmental impact statement, advanced waste treatment is involved, or the Administrator determines that more active public participation is needed.

In addition to meeting the requirements of the basic public participation program, a grantee with a *full-scale* program:

- Hires or designates a coordinator to carry out the public participation workplan
- Holds a public meeting (instead of general consultations) early in the facility planning process at the time when current and future situations are being identified, and initial alternatives are being screened
- Establishes an advisory group shortly after acceptance of the Step 1 grant award

Planning Steps

The facility planning process has several planning steps. On the surface these steps may appear sequential, but, in fact, they are intertwined Decisions must be constantly reevaluated as new information becomes available

The major steps are

1 Assessing the current situation
2. Assessing the future situation
3 Identifying alternatives
4 Conducting environmental assessment
5 Making cost-effectiveness analysis
6 Selecting the plan

The advisory group should play an important role in the public participation program, which continues through all of these steps.

Many aspects of the community's future must be considered during the planning process

Assessing the Current Situation

Public involvement is crucial in the first step Information overlooked or misinterpreted may substantially affect the outcome of the facilities planning process The severity and extent of existing problems should be verified.

During this stage the agency gathers information on the planning area: institutions, population, and environmental aspects such as water quality Data also is needed on existing wastewater flows, treatment systems, and the performances of these treatment systems. One special concern is environmental consequences of infiltration and inflow (I/I) Infiltration and inflow are surface and groundwaters that get into the sewer systems Is it cheaper (more cost-effective) to provide treatment capacity to compensate for excessive I.I, or is it better to repair the sewer system?

Advisory groups should watch carefully the assessment of the current situation. They will want to be sure, that the data is accurate, that data collection methods are thorough, and that operation and management of existing facilities are adequate. Before going any further, the community should know what the problems are and what is causing them.

Advisory Group Questions: Current Situation

- **Do water quality problems really exist?**
- **What are they?**
- **Are the existing facilities sufficient?**
- **Is the soil adequate for onsite disposal?**
- **What unique resources does the community have that are worth protecting?**
- **How does the areawide 208 plan relate to the facilities plan?**

Assessing the Future Situation

Assessment of the future situation is often the most difficult part of facility planning. and probably has the most impact on the planning process The advisory group is made up of a cross section of residents who know the community For this reason the advisory group can play an important role in discussing the community's future Projections about the future are uncertain. and even the experts admit that some guess work is involved. This important step in facility planning can benefit from the experience and knowledge of advisory group members.

A whole series of issues must be addressed:

- How is the future population estimated?
- How much wastewater will the population generate?
- What is the basis for estimating the total wastewater flow?
- How does the facility relate to other community objectives such as recreational opportunities?
- How does industry affect the size of the facility?
- Is it better to seek reduced flows through water conservation, or to build reserve capacity for growth?
- What geographic areas will the facility serve?
- What are the projected land uses?

Each of these issues has a major impact on the facility They warrant more detailed analysis and advisory group discussion

Population Estimates

Sewage collection and treatment facilities can turn bullish population forecasts into self-fulfilling prophesies Many communities have nearly gone bankrupt because of oversized and underused wastewater treatment plants Such facilities create economic pressures to spread around the cost by adding more users In addition to unwanted growth, in the early years the users essentially pay the tab for nonexistent population To avoid paying for more wastewater treatment capacity than is actually needed. the advisory group should be sure that reasonable projections are made

Assumptions or calculations should not be accepted without careful consideration and discussion

The EPA gives special attention to this important issue Guidelines to the cost-effectiveness analysis regulations give the procedures for using population projections in both 208 areawide and 201 facilities planning

Wastewater Generation

The future need for sewage treatment capacity is determined by multiplying the total population times the estimated wastewater volume per person The large populations can magnify small errors in per capita estimates Recent studies show per capita sewage flows in the range of 50-80 gallons per day (gpcd) The common estimate of 100 gpcd includes flows due to infiltration and inflow, and small amounts from commercial establishments The advisory group should ask for verification of the flows

Industrial Contribution

Joint treatment of industrial and domestic wastes produces economies of scale and sometimes improved operations However, these wastewater mixtures can make biological sewage treatment processes less effective They also can contain substances that cause problems in sewers, sludges, or land treatment systems

Since industrial wastes may upset (damage) wastewater treatment plants, the EPA has issued general standards for the pretreatment of these wastes. The EPA requires each federally-assisted agency to adopt industrial waste ordinances and equitable user charges

Industrial waste flows should be assessed to ensure that the treatment capacity reserved for industry is adequate but not excessive.

Water Conservation

The EPA requires the community to consider wastewater flow reductions in studying various planning alternatives As a minimum the grantee must assess

- Flow reduction methods for existing residential, commercial, and industrial sources
- Future flow reductions achieved through changes in local ordinances, codes, price strategies, and public information programs

Sewer Service Area

The service area is determined by the community with the advice of the engineering consultant. Regional plants have been favored in past years since they appeared to offer ease in regulation, monitoring, and economies of scale for treatment This has not always proven to be the case Also, considering that 70 percent of the money for wastewater pollution control is spent on the collection and transport of wastes, moving sewage from one spot to another may not be cost effective!

Small-scale treatment alternatives, including individual septic systems, are regaining prominence in water quality planning *The issue of sewer pipe size and service area thus extremely important*

Sewer Issue

Advisory groups should be interested in sewers because sewers:

- **Cost 70 percent of water pollution control expenditures**
- **Are usually not fundable with federal monies, but can cost more than $50 per foot!**
- **Affect future land uses and land values**
- **Spur development into areas**
- **Affect future growth of the community**
- **Can have adverse environmental effects.**

There are three basic types of sewers. Interceptor sewers, collector sewers, and lateral sewers. The interceptor sewers are large pipes that gather wastes from neighborhoods and communities Their location can determine where new neighborhoods are built, where industry will locate, and where new commercial development will occur. Without careful planning, interceptors can lead to unwanted development and suburban sprawl Interceptor sewers are eligible for 75 percent federal grants

The potential for unwanted growth associated with an interceptor sewer was so great in the Gettysburg, Pennsylvania, facility plan that the EPA ordered work stopped and an environmental impact statement prepared

Collector sewers pick up sewage from within the neighborhood itself Collector sewers for new communities generally are not fundable. Lateral sewers, the hookups from the homes to the collectors, are not eligible for federal grants

The funding policies of the EPA and states, however, are often complex and confusing. Advisory groups should be aware of those which relate to the particular situation and identify the portion of the collection system that will have to be paid for with 100 percent local funds.

Advisory Group Questions: Future Situation

- **How much growth is projected?**
- **Are projections consistent with community goals and land use plans?**
- **What per capita flow projections are being used?**
- **Are wastewater flow projections accurate?**
- **Where will interceptor sewers be located?**
- **What parts of the community will be served by sewers?**
- **What are the environmental effects of new sewers?**

Most costs of a sewer system arise from acquiring rights of way, laying pipes, and building pumping stations It costs little more to install a large diameter sewer than a small one There is a strong temptation to build reserve or growth capacity into the system. Growth capacity and location of sewers thus are of enormous importance to many communities. The advisory group can see that the issues are fully evaluated and discussed

Total Flow Estimates

Daily average wastewater flow is often used for the design of treatment works It is based on expected future population, per capita waste contributions, industrial flows, commercial flows, reasonable infiltration and inflow estimates, and the impacts of water conservation. From a technical perspective it is easy to design a plant after the design flow is chosen.

Unfortunately, much more effort often goes into the design of processes rather than the more important matter of design flow predictions. The advisory group should see that this does not occur. An advisory group should place considerable emphasis on the design flow estimate!

Identifying Alternatives

There are many ways to collect and treat wastewater However. given all the limitations of water quality standards, regional service area, and cost effectiveness, the community may find that only a few alternatives exist

As the number of options diminishes, the selection of the treatment processes becomes more a matter of an engineering and economics choice. This is why the early work in identifying the problem and assessing the current and future situations becomes so important to the advisory group. Nevertheless, the advisors can still emphasize processes that appear the most economically and environmentally sound.

Some of the basic options include

• *No Facility*

Are new or upgraded facilities really required to solve existing environmental problems? This basic question should be answered before any other options are pursued. The performance of existing facilities may possibly be improved as an alternative to constructing new facilities. Recycling or pretreatment may reduce industrial waste loads Water conservation may reduce residential flows Other considerations exist.

One option is not to build a facility

• *Conventional Wastewater Treatment Alternatives*

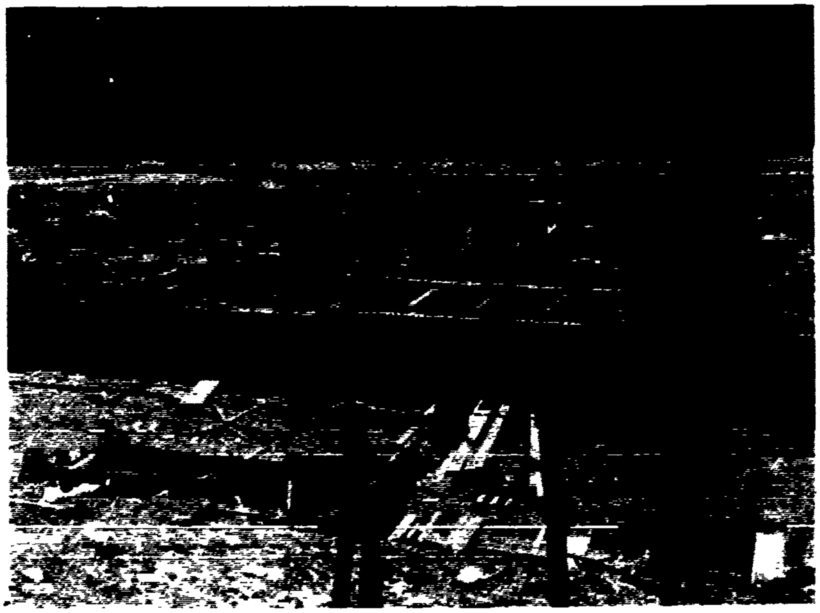
Conventional wastewater treatment systems deliver wastewater to a central treatment facility, subject the wastewater to a series of treatment processes, and discharge the effluent into surface waters If operated properly, conventional technologies can produce effluents of high quality, although sometimes at high cost These processes are usually time-proven and dependable.

• *Advanced Wastewater Treatment Options*

Do water quality problems really require advanced wastewater treatment? Advanced wastewater treatment methods may double the cost of treatment as compared to secondary methods With land application as a notable exception, they often consume large amounts of energy and chemicals, and produce excessive volumes of waste by-products called sludges

• *Waste Treatment and Reuse of Purified Water*

Water resources are becoming increasingly more limited and/or expensive to develop. As the cost goes up, the reuse of treated wastewater becomes more attractive Reuse currently occurs as industrial cooling or process waters, recreational water supplies, and agricultural irrigation *In Lubbock, Texas, where irrigation water is scarce, 15 mgd of secondary effluent is applied to 2,300 acres of wheat, barley, oats, rye, cotton, and sorghum An aquifer created by the effluent over the decades is now used to supply recreational lakes.*



Another option is to build a conventional treatment plant

Advisory Group Questions: Alternatives

- **Is a full range of alternatives considered, including small-scale options as well as the central treatment facilities?**
- **Is land treatment seriously considered?**
- **Is operation and management taken into account?**
- **Is sludge handling and disposal accounted for?**
- **Are there opportunities to recycle or reuse treated wastewater?**
- **How much treatment capacity is required?**
- **Are innovative and alternative technologies considered?**
- **Is the plan compatible with the 208 areawide plan?**

Construction of onsite treatment systems is also an option

Another option is land application

Better operation and management of the existing facility is an option

• *Small System Waste Treatment and Disposal*

Onsite treatment systems to collect and control wastewaters include septic tanks, mounds, holding tanks, small aerobic treatment plants, or other onsite and small processes serving residences or commercial establishments. The onsite alternative is becoming increasingly attractive since the Clean Water Act provides federal grant funds for onsite treatment works in certain situations

• *Conventional Treatment and Land Application*

Wastewater is processed in the conventional manner at the primary or secondary treatment level However, the effluent is applied to the land, not discharged into surface waters Federal law requires the specific consideration of land application as an alternative Land treatment is a good consideration for advanced waste treatment Some states require secondary treatment before application, which placed land treatment at a severe economic disadvantage to conventional methods except for advanced waste treatment requirements.

In Muskegon County, Michigan, 6,300 acres planted mostly with corn are irrigated by secondary effluent from a 43 million gallons per day (mgd) wastewater project

• *Sludge Management*

Sludge management and disposal is a major problem! Unfortunately, the pollutants removed from wastewater do not vanish They become an obnoxious material called sludge The cost of sludge treatment often equals the cost of sewage treatment It, therefore, is a vital part of the analysis of every treatment system. Advanced wastewater treatment sludges add to the problem Some land treatment procedures do not produce sludge.

• *Operation and Management*

Operation and management is a major concern of both existing and new treatment facilities The EPA has found that many facilities do not meet water quality limits because they are not operated properly. Operation and management are extremely important in facility planning. These costs must be borne solely by the locality

• *Other Considerations*

The EPA guidelines also call for a few other considerations in the selection of alternatives Matters such as construction staging schedules, and multiple use opportunities for open space and recreation are taken into account

Conducting Environmental Assessment

Environmental aspects of different sewage management alternatives are assessed during the facility planning. Both the primary and secondary impacts associated with various alternatives are addressed.

The primary effects are those that directly relate to location, construction, and operation of the project For example, impacts on a stream from the effluent are direct effects Secondary effects are indirect or induced by the project, such as changes in population, economic growth, and land use

A grantee has to prepare an environmental information document, which is used in the facility planning, and is submitted to the EPA The EPA then reviews it to determine whether or not to prepare a full environmental impact statement (EIS) An EIS must be prepared if

- The facility plan will induce significant development and changes in land use
- The treatment works is located on productive wetlands or will affect endangered species
- The treatment works will have a significant adverse effect on public lands, and recreational or historic opportunities
- The treatment works will have a significant adverse effect on air or water quality, noise, and/or on fish and wildlife habitats
- The effluent limitations for pretreatment are insufficient to protect present or future water uses
- The treatment works will cause significant social dislocations, or will adversely affect significant amounts of agricultural land

To save time EIS's are often conducted concurrently with facility planning EIS's are prepared for only about five percent of the construction grant projects.

The advisory group can help identify potential impacts at the local level. It should see that the environmental information has adequate public and governmental review. The federal requirements are quite specific and should be consulted.

Advisory Group Questions: Environmental Effects

- **What are the existing and future environments without the project?**
- **Has an environmental, social, and economic evaluation of waste treatment alternatives been made?**
- **Have all environmental impacts been identified and thoroughly discussed?**

Making Cost-Effectiveness Analysis

The final selection of the wastewater treatment alternative is based upon a cost-effectiveness analysis It is a method of determining how well a treatment system achieves its objectives in terms of overall costs, including economic, social, and environmental costs This may not sound very interesting, but it is important. Except for certain innovative and alternative projects, the EPA can only fund the most cost-effective solution The most cost-effective wastewater management solution is the one with the lowest overall monetary costs (including capital, operation, management, mitigation, and opportunity costs over a 20-year period) without significant adverse nonmonetary effects such as environmental or social drawbacks

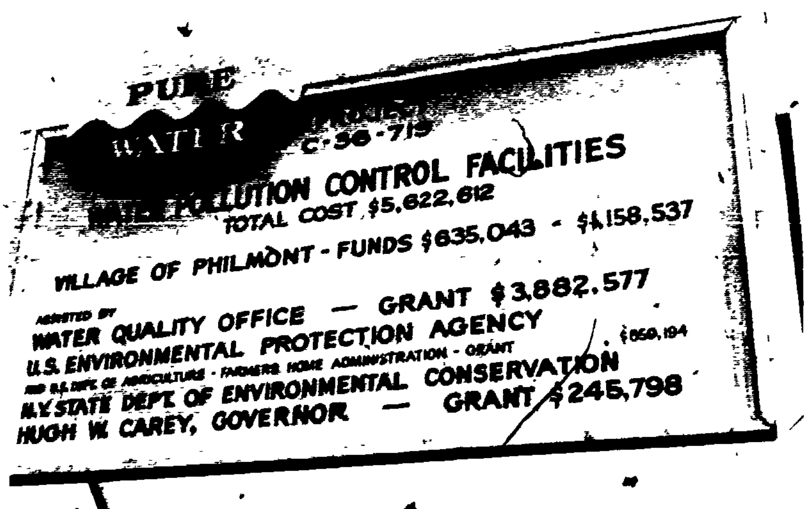
Capital costs are eligible for federal grants, but operation and management costs are borne completely by the municipality. The costs of mitigating adverse environmental effects, and the costs associated with opportunities lost because of the project, are also figured into the analysis Besides costs there are offsetting revenues. For example, the revenues from the sale of wastewater or organic sludge to farmers, or the value of crops grown on public land with land application of the wastewater go into the calculations

Another area of costs is important to localities, but do not enter the cost-effectiveness analysis. This matter — finance — concerns how the community will pay for its share for planning, design, and construction costs It is not a subject that is ignored until the end of the process. Indeed, the means of local finance such as taxes, and user fees must be fully discussed in the facilities plan

The advisory group is not expected to perform detailed cost calculations. Nevertheless, it can probe the costs and offsetting revenues that go into the bottom line dollar value. Even more important, however, is the review for overriding environmental and social considerations. The advisory group also should see that the full meaning of the local financial arrangements, such as household charges, are realized by the community.

Advisory Group Questions: Cost Effectiveness

- Which sewage treatment alternative has the least monetary cost without overriding environmental and social drawbacks?
- Are the environmental and social effects adequately assessed?



Sign showing cost of water pollution control facilities for Philmont, NY

Selecting the Plan

All the activity in facility planning culminates in the selection of a preferred alternative. Before the final choice is made the number of alternatives has already been reduced. This initial screening eliminates certain options from further analysis.

The advisory group should be sure at every stage that there are valid reasons for dropping alternatives. The ramifications and tradeoffs of all alternatives should be evident.

The local agency (the grantee) is responsible for making the final decision. The basis for this decision is the sum total of facility planning.

This includes the technical work of the consultant and the advice of the advisory group and other residents of the community. Some final questions for the advisory group are:

- Does the final choice meet the initial goals and objectives?
- Will it solve the community's problem for the least cost and with the least adverse effects?

Summary

An important point to remember is that facility planning accounts for only five percent of the construction grant dollars spent. However, this small amount directs how the remaining 95-percent will be spent in design and construction. The need for goal planning and the consequences of inadequate planning should be evident.

The advisory group can incorporate the values and ideas of community residents into the facility planning process, thereby ensuring a better final solution at reasonable costs to the community.

Choosing the Alternative
Southeastern United States

This case study is adapted from Rastatter C L, ed Municipal Wastewater Management Citizen's Guide to Facility Planning FRD-6, Washington DC U S Environmental Protection Agency, Office of Water Program Operations, January 1979, 263 pp

This is the actual case of a small town in the Southeast that has no public management of wastewater The circumstances and facts about the town's facility plan show how treatment alternatives are evaluated

The town's population is 3,150 A water district provides water service to 436 people through 170 water meters, of which 150 are located in the town itself The district includes 19 small businesses, one factory, and an elementary school. The district desires to provide sewerage service It has prepared a 20-year wastewater facilities plan, and has applied to the EPA for grant assistance

The planning area is about 2,300 acres. Overflowing septic tank systems are the only source of wastewater discharges There are no known point sources of wastewater effluent About 20 percent of the homes are located on soils with very low permeability, which probably accounts for the occasional failures of the septic tanks

The area's population is relatively stable. The district currently has a moderate growth rate, adding about four customers a year The factory, however, plans to expand Population is expected to grow by 50 to 100 percent in the next 20 years

The district sees a public wastewater system as a key ingredient for future growth and improvements, and as a remedy for the current health hazards and environmental pollution

Some wastewater management alternatives were initially rejected. Upgrading existing facilities — more than 130 septic tanks and pit privies, inadequately designed and poorly maintained — was considered impracticable, because the impermeable soils were unsuitable for onsite disposal systems.

Regional solutions were much too costly. The nearest existing treatment facility is 17 miles away. The capital costs of sewers, force mains, and pumping stations to deliver the district's small flow to the regional plant would exceed $1 million, nine times the cost of any local alternative

Monetary Evaluation

The district analyzed the complete spectrum of waste treatment alternatives. Four were evaluated in detail Monetary costs were determined for them:

- **Alternative No. 1.** A conventional gravity sewer system, with a central treatment facility The least expensive type of treatment would be an oxidation lagoon, followed by an infiltration-percolation land treatment system Another option — aerated reactor tanks followed by soil infiltration-percolation — was rejected as slightly more expensive

- **Alternative No. 2.** Similar treatment process, but most of the sewer system would employ effluent sewers In this approach wastewater solids are removed by septic tanks and stored near each source Only the liquid effluent from the septic tanks is pumped to the central treatment site. The effluent sewer system consists of interceptor tanks and siphons or heavy duty sump pumps, with small diameter plastic pipes carrying the effluent to a central oxidation pond for additional treatment

- **Alternative No. 3.** This alternative would involve the use of short stretches of effluent sewer (similar to sewers in Alternative No. 2), but the septic tank effluent would be carried directly to a subsurface disposal site The effluent would be disposed in 22 separate community sites New individual disposal systems also would be provided for an additional 22 customers. All onsite and offsite wastewater facilities would be publicly-owned and managed, including septic tanks, sewers, and treatment disposal facilities. Services to the elementary school and to the factory would be an option that would not affect the relative costs of the four alternatives, but could reduce the average charges per customer Even without the school and industry sharing the costs, the user costs for this alternative would be significantly lower than for the other two options User costs were estimated to be just 58 percent of those required for Alternative No. 2, while construction costs were about 21 percent lower than Alternative No. 2, and 42 percent lower than Alternative No. 1

- **Alternative No. 4.** This approach would consist of onsite disposal for all of the 144 customers included in Alternative No 3. Serious problems of design and implementation caused this alternate to be rejected

Monetary Costs of Four Alternatives

Item	Alternative 1	2	3	4
Sewers	$390,100	$246,900		
Treatment	81,600	81,600		
Disposal	53.900	53.900		
Total	$525,600	$382,400	$302,700	$268,300

By avoiding the costs of sewer construction and maintenance. Alternative No. 4 would have the lowest capital and operating costs However, about 20 percent of the existing structures are located on soils that severely limit onsite disposal

The next least costly option would be Alternative No 3, the community subsurface disposal system It would be 11 percent more expensive than No 4 However, the cost estimates of Alternative No 3 probably would be more accurate since there were fewer uncertainties in construction and operation

Nonmonetary Evaluation

All four alternatives would meet the effluent criteria, and satisfy other environmental criteria In the actual facilities plan the environmental effects were qualitatively evaluated in detail, and then rated with numbers from 1 (best) to 4 (worst)

Alternative Nos 1 and 2 would have larger erosion losses because of the construction of conventional gravity sewer systems. lagoons. and an infiltration basin Alternative No 2 would have less erosion and disturb streams less than No 1 because small diameter pressure sewers are not buried as deep as conventional gravity sewers These alternatives also would produce significantly more noise because of sewer construction

As for developmental effects. conventional gravity sewers could stimulate slightly more growth and new industry where excess sewerage capacity exists Thus. Alternative No 1 would have greater potential for secondary impacts than options Nos 2. 3, and 4 However, this is a rural community, and other factors such as labor supply and transportation influence growth as much as sewer services affect growth Thus, all alternatives would have only slight secondary impacts

Implementation

All alternatives could be implemented legally by the water district Alternative Nos 3 and 4 are less common techniques Therefore, they could require additional time for local. state, and federal approvals However, since Alternatives Nos 1 and 2 may require trained operators, and require more local funds. potential users may object to the user charges

Since the water district would operate wastewater services, and it is an organization known to and generally supported by local users, it probably would satisfactorily implement construction, operation, maintenance, and financial management. The fourth alternative would be particularly difficult to implement since 20 percent of the homes are located on soils with low permeability Generally, none of the alternatives has any overwhelming advantage for implementation.

Cost-Effectiveness Analysis

Monetary costs, environmental effects, implementation feasibility, and other factors are considered together in a cost-effectiveness analysis Alternative No 2 was considered better than No 1 The second alternative removes 70 percent of the suspended solids and 50 percent of BOD in the interceptor tanks, reduces the organic load in the sewer, and reduces the environmental effects of accidental discharges from the sewer system Alternative No 3 was considered ecologically sound since accidental sewer discharges are minimized, and nutrients are returned to the land

Alternatives Nos 3 and 4 also avoid the need to upgrade treatment facilities to meet changing standards for effluent discharges to surface waters Alternative No 3 minimizes system complexity and reduces O&M costs Alternatives No 3 and 4 also permit planning of community expansion since strip growth could be encouraged by conventional sewers Alternatives Nos 3 and 4 would not produce odors, while odors may occur from a treatment facility

In general, the environmental effects did not differ greatly for the four alternatives, partly because of the small size of the project, the lack of sensitive environmental features. and the relatively slow rate of growth

Plan Selection

Public hearings were held on the alternatives after the costs and effects of each were predicted Generally. Alternative No 3 was preferred due to lower total cost and simplicity of operation The cost of community wastewater management was thought to be about equal to the cost of privately maintaining and replacing existing septic tank systems — about $7 per month for an average user charge. By contrast. the conventional sewers and central treatment were expected to cost $15 per month

Alternative No. 3 was selected by the community and funded by the EPA

55

Need More Information?

Deese, P. L. and J. F. Hudson. *Planning Wastewater Management Facilities for Small Communities* Draft. Cincinnati, OH: Municipal Environmental Research Lab., Office of Research and Development, U.S. Environmental Protection Agency, July 1979. 141 pp.

This manual presents a set of procedures for planning wastewater management for small communities and is directed at areas with populations less than 10,000 persons. Part 1 gives an overview of the planning process and is most useful for the advisory group. Part 2 is a technical reference showing details using case studies. This manual can be obtained from ORD Publications Center for Environmental Research Information U.S. EPA, 26 West St. Clair Street, Cincinnati, OH 45268

Rastatter, C. L., ed. *Municipal Wastewater Management: Citizens Guide to Facility Planning* FRD-6, Washington, DC: U.S. Environmental Protection Agency, Office of Water Program Operations, January 1979. 263 pp

A publication prepared by the Conservation Foundation, Washington, DC, provides a selected and extensive discussion of activities pertinent to the responsibilities and work of advisory groups. It includes discussion on public participation. This publication can be obtained from General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225

Rastatter, C. L., ed. *Municipal Wastewater Management: Public Involvement Activities Guide* FRD-7, Washington, DC: U.S. Environmental Protection Agency, Office of Water Program Operations, February 1979. 125 pp

This handbook was prepared by the Conservation Foundation for use in a training program to acquaint citizen leaders with the important decisions that are made in planning of wastewater facilities. It condenses the *Citizen's Guide to Facility Planning*. It is available from General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225

Additional guidance is available from the Facilities Requirement Division (WH-595), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460. Of particular interest is a reference document called *Facility Planning* which EPA publishes yearly. It contains guidance for preparation of facility plans receiving an EPA Step 1 grant in that particular fiscal year. Copies of all applicable regulations and summaries of all applicable program requirements and program operations memoranda are included. It defines all requirements clearly in one document.

Chapter 4

Municipal Wastewater Processes: Overview

Lorna Chr. Stoltzfus, E. Drannon Buskirk, Jr., and John B Nesbitt

The Problem Doesn't Disappear

Decisions made by society years ago still haunt us today How do we get rid of unwanted material? Easy Dump it in water Yes, dilution in water allows the waste to be quickly and easily transported away Dilution also makes the waste less offensive. Out of sight (smell) means out of mind!

Or does it?

Currently we have many waste removal systems designed to operate in this way, and have developed a lot of sophisticated technology to go along with it Miles of pipe lie under our cities to collect wastewater and carry it somewhere "out of sight" Conventional systems are not all that bad They can be remarkably dependable Most can produce environmentally acceptable wastewaters Some operate for decades beyond their intended life spans

However, because of high costs and other drawbacks localities are turning to various nonconventional methods of wastewater management. Some communities have inadequate sewage collection, treatment, or disposal These communities have a choice whether to continue with similar adequate facilities, or to try something different

Sewage: Pollutant or Resource?

Sewage presents both problems and opportunities

The construction of wastewater treatment facilities historically began out of concern for waterborne diseases Most organisms in sewage are harmless to humans, but disease-causing bacteria and viruses are present Industrialization has created other hazards — toxic substances such as pesticides, heavy metals, and even radioactive materials

Sewage also contains nutrients such as *organic*, carbon-containing substances that result from living things, and inorganic matter such as nitrogen compounds Inorganic matter does not come from living things, but from minerals These materials are not problems at low levels, but at high levels they can degrade water quality These materials serve as nutrients for bacteria and algae, which can deplete and dissolve oxygen in lakes and streams As bacteria feed on organic matter, oxygen is consumed in direct proportion to the amount of organic matter present Such organisms cause a *biochemical oxygen demand* (BOD). The measurement of BOD represents the amount of this kind of organic matter present in water Excessive growth of aquatic plants may also result from nutrients

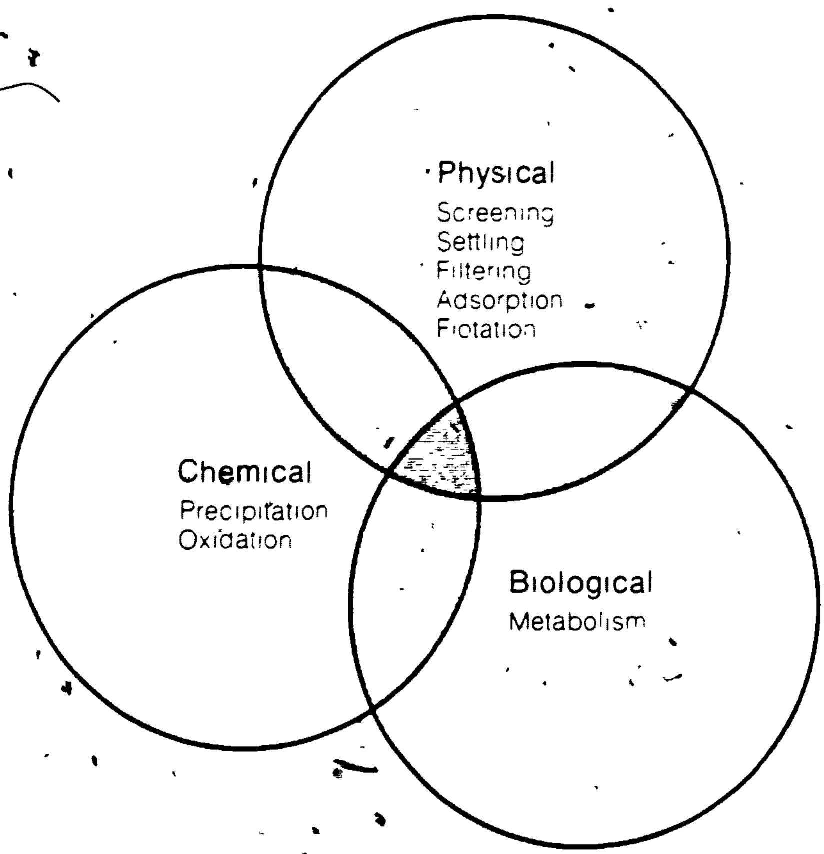
Thus concentration as well as kind determines whether a substance is a pollutant or a resource

Removal of Pollutants

Sewage is more than 99.9 percent pure water. This amounts to about two drops of waste in a quart of clean water. Because this small amount of pollution can cause a lot of trouble, dirty waters must be cleaned before being discharged into rivers and lakes. This is neither an easy task nor an inexpensive one.

So, what sorts of things are found in this 0.1 percent waste in sewage? How are we going to remove them? The ways of removing pollutants depend upon their biological, chemical, and physical properties.

Wastes in water exist in all three states of matter: gases such as ammonia, liquids such as oils, and solids such as feces or sediment in chunks of various sizes. The physical state of a pollutant has a direct bearing on the selection of wastewater treatment processes.



Methods to remove pollutants combine biological, chemical, and physical approaches

Large Solids

In wastewater treatment pollutants generally are removed according to size. Large chunks of solids get removed first. Materials such as sticks and rags can be removed by passing the wastewater through a screen. Another approach is to collect the large objects, grind them up, and return them to the wastewater for further processing. A way to deal with floating objects is to skim them off.

Small Solids

Wastewater often contains gravel, grit, and sand in runoff from streets. One removal method is to allow the particles to settle naturally. This can be done by putting the wastewater in a basin where the water current slows slightly, giving the small but heavy solids time to settle with the help of gravity.

Suspended and Dissolved Particles

Other small organic particles are not as heavy as the gravel, grit, and sand. They remain suspended due to the movement of the water. Given more time and less agitation, these particles will settle as well. This process is called *sedimentation* and produces a clearer (clarified) wastewater.

Organic Pollutants

Removal of the smallest organic suspended solids is often done by biological organisms. Three types of treatment alternatives are often used: The trickling filter, activated sludge, and land treatment. In a trickling filter a film of microorganisms grows on stones or a synthetic medium. The wastewater is allowed to trickle through these materials, and the microorganisms metabolize or digest most of the organic pollutants. In an activated sludge system, the organisms are suspended in wastewater with air blown in to provide oxygen and to enhance mixing. The third alternative is called the "living filter," where wastewater is applied to land, and is purified by the natural biological, chemical, and physical processes of the soil.

After biological treatment, some small suspended organic particles still remain. Most can be removed by *filtration* through a fine screen with small openings, or a deep bed of sand

Dissolved organic matter can be removed both by biological treatment and by *activated carbon adsorption*, a process in which the pollutants adhere to the carbon particles

Inorganic Pollutants

Inorganic pollutants such as phosphorus are usually dissolved in water Dissolved material is generally in the form of tiny charged particles called ions These ions can be removed by various means, including *precipitation* Precipitation is really just changing the conditions so as to make the material insoluble in water Once the solubility is altered, the pollutants can be removed by sedimentation or filtration Precipitation can be carried out by adding certain chemicals to the wastewater

Another way is *ion exchange* In this process a more desirable ion is substituted for the undesirable pollutant Ammonia nitrogen may be removed from wastewater in this fashion

Two other approaches, *electrodialysis* and *reverse osmosis*, use membranes In electrodialysis the ionic compounds, usually salts, are forced out of the water by the action of an electric field In reverse osmosis, clean water is forced through a membrane, leaving the dissolved solids behind

Dozens of other treatment processes exist All are based upon three types of mechanisms Biological, chemical, and physical actions These removal approaches can be combined in many different ways to clean up particular kinds of wastewater Most are patterned after natural methods of water purification It's just that the methods are accelerated in time, and concentrated in space to keep up with our huge volumes of wastewater

Wastewater Treatment Mechanisms

Type	*Function*	*Example*
Physical	Screen	Bar rack
	Settle	Sedimentation
	Filter	Sand filter
	Adsorption	Carbon column
	Flotation	Sludge thickening
	Selective transport	Electrodialysis
Chemical	Precipitation	Phosphorus removal
	Oxidation	Odor control
		Disinfection
Biological	Metabolism	Trickling filter
		Activated sludge
		Septic tank
		Land treatment

For additional information see the glossary and the program unit entitled Municipal Wastewater Processes Details

Things to Consider

The advisory group can ask questions that, in effect, direct the scope of water quality planning. A few pertinent questions should be asked early in the planning process:

- **What assumptions are the planners using from the outset? Are they appropriate?**
- **What are the reasons for using a particular removal concept — climate, experience of engineering consulting firm, reliability, nature or amount of wastewater?**
- **Are the basic design principles well-suited to the particular problem at hand?**
- **What are the existing facilities? Are these a constraining factor in considering methods?**

Before and After Treatment

Any considerations of municipal wastewater process should also include a look at what happens *before*, and what happens *after* the removal of pollutants Where the wastewater comes from, and how it is collected and transported have a direct bearing on the kinds and concentration of pollutants that must be removed from the wastewater Also, the disposal of products left after treatment should be considered in the selection of treatment processes

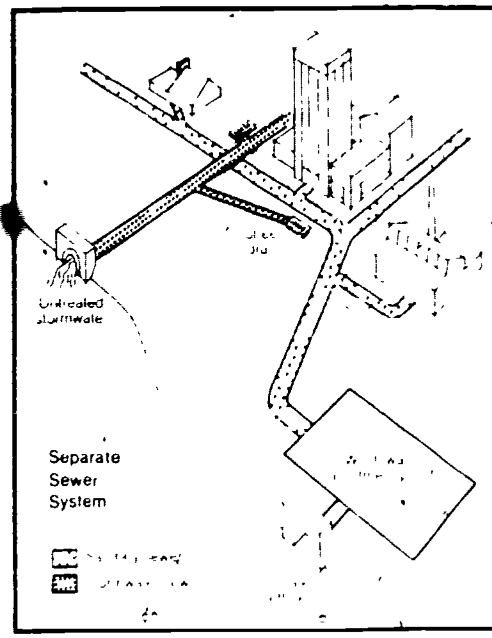
Collection of Wastewater

First of all, how is wastewater collected so that it can be treated? In central treatment systems wastes from homes, businesses, and, sometimes, industry are carried by water through pipes called sewers which lead to the treatment plants Wastewater is transported by conventional gravity sewers, and other methods such as pressure or vacuum sewers

Although gravity sewers have a good record for dependability and efficiency, they have drawbacks In addition to being expensive, they may disrupt the environment They can require deep excavations that cause extensive dust, erosion, and sedimentation problems Odors may also be a problem where flat terrain contributes to the slow flow of sewage Because gravity sewers typically follow natural drainage paths, their construction may disturb nearby watercourses They also may overflow into adjacent watercourses from time to time

Other methods of transporting wastes involve the use of small diameter vacuum or pressure sewers These systems are relatively new and are used only on a small scale. They are likely to have greater operational, maintenance, and energy costs than gravity sewers, but cost much less to install.

Modified onsite disposal systems also may use small diameter sewers Wastewater from several conventional septic tanks can be transported by sewers to a common disposal area (absorption field)

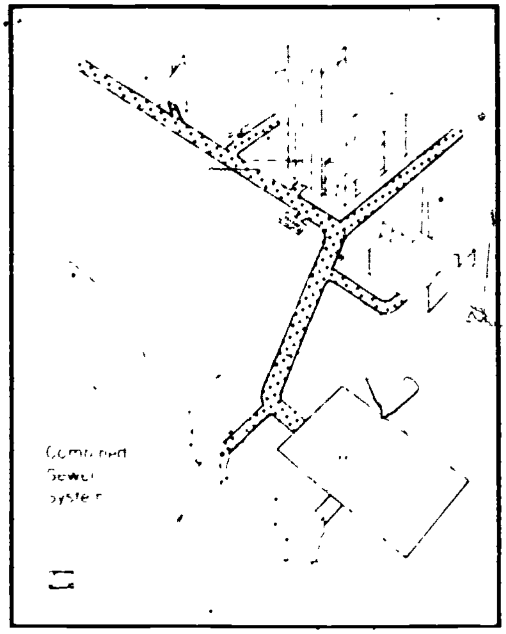


Types of Sewer Systems

There are two basic types of sewer systems — combined and separate *Combined sewers* carry both water polluted by human use, and water polluted as it runs off rooftops, streets, and land during rainstorms, snow melts, or other forms of precipitation

Separate sewer systems have two sets of sewer pipes One system called *sanitary sewers* carries only wastewater from homes, businesses, and industries A separate system carries rainwater polluted by dirt and other contaminants into pipes that are known as *storm sewers* These separate storm sewers empty directly into water courses

Combined sewers are common in the older cities of the eastern United States. About 1,600 communities with a total population of 31 million persons have combined sewers One problem which plagues these systems is how to accommodate the large quantitites of wastewater during and after rainstorms When storms occur, the treatment plant often is overloaded It is then necessary to have some of the wastewater bypass the plant, and flow into the receiving surface waters without treatment If part of the increased load of water were not diverted, the treatment plant would be hydraulically overloaded, and the purifying processes would not function properly for a long period of time At times like this some wastewater gets treated and some gets dumped into



waterways as raw sewage Treatment plants generally are designed to accommodate only dry weather flows, plus a small portion of the stormwater Special facilities may be constructed to treat excess flows during storms where such flows create pollution problems Separate holding tanks and equalization basins for storing wastewater are possible remedies Another approach, but costly, is the separation of sanitary and storm sewers The cost for this alternative around the country would be millions of dollars However, this method for stormwater pollution abatement facilities may be eligible for federal funds if they are the most effective means of protecting surface waters

Sewer Funding

Sewer funding is complex Eligibility for EPA funds mainly depends upon the type of sewer, installation situation, and state priorities

Sewer systems are composed of piping, pump stations, manholes, and associated items The pipes consist of house connections, collectors, interceptors, and force mains *House connections* carry wastewater from the house into the sewer system The cost of house connections must be borne completely by the homeowner The wastewater flows from these pipes into *collector sewers* New communities, or newly developed areas of existing communities, must bear the entire cost of the collectors Only communities in existence or wastewater systems two-thirds completed before October 1972 can qualify for collector sewer funding In many states, however, collector sewers do not receive a sufficiently high priority to receive any funds

The main conveyance pipe which gathers flows from the collectors and transports the wastewater to the treatment plant is called an *interceptor* Depending on the terrain, a *force main* may be necessary to carry water, under pressure, from a *pump station* to the treatment plant. Interceptors, force mains, and pump stations are all fundable by the EPA which will pay 75 percent of the cost on all eligible items However, only 25 percent of state allocations can be spent on pipe-related projects such as interceptors and pump stations

The community, of course, must pay for all construction costs not covered by federal or state funding The local users also must pay for operation and management costs from the time the sewers are completed

In addition to costs, the important considerations in wastewater collection and transport systems include the size of the service area, and service area characteristics such as soils and population projections. This last concern — population — is crucial in determining the sizes of both sewers and treatment facilities While the sizes must be adequate, they must not exceed reasonable future needs Otherwise, unwanted costs and undesirable development may occur

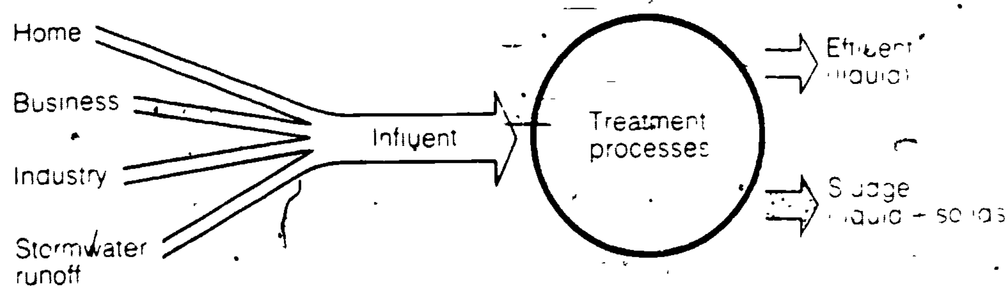
Gravity Sewers

Advantages

- Dependable
- Have low energy and maintenance needs

Disadvantages

- Require deep excavations
- Often built along streams and lakes
- Usually more environmentally disruptive than other sewer alternatives



Disposal of Effluent and Sludge

No matter how good the treatment is, all the pollutants are never taken out of the wastewater These pollutants leave the treatment facility in two ways There is the treated liquid called *effluent* There also is a liquid mixture called *sludge*, which contains solids that have been removed from the wastewater

Effluent

Before it leaves the treatment plant, the effluent is treated further to kill any disease-causing bacteria This is usually done by disinfecting the water with chlorine Then the effluent can be either diluted through discharge into surface waters, applied to land for agricultural production, recreational use, or groundwater recharge, placed in containment ponds to evaporate, or reused as process or cooling water for industry or utilities The use and the cost of this reclaimed water depend on the degree of waste removal needed, and the availability of alternate water sources

The quality of the effluent which leaves the plant is of primary importance in the protection of the receiving water This quality is measured by several factors

- Organic matter (biochemical oxygen demand and suspended solids)
- Nutrients (ammonia and phosphorus)
- Coliform bacteria (fecal organisms)
- Toxic materials

The concentration of these substances determines the quality of the effluent, and represents the efficiency of the treatment plant.

Sludge

Sludge is akin to the tail that wags the dog in many municipalities Proper disposal of sludge is necessary to complete effective waste treatment It is a mushrooming problem that demands larger portions of wastewater treatment funds every year Sludge handling may make up half the cost of wastewater treatment

Sludge is largely water (90-95 percent) The solids are separated by centrifuges, filtration, or drying beds Final sludge disposal methods include burying, burning, composting, and direct land application However, these methods are not without their own problems Incineration can result in air pollution and generates ash that itself must be disposed Expensive energy supplies also may be consumed in the burning process, although new dewatering methods can minimize this problem Good engineering design and operation, however, can result in facilities that meet environmental standards

Composting and direct land application also have mixed benefits. Energy and nutrients may be obtained from sludge, but toxic agents such as heavy metals and disease-causing organisms also may be present. Indeed, since sludge contains *concentrated* pollutants, it must be disposed of with care. Whether or not sludge is a resource or a problem depends upon its contents, processing, and the market for compost. Sludge disposal becomes much easier and less expensive if heavy metals and toxic materials are kept out of municipal wastewater. This can be accomplished through an effective industrial pretreatment program.

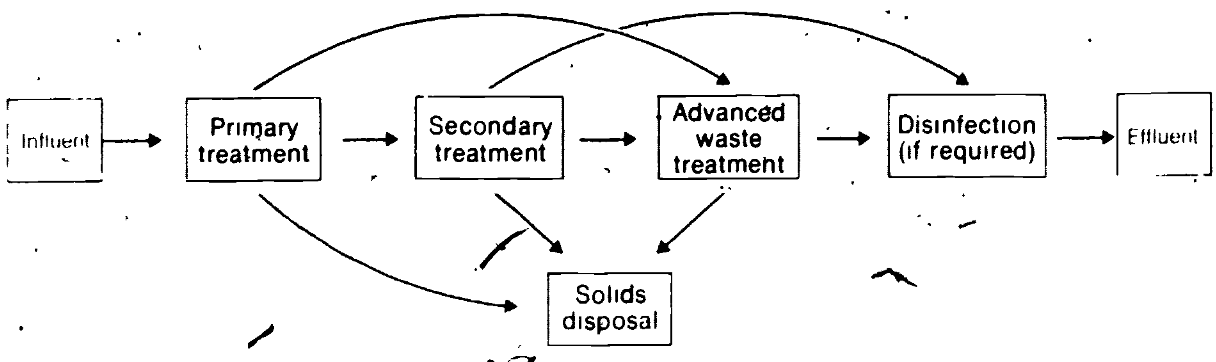
Sludges must be evaluated with the *least-risk* method of disposal chosen for each community. There is no such thing as an alternative without risk.

Construction of a sewer system

Questions about Sewers and Sludges

Questions to ask about "before and after treatment" include:

- **Where does the wastewater come from, and has thought been given to reducing this quantity of water?**
- **How is the stormwater runoff controlled, collected, and treated?**
- **How is sewage collected and transported?**
- **If new sewers are necessary, where are they to be built?**
- **What are the effluent/sludge disposal options and their related costs?**
- **How will the disposal techniques affect the environment?**
- **Do the choices fit in with the values of the community?**
- **What environmental standards must be met for the effluent and sludge?**



What Happens at the Treatment Plant?

Traditionally, the stages of wastewater treatment were designated as *primary*, *secondary*, and *tertiary*, but the definition of tertiary was unclear. Therefore, tertiary is now referred to as *advanced waste treatment* since there is a lot of overlap in what certain processes can accomplish.

Primary Stage

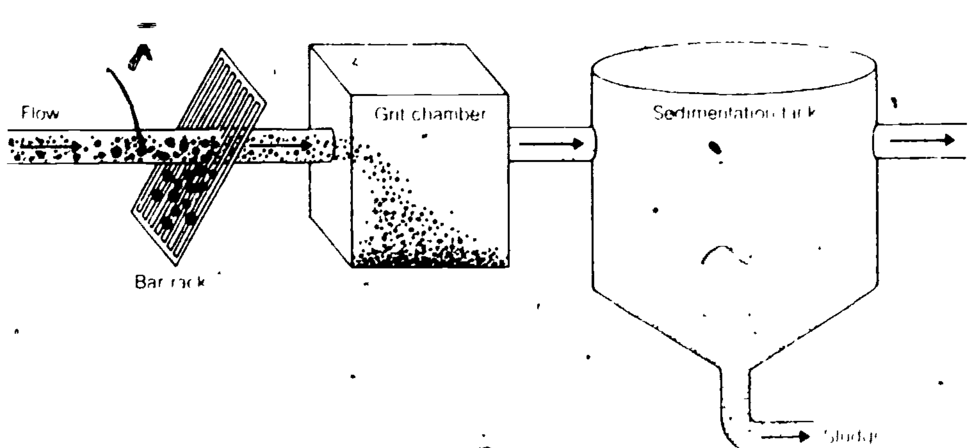
This process, mainly mechanical, removes solids which either settle or float. At best suspended solids can be reduced by 60 percent and the BOD by 35 percent at the primary stage.

Basically this process involves passing the wastewater through a screen or bar rack to remove large floating solids. Instead of a screen, some treatment plants use a grinder to shred large pieces of solid materials. Next, the wastewater flows into a *grit chamber* where sand, cinders, and small stones settle out. Suspended solids are then removed in a *sedimentation tank* collecting on the bottom as raw sludge.

Primary treatment is a rather coarse procedure. Only the large chunks of wastes and solids that either float or settle are removed. The process has little effect upon finely suspended and soluble pollutants. They must be removed at other levels of treatment.

Secondary Stage

By adding secondary treatment to the primary processes, more than 85 percent of the BOD and suspended solids are removed. Under controlled conditions, biodegradable organic wastes are converted



Primary stage of wastewater treatment

into carbon dioxide and water by microorganisms in an accelerated process similar to that which occurs in a natural stream

Two common types of secondary treatment are the *trickling filter* and the *activated sludge* processes. A trickling filter is a bed of stones or synthetic material through which the wastewater passes after primary treatment. Bacteria and other organisms on the stones consume most of the organic matter in the wastewater as it trickles through the bed. In the activated sludge process, aerated wastewater and microorganisms are held together for several hours in a basin.

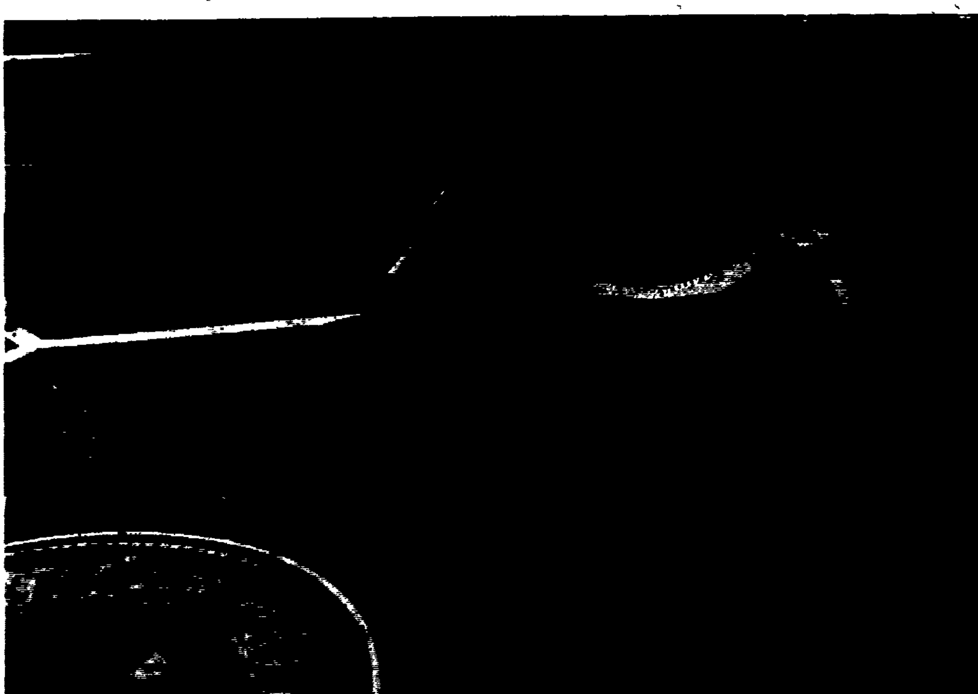
Other approaches to secondary treatment are the *oxidation pond or lagoon, carrousel aeration, rotating biological contactor, activated biofilter*, and *land treatment*. Oxidation ponds or lagoons that are not artificially aerated offer a low energy and operational cost alternative where land space is available. Complexity of operation is low for ponds as it is for land treatment. These approaches are also biological in nature, and provide an adequate environment for the breakdown of soluble organic materials. Many of these processes with unusual names simply provide surface areas onto which the microorganisms attach, or create suitable conditions for growth.

Since secondary treatment is a biological process it is effective mainly for removing biodegradable wastes. Care must be taken not to introduce substances that are toxic or damaging to the microorganisms.

Most regulatory agencies require that the final step in secondary treatment be disinfection to kill any pathogenic bacteria and viruses. Disinfection is usually accomplished by adding chlorine to accomplish the required kill.

Secondary Treatment Processes
(BOD and Suspended Solids Removal)

Trickling Filter
Activated Sludge
Oxidation Ponds or Lagoon
Carrousel Aeration
Rotating Biological Contactor
Activated Biofilter
Land Treatment



Trickling filter for breakdown of organic wastes

Advanced Waste Treatment

The pressures are mounting on our waste treatment systems. As we become more urbanized, wastes concentrate faster than the local environment can assimilate them. Every year industry creates new products which also become pollutants. Our demands for larger quantities of water further aggravate the problem. Today water must be used over and over in a variety of ways. This increasing need to reuse water calls for better waste treatment. Advanced methods of treating wastes satisfy some of these needs.

When secondary levels of treatment are not adequate to protect the quality of sensitive water bodies, more advanced processes must be used. Treatment beyond the conventional primary and secondary stages can remove most of the pollutants: nitrogen, phosphorus, non-biodegradable organic matter, and heavy metals as well as BOD and suspended solids. However, the costs often are very high.

Combinations of chemical, physical, and a few biological techniques accomplish this additional removal of pollutants. Examples of conventional advanced treatment processes are chemical precipitation to remove phosphorus, chemical reactions to remove nitrogen, coagulation and filtration to extract additional amounts of suspended solids, and activated carbon to adsorb organic compounds that cause unpleasant tastes or odors or are not biodegradable. However, the increasing appearance of hazardous substances such as polychlorinated biphenyls (PCBs) and synthetic chemicals is challenging even these advanced processes. New approaches to wastewater flow reduction and treatment are needed. A relatively old process, land treatment, is becoming more and more viable as an alternative to conventional advanced waste treatment processes.

Advanced Waste Treatment Processes

Phosphorus Removal

Coagulation-sedimentation
Land treatment

Nitrogen Removal

Biological nitrification-denitrification
Ammonia stripping
Ion exchange
Breakpoint chlorination
Land treatment

BOD and Suspended Solids Removal

Coagulation-sedimentation
Filtration
Microscreening
Land treatment

Non-biodegradable Organic Materials Removal

Activated carbon
Land treatment

Advanced techniques are not a cure-all for our wastewater problems. Many require chemicals that are expensive to purchase or create residues that are difficult to dispose. Some approaches are very energy intensive. Many advanced techniques are relatively new, and may not be time-tested. The benefits of advanced waste treatment must be weighed against the costs. Communities must carefully consider the need for advanced waste treatment.

67

Concerns about Advanced Waste Treatment

Much thought needs to be done before planning advanced wastewater treatment (AWT) systems. The advisory groups can contribute by keeping the following questions at the forefront of the discussion:

- **Have community options such as wastewater flow reduction and changed water uses that will diminish the need for AWT been explored?**
- **Is AWT really needed to meet surface water quality standards?**
- **Has land treatment been considered as an alternative to conventional AWT?**
- **Can the community afford the on-going chemical and energy expense of AWT?**
- **Are there sufficient disposal sites in the area for increased sludge due to AWT?**
- **Will the treatment facilities have competent personnel for dealing with the complex AWT processes?**

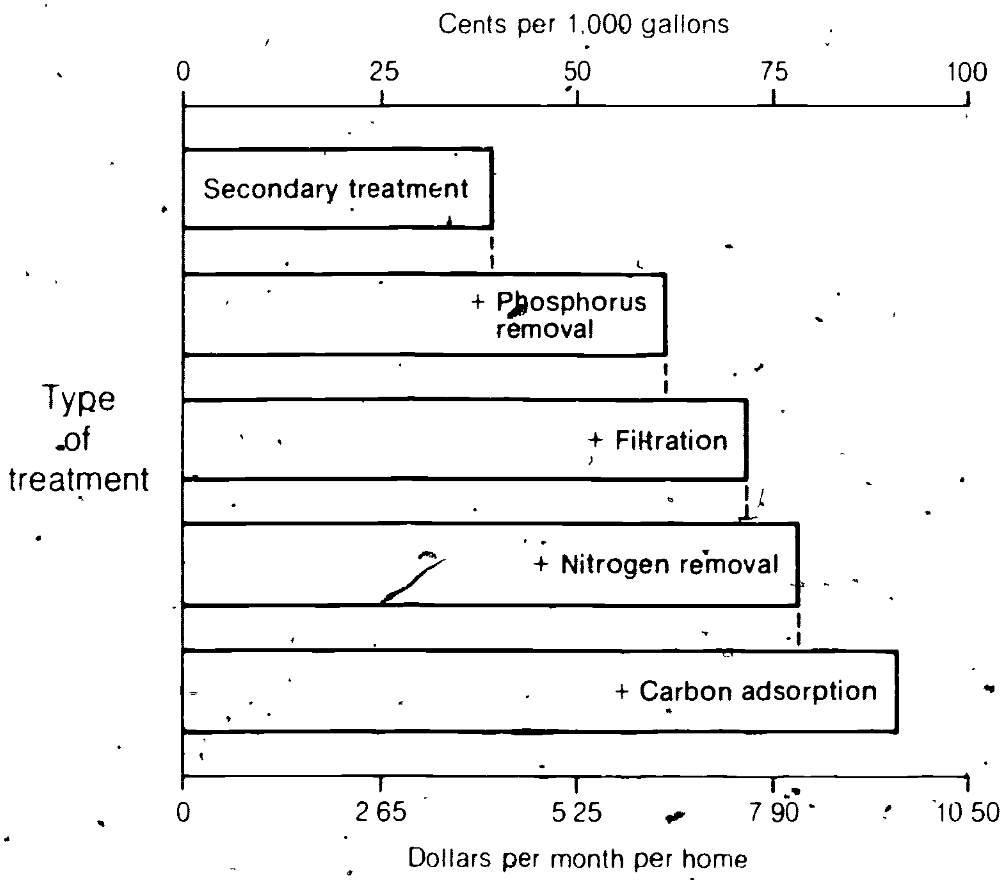
Efficiency of Treatment Processes

(Percent of Pollutant Removed from Domestic Wastewater)

Pollutant	*Primary Treatment*	*Secondary Treatment*	*Advanced Treatment*
BOD	25-30	85-95	90-99
Suspended Solids	60-65	85-95	90-99
Nutrients (Nitrogen, phosphorus)	Minimal	Minimal	90-95

Increased removal efficiencies are achieved at increasing costs. The elimination of the last 15 percent of major pollutants from wastewater is several times more costly than the removal of the initial 85 percent. Indeed, wastewater clean-up does not come cheap.

An advisory group can play a key role in identifying tradeoffs between the degree of pollutant removal and the monetary and environmental costs.



Treatment beyond the secondary level nearly doubled the cost in 1978

Planning Questions

Additional questions for advisory groups include:

• Are local environmental values reflected in the final choice?

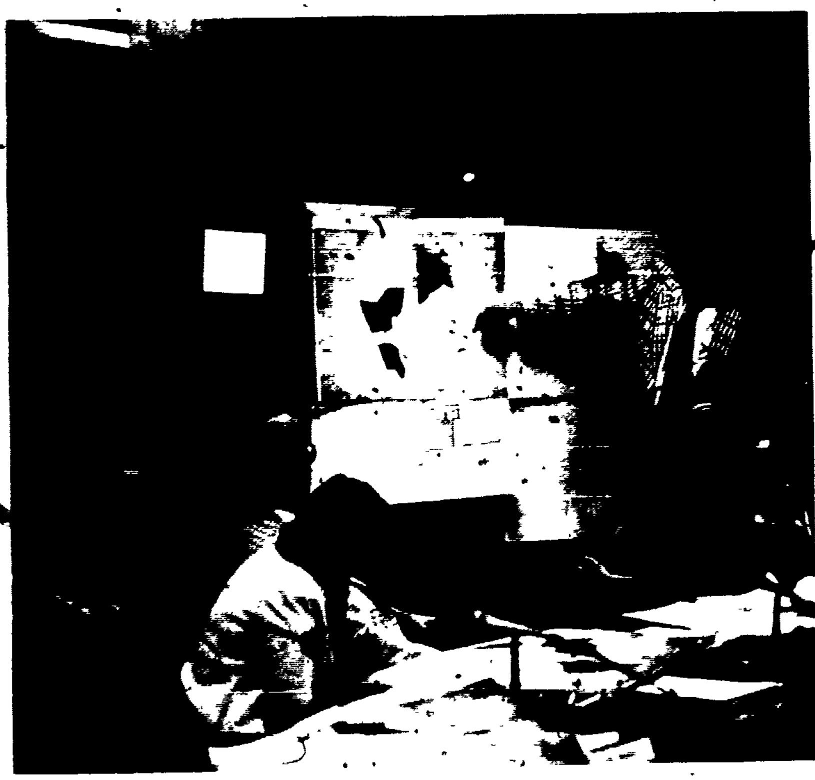
• Are alternative and innovative technologies as well as multiple uses of treatment facilities considered?

• Will the level of sophistication of the treatment processes create problems in finding qualified people to operate and maintain the plant?

• If the wastewater treatment facility has other uses such as recreation, will funding still be obtainable?

• Will the removed pollutants create future environmental problems at another place or time?

• Does the plan permit revisions for increased flows, wastewater reclamation, or water reuse in the future?



Advisory group participation in facilities planning

Room for Improvement

Alternative or innovative wastewater treatment technologies may possibly be substituted for conventional treatment processes. These may save energy, operating or construction costs, or offer some other advantages. Another cost-saving approach is to improve the efficiency of conventional facilities through design changes or improved operations and management. Such measures may avoid the need for expensive new facilities.

Another approach involves the equalization of sewage flows. The flow of wastewater corresponds to our daily activities. This routine sets a pattern of peaks and valleys of sewage flow and strength. The purpose of flow equalization is to dampen these variations, and to permit the treatment facilities to operate at greater efficiencies, rather than constantly trying to adjust to changing flows. Large basins for collecting and storing wastewater are used to achieve flow equalization.

Treatment facilities may be used effectively for multiple uses such as environmental education. Experience has shown that both the facility operations and educational experiences are improved by this use.

It may be surprising to learn that treatment plants do not always achieve the results they are supposed to. Studies show that these can be deficiencies in design or equipment, but inadequate operations and management (O&M) can also be at fault. The principles of wastewater treatment processes are few and simple, but the technologies that use these principles are complicated. Many processes, especially those of advanced waste treatment, require considerable operator training. Since communities pay the entire cost of O&M, some localities take funding short cuts in maintenance and operator training. Plant operations suffer as a result. Well-trained and paid operators are essential to facility operations and management.

Wastewater treatment facilities are community resources that must be planned in coordination with development of the rest of the community. Plants that become prematurely overloaded are victims of poor planning. Similarly, plants that are too large for a community do not operate efficiently, and the costs of operation fall on the few users.

Selection of Processes

The array of treatment processes is extensive A major portion of facility planning involves choosing one of them

Over a hundred different techniques, options, and processes exist for wastewater treatment In determining the best solution to a wastewater problem, these alternatives should be evaluated carefully in light of specific local conditions Among the factors that should be considered are

- Wastewater amount and characteristics (domestic, commercial, industrial uses)
- Effluent requirements
- Environmental effects
- Public acceptance
- Resource consumption
- Sludge handling
- Process complexity, reliability, and flexibility
- Implementation capability
- Monetary costs

The bottom line for most people is how much a system costs Both nonmonetary and monetary costs are involved Environmental, social, and indirect effects such as land development are the principal nonmonetary considerations Monetary costs consist mainly of capital, operations, replacement, and management expenditures The costs should be presented in a form that has meaning for the taxpayer, such as dollars per household per year These costs, especially for operations, are increasing rapidly due to escalating energy costs

Total Energy Consumption In Wastewater Treatment Systems

Treatment Level	*Electricity (Thousand Kwh/yr)*	*Fuel (Million Btu/yr)*
Treatment Higher than Secondary		
BOD, 10-20 mg/L; SS, 5 mg/L, Total Phosphorus, 1 mg/L		
• Independent physical-chemical	1,781	72,747
• Activated sludge plus chemical clarification and filtration	2,301	26,278
Advanced Treatment		
BOD, 1 mg/L, SS, 1 mg/L Total Phosphorus, 0 1 mg/L Total Nitrogen, 3 0 mg/L		
• Land treatment	2,701	0
• Activated sludge plus nitrification, denitrification, chemical clarification, and filtration	3,477	48,430

Total requirements for a 5 million gallon per day plant including indirect requirements for chemicals 1978

Main Points

Whether or not a substance is a pollutant or a resource depends upon its nature, concentration, and location

Basic biological, chemical, and physical mechanisms are involved in removing pollutants from wastewater. Usually the larger floating and suspended particles are removed first. The remaining suspended materials come second. The dissolved substances, where necessary, are extracted last

Pollutants generally are separated by processes that operate in three stages: primary, secondary, and advanced. The total cumulative removal of pollutants increases through this series of stages. However, costs also increase markedly, especially from the secondary through the advanced waste treatment stage

Current treatment practices are being improved through approaches such as flow equalization, comprehensive planning, and efficient operations and maintenance

Considerations other than treatment — the collection of wastewater and the disposal of wastes, effluent, and sludge — affect the choice of wastewater treatment methods. The disposal of sludge can be especially troublesome

The selection of treatment processes is based upon many of the same factors that are used elsewhere in facilities planning: wastewater characteristics, effluent requirements, monetary costs, sludge handling, process reliability and flexibility, implementation capability and public acceptance

Costs are the main concern for most people in selecting treatment processes

This handbook provides background information. Another unit entitled, *Municipal Wastewater Processes: Details*, gives specific information on comparing and evaluating various wastewater treatment alternatives

Wastewater treatment facility under construction

Need More Information?

Construction Costs for Wastewater Treatment Plants Publication Number EPA-430/9-77-013 Washington, DC U S Environmental Protection Agency, January 1978 125 pp

This document presents information which can be used to determine the alternate municipal wastewater treatment process schemes that will meet specific effluent guidelines Procedures and information which can be used in determining the cost of each alternative are also given This publication is available as MCD-37 from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225

Environmental Pollution Control Alternatives Municipal Wastewater Publication Number EPA-625/5-76-012 Washington, DC U S Environmental Protection Agency, May 1976 79 pp Order #5012 (Note An updated edition is in press at the time of this writing)

This document is an excellent non-technical discussion of available municipal wastewater treatment processes It describes the processes, gives costs and energy requirements, and discusses their efficiency, advantages, and disadvantages The discussion in this handbook is based upon this document It is available from Technology Transfer, U S Environmental Protection Agency, Cincinnati, OH 45268

Innovative and Alternative Technology Assessment Manual MCD-53 Washington, DC U S Environmental Protection Agency, September 1978 388 pp

This document contains fact sheets for 117 different wastewater treatment process variations Each fact sheet describes the process and its modifications and discusses technology status, applications, limitations, equipment manufacturers (list only), environmental impact, and references. Flow diagrams, capital costs, and operating costs are also given It is available from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225

Primer on Wastewater Treatment MCD-65 Washington, DC U S Environmental Protection Agency, Fall 1980 26 pp

This booklet is a vastly reduced version of the above publication Although it does not give details such as the advantages of specific treatment process, it is valuable as a brief overview of major water quality concerns and treatment options It is available from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225

Chapter 5

Municipal Wastewater Processes: Details

Charles A Cole and John B Nesbitt

Communities may save 40 percent of their local wastewater treatment costs by using alternative or innovative technologies This is an attractive incentive, but many of these communities will still choose conventional modes of treatment. Why? It is because most are dependable, and they produce wastewater that is environmentally acceptable

Whatever method of treatment is chosen, the task is the same the separation of pollutants (mainly solids, but also dissolved materials) from water This separation is accomplished by biological, chemical, and physical methods Most approaches are patterned after Mother Nature's methods of water purification, but are accelerated and are concentrated to keep up with our huge volumes of wastewater

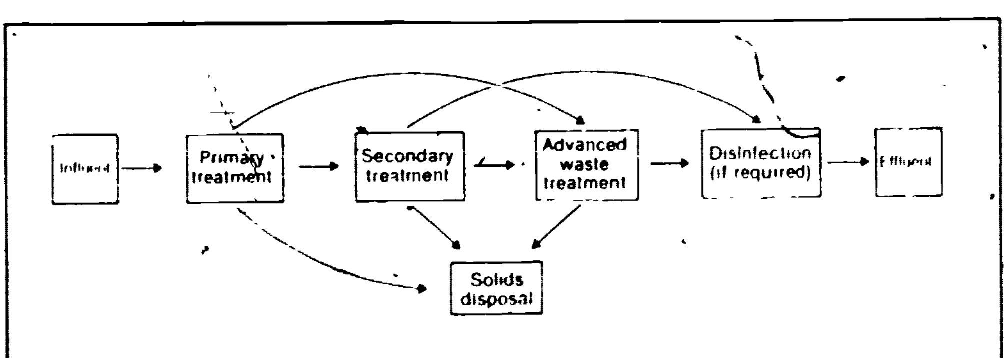
Although the principles of the treatment processes are simple, the technologies can be complicated Understanding these technologies is made more difficult by the technical language in which the processes are sometimes discussed When an advisory group discusses wastewater treatment options, it must be familiar with the requirements and limitations of these processes. An understanding of treatment processes can begin by following the path of a drop of wastewater as it travels through treatment facilities

A Drop of Wastewater

Upon entering a treatment plant, a wastewater drop (and billions like it) usually flows through a series of *preliminary processes* — screening, grit removal, and/or shredding These processes either remove the coarse materials from the wastewater, or make them smaller for further treatment The drop then undergoes a stage of *primary treatment* During this treatment phase, solids that float or settle are separated from the wastewater

Some pollutants that remain are removed by *secondary treatment* processes These methods usually involve biological treatment Organisms, mainly bacteria, through their metabolic functions convert the pollutants into forms which are easier to remove from wastewater Secondary treatment is now required as a minimum for all wastewaters

The drop may undergo *advanced waste treatment* for the removal of substances not ordinarily taken out at other stages of treatment Dissolved nutrients and some



Categories of wastewater treatment processes organic materials are removed with advanced treatment. These advanced processes may follow previous stages, or they may be used instead of them. As compared to other options, advanced waste treatment is costly.

Waste materials that are removed by the treatment processes go to facilities for handling solids These materials, called *sludge*, are ultimately disposed of by land application, incineration, or other means

Before the treated drop is discharged into a lake or stream, it may be disinfected to reduce the risk of disease The drop then returns to the natural water cycle It may collect impurities and immediately undergo treatment, or it may not appear in wastewater again for centuries

The number of treatment processes and the degree of treatment usually depend upon the uses of the receiving waters Treated wastewaters discharged into a small stream used for a domestic water supply will require a considerably higher level of treatment than wastewater discharged into water used solely for transportation Effluent criteria are thus established for each wastewater treatment facility Two principal criteria for assessing the efficiencies of many wastewater treatment processes are the removal of suspended solids and BOD Many solids serve as food for organisms present in the sewage As organisms such as bacteria feed on organic matter (carbon-containing substances), oxygen is consumed in direct proportion to the amount of nutrients present These organisms cause a biochemical oxygen demand (BOD) The measurement of BOD thus represents the amount of organic matter present in water.

Effluent requirements are only one factor to be considered in selecting wastewater treatment alternatives Others include

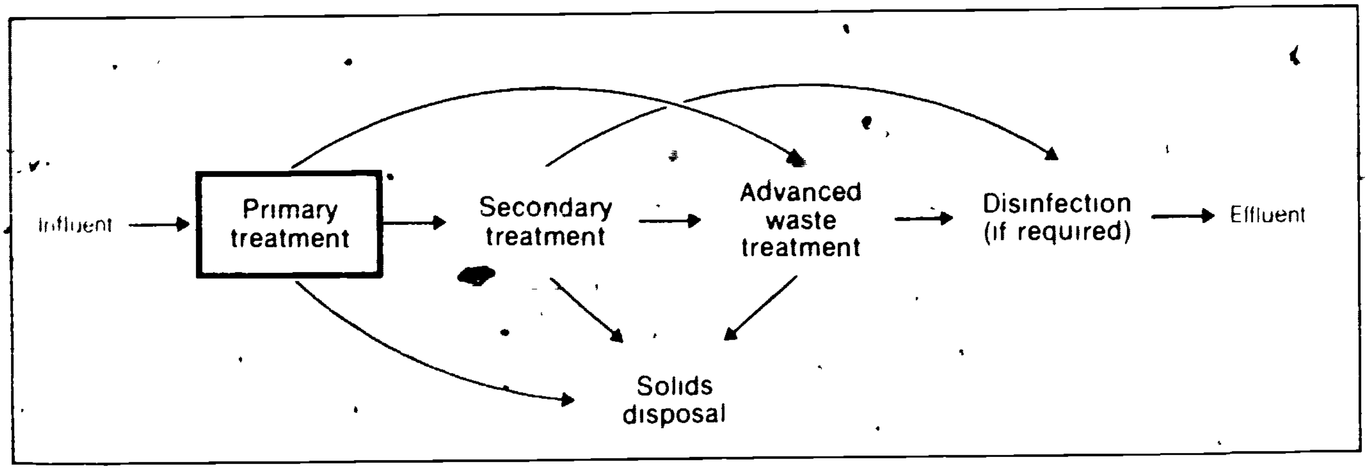
- Wastewater characteristics
- Environmental effects
- Resource requirements (energy and chemicals)
- Monetary costs
- Sludge handling and disposal
- Process reliability and flexibility

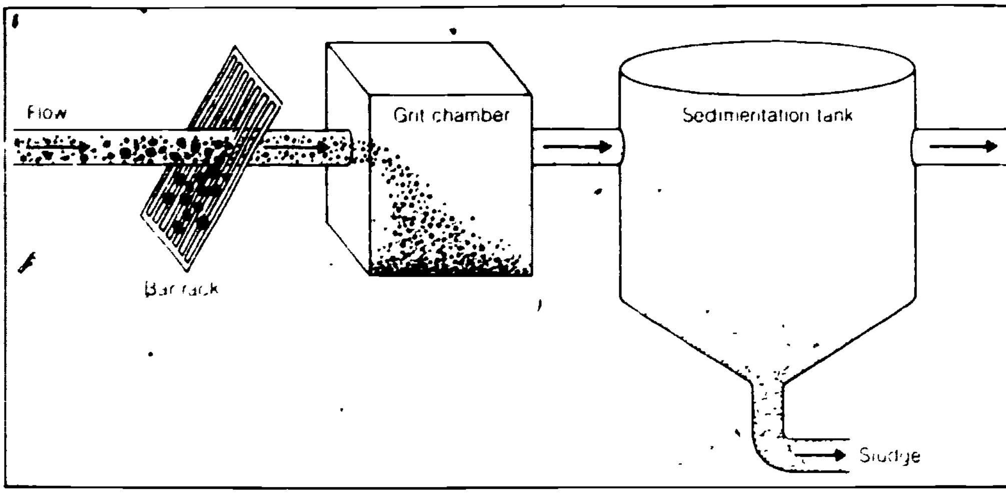
Primary Treatment

Primary wastewater treatment removes those pollutants which will either accumulate on a screen or settle The screen removes large floating objects such as rags and sticks that may clog pumps and small pipes The debris removed from the screen is usually buried in a landfill

Some plants use a device known as a *comminutor*, which combines the functions of a screen and a grinder This device shreds the solid material in the wastewater The pulverized matter remains in the wastewater to be removed later in a settling tank

After the wastewater has been screened or comminuted, it passes into a *grit chamber* where cinders and small stones are allowed to settle to the bottom A grit chamber is highly important for cities with combined sewer systems It removes the grit or gravel that washes off streets or land during a storm and ends up at treatment plants This material is usually





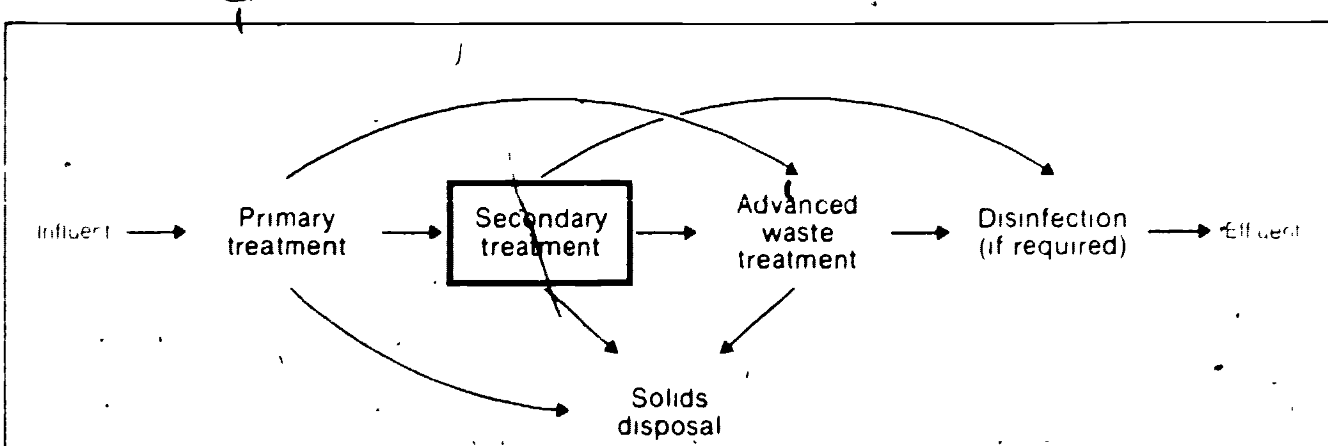
taken from the tank, washed, and buried in landfills near the treatment plant

After the screening and grit removal, the wastewater still contains suspended solids Some can be removed from the sewage in a sedimentation tank or *primary clarifier* Wastewater flows through the tank very slowly During a two-hour period, the suspended solids gradually sink to the bottom This mass of settled solids is called raw primary sludge It is removed from the primary clarifier tank by mechanical scrapers and pumps, and is transferred to sludge processing operations Floating materials, such as grease and oil, rise to the surface of the sedimentation tank where they are collected by a surface-skimming system They are removed from the tank for further processing usually to a sludge digester

In primary treatment only the heavier particles are removed The very fine suspended solids and dissolved substances are taken out in subsequent treatment operations

Secondary Treatment

The major purpose of secondary treatment is to remove the BOD-causing substances that escape primary treatment, and to remove more of the suspended solids In most cases the secondary processes function by biological means They are designed to provide the proper surroundings for the breakdown of organic materials by microorganisms A variety of approaches are used to establish a growth



environment These secondary processes usually supply oxygen, and/or provide surfaces on which the microbes can grow Some possibilities include

- Trickling filter
- Activated sludge tank
- Oxidation pond and lagoon
- Rotating biological contactor
- Activated biofilter
- Aquaculture
- Land treatment

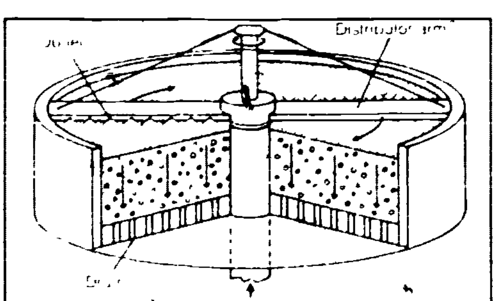
Land treatment of effluent has gained considerable popularity in recent years Wastewater with at least primary treatment is applied to vegetated soils Biological, chemical, and physical actions remove contaminants from the water Land treatment is discussed in more detail in the section on advanced wastewater treatment

Trickling Filter

A *trickling filter* consists of a bed of coarse materials, such as rocks, slats, or plastics, over which wastewater is applied by rotating pipes or fixed nozzles

As the wastewater trickles through the bed to underdrains, microbial growth occurs on the surface of the materials Microorganisms consume most of the organic matter in the sewage. However, the microorganisms sloughed off the filter surfaces result in suspended solids in the wastewater Thus, the flow from the

Trickling filter



trickling filter is passed through a sedimentation basin which collects these solids by allowing them to settle This sedimentation basin is referred to as a *secondary clarifier* or a *final clarifier*, to differentiate it from the sedimentation basin used for settling at the primary treatment phase Solids from this clarifier are further treated in the sludge handling operation

Rock trickling filters have performed well for decades In recent years other materials have found increased use, such as plastic rings, corrugated plastic sheets, and redwood slats These materials offer a larger surface area for the growth of microbes, and more open space for air flow than rock They also weigh less so it is possible to construct a taller filter bed that uses less land area than a rock filter

A typical overall efficiency of a municipal wastewater trickling filter treatment plant is about 85 percent removal of BOD and suspended solids, which corresponds to about 30 milligrams per liter of each in the final effluent Trickling filters have long been a popular treatment process

Trickling Filter

Advantages

- Simple process and equipment
- Responsive to variable pollutant loads
- Minimal operator skills
- Minimal plant maintenance
- Low energy requirements relative to activated sludge

Disadvantages

- Vulnerable to cold weather
- Reduced treatment efficiency in winter

Activated Sludge

The activated sludge process is a biological wastewater treatment technique in which a mixture of wastewater and biological solids (microorganisms and wastes) is agitated and aerated. The biological solids are subsequently separated from the treated wastewater. A portion of these solids is returned to the aeration process as it is needed. As the microorganisms grow and are mixed with the air, the individual organisms clump together to form an active mass of microbes called *activated sludge*.

In the conventional activated sludge process the wastewater flows continuously into an aeration tank where air mixes the activated sludge with the wastewater, and supplies the oxygen needed for the microbial growth. The mixture from the aeration tank flows to a secondary clarifier where the activated sludge is settled. Most of the settled biological sludge is returned to the aeration tank to continue rapid breakdown of the organic materials. Because more activated sludge is produced than can be used in the process, some of the returned sludge is separated for final treatment and disposal. In conventional systems the wastewater is typically aerated for 6-8 hours in long, rectangular aeration basins. Air is introduced either by injecting it near the bottom of the aeration tank, or by mechanical mixers located at the surface.

Many variations of this conventional system have improved the process performance. These variations depend on adjustments in treatment time, method of aeration, or in use of pure oxygen rather than air. Approaches known as *contact stabilization*, *extended aeration*, and *ditch oxidation* are all variations of the basic process.

Activated Sludge

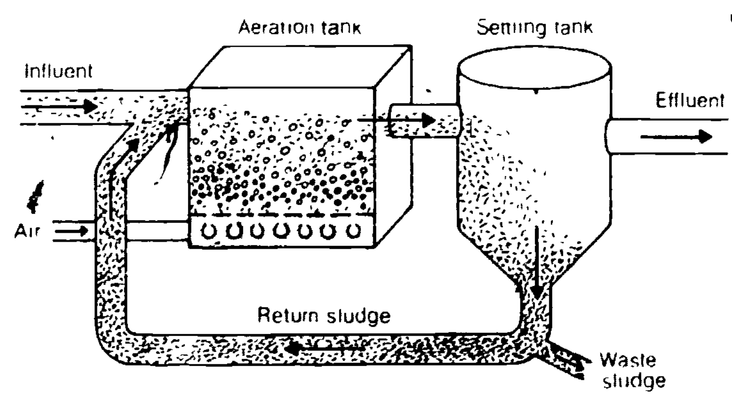
Advantages

- Treats various wastewater compositions
- Meets various effluent standards
- Compared to trickling filter higher quality of effluent, slightly lower capital costs, and smaller land area requirement

Disadvantages

- Need for careful operational controls
- High energy requirements

Activated Sludge

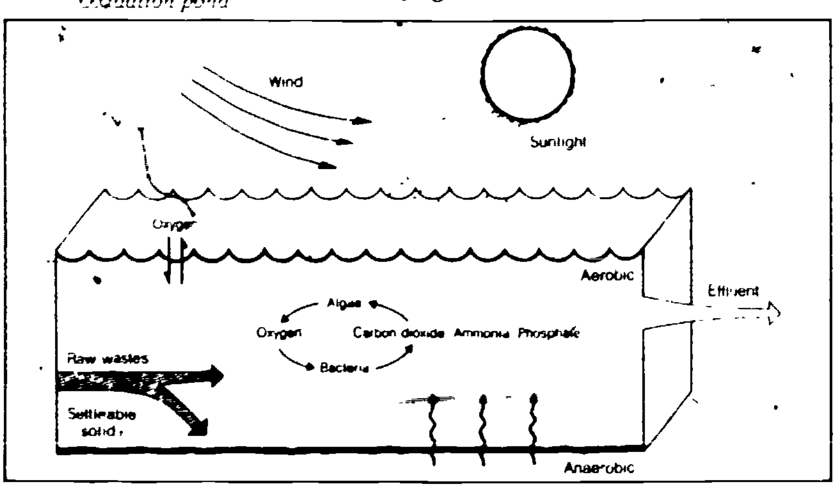


Oxidation Pond and Lagoon

Large, relatively shallow basins used for treating wastewater through the interaction of sunlight, wind, algae, and oxygen are called *oxidation ponds*, *lagoons*, or *stabilization ponds*. They are one of the most common treatment systems. They account for about one-third of all secondary treatment plants in the United States. About 90 percent of the ponds are used in towns with less than 10,000 people (1 million gallons per day treatment capacity). Primary processes are sometimes used for the pretreatment of wastes, but this added cost is usually not justified.

The most critical factor in this process involves the supply of oxygen If oxygen is insufficient, acceptable treatment will not occur To eliminate the dependence of algal-produced oxygen and to reduce the area required by the ponds, aeration equipment is sometimes used to supply oxygen Such a system is called an *aerated lagoon* Air can be supplied by a compressor that injects air into the pond through tubing on the pond bottom, or by mechanical aerators installed at the surface of the pond Aerated ponds are typically about one-fifth the size of a conventional oxidation pond Aerated lagoons are usually followed by a second settling pond A pond can often accomodate 15 to 60 days of wastewater flows In conventional ponds, sludge is removed by dredging

Oxidation pond



Oxidation ponds usually meet secondary treatment requirements for the removal of BOD. However, they occasionally fail to meet secondary requirements for suspended solids removal because of the algae in the pond effluent. Effluent suspended solids requirements for ponds have been relaxed in most states because of this algae concentration.

Oxidation Pond

Advantages

- Ease in construction, operation, and maintenance
- Low construction costs
- Minimal equipment maintenance
- Effective removal of disease-causing organisms

Disadvantages

- Large space requirement for conventional pond
- Weed problems and dike failures
- Difficulty in meeting effluent requirements due to algae
- Complex operations and high costs if algae removal is required

Rotating Biological Contactor

This process, also sometimes called the *biodisc* or *rotating biological surface*, consists of a series of closely-spaced plastic discs mounted on a horizontal shaft. They are rotated while about one-half of their surface area is immersed in wastewater

Oxygen is absorbed onto a film of wastewater on the discs. These devices provide a surface for the growth of microorganisms. As the microbes become dislodged, they are kept in suspension by the moving discs As the treated wastewater flows from the reservoir below the discs, it carries the suspended growths to a settling basin for removal

Rotating Biological Contactor

Advantages

- No recycling of sludge
- Minimal maintenance on mechanical equipment
- Higher pollutant removal than trickling filter
- As compared to activated sludge less susceptible to upset and washout, and fewer process decisions by operator

Disadvantages

- Needs to be protected from weather by covers
- Reduced efficiency in cold climates
- No long-term operating experience in U S

Activated Biofilter

This process combines features of both the trickling filter and activated sludge systems The process recirculates both the effluent and the settled sludge from the secondary clarifier thus creating a mixed liquid The trickling filter media used in this system is made up of redwood slats. Oxygen is supplied by the splashing of the wastewater between layers of the redwood slats, and by the movement of the wastewater across the layer of microbes attached to the slats Supplemental aeration is sometimes provided in an aeration tank between the filter and clarifier

Activated Biofilter

Advantages

- Stable operations and minimal process upsets
- Improvement of activated sludge efficiency
- As compared to a trickling filter needs less area, and is more vulnerable to cold temperatures

Disadvantage

- Requirement for supplemental aeration

Aquaculture

Aquaculture is the growing of plants or animals in water Aquacultural systems for wastewater treatment include both natural and artificial wetlands and other systems that usually involve the production of algae and other plants The natural wetlands suitable for treatment may closely resemble a bog. Water hyacinth, a large fast-growing plant, is found throughout the South, and is being used for waterwater treatment The growing plants have a high capacity for using both nutrients and organic matter in the wastewater

Aquaculture

Advantages

- Low energy requirements
- Low capital and operating costs
- Useful for polishing effluents
- Possible plant by-products

Disadvantages

- Climate-limited to southern U S
- Requires large land area
- Toxic materials may affect plants

Secondary Treatment Considerations

Most secondary wastewater treatment processes are well developed, but choosing technologies for a facility cannot be done in a supermarket fashion Many different factors must be considered, including process benefits and drawbacks For example, a trickling filter can save energy, but it may cost more for construction Capital, energy, chemicals, and land costs can be traded off, depending on particular processes

In evaluating treatment alternatives, various considerations can be taken into account. They include capital cost, operation and management costs, energy requirements, land requirements, treatment reliability, climate impact, operator simplicity, response to shock loads, effects of toxic materials, and sludge production

In planning a wastewater treatment facility several parties work together, including the grantee, the consultant, and the advisory group. Difficult technical decisions have to be made.

A potential for conflict exists. As community representatives, the advisory group must see that community concerns enter the discussion. Although the advisors usually have no water quality training, they must communicate with the consultants on technical matters. Questions must be asked without unrealistic second-guessing. In selecting treatment processes the following questions need answers:

- **What is the source of wastewater, and can the quantity of water be reduced?**
- **Can the community afford to pay for and operate particular processes?**
- **What are the reasons for using a particular pollutant removal scheme — climate, experience of the consultants, process reliability, monetary costs, suitability to the problems of the area, or what?**
- **Does the plan permit future modifications and additions to the system?**
- **Are innovative or alternative solutions as well as multiple uses considered?**
- **Do the choices fit in with the values of the community?**
- **How will the treatment alternatives affect the environment?**

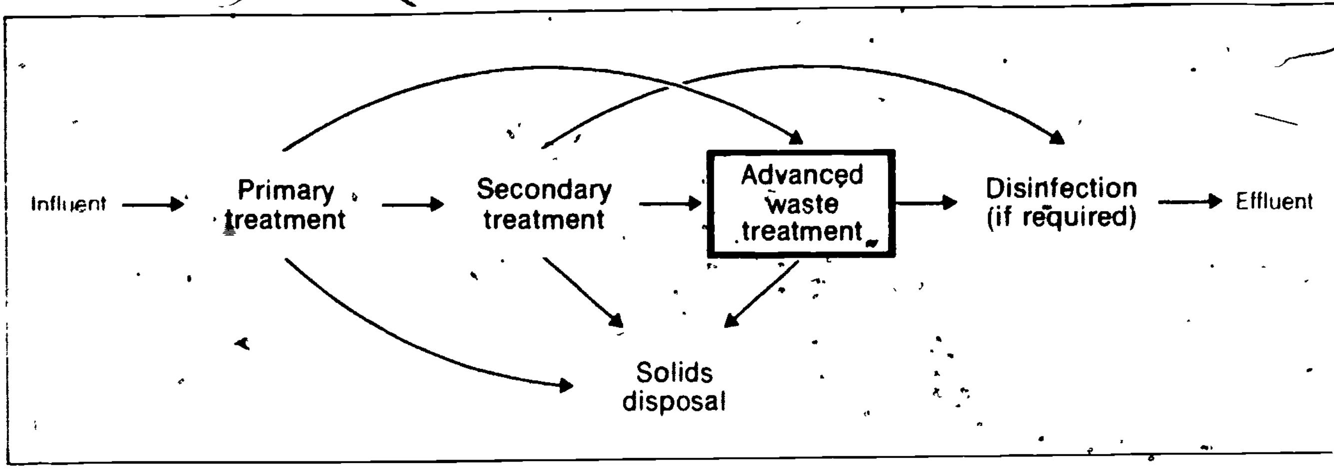
Evaluation of Secondary Treatment Alternatives

System	*Treatment Reliability*	*Land Requirement*	*Capital Cost*	*Energy Requirement*	*Operating Cost*	*Climate Impact*	*Sludge Production*
Conventional activated sludge	M	M	M	M	H	L	H
Pure oxygen activated sludge	H	L	H	M	H	L	H
Rock trickling filter	H	M	M	L	M	M	M
Plastic trickling filter	H	L	M	L	M	M	M
Activated biofilter	M	M	M	M	M	M	M
Rotating biological contactor	M	L	H	L	M	M	M
Oxidation pond with filtration	H	H	L	L	L	H	L
Aerated lagoon with filtration	H	H	L	L	M	H	L
Land treatment	H	H	M	M	M	H	L
Preferred Rating	H	L	L	L	L	L	L

Relative Ratings High H Medium M Low L

80-90 percent removal of BOD

81



Advanced Processes

Conventional secondary processes do not remove all pollutants Some that remain may be of major concern Processes are available to remove these additional pollutants Besides solving tough pollution problems, these processes improve the effluent quality to the point where it is adequate for many reuse purposes They may convert what was originally wastewater into a valuable resource too good to throw away, such as the reuse of effluent by industries

In the past the advanced processes were often called "tertiary wastewater treatment" or just *advanced wastewater treatment* They can be subdivided into "advanced secondary wastewater treatment" and "advanced wastewater treatment" categories However, the following sections describe available advanced processes without dividing them into their two separate classifications

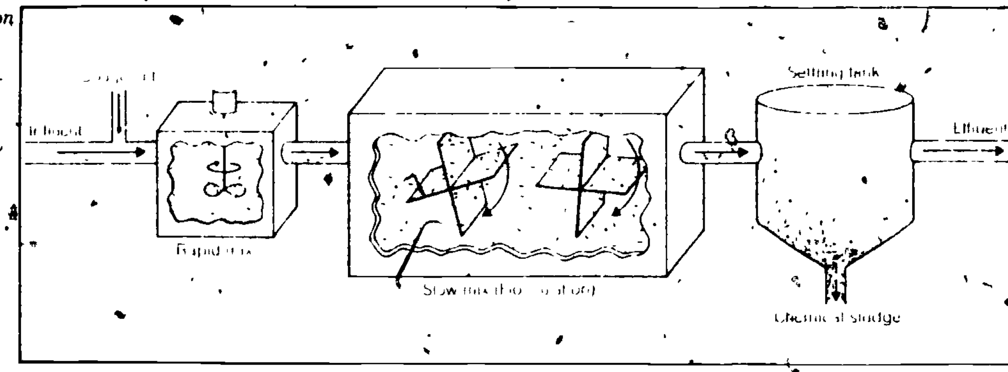
Phosphorus Removal

Phosphorus is one of the components of wastewater that can seriously disrupt the ecological balance of our waters To meet water quality standards, many cities are required to reduce phosphorus to low concentrations in wastewater discharges Phosphorus is not removed to any appreciable extent in conventional primary or secondary treatment However, it can be removed by relatively minor modifications to existing municipal wastewater treatment facilities Phosphorus removal processes involve

- Chemical precipitation
- Biological removal
- Land treatment

In the *chemical precipitation* processes, chemicals called *coagulants* — substances such as aluminum sulfate (alum), lime, or ferric chloride — are added to the wastewater These substances cause the solids in the wastewater to coagulate and clump together so as to settle faster If the proper amount of coagulant is added, it also converts the phosphorus in the wastewater into an insoluble form that can be removed by settling Approximately 90 percent of the phosphorus and suspended solids, and an additional amount of the BOD normally present in a secondary effluent can be removed through precipitation

Chemical coagulation



The necessary amount of coagulant varies among localities, depending on the characteristics of the wastewater being treated. Large amounts of chemicals are usually required for the maximum removal of phosphorus, while a much smaller quantity may be adequate for just suspended solids removal

Chemical Precipitation

Advantages

- Removal of BOD, phosphorus, and suspended solids
- Simple process controls
- Improved reliability of secondary treatment
- Significant separation of metals, bacteria, and viruses

Disadvantages

- High cost
- Large quantities of chemical sludge for disposal
- Some chemicals (alum, ferric chloride) are not reusable
- Increase in wastewater dissolved solids
- Untested full-scale operations (biological removal)

In *biological removal*, a modified activated sludge process is operated so that the microbes take up the required amount of phosphorus The phosphorus is then separated from the activated sludge in a stripping process These actions remove phosphorus from the wastewater, and either significantly reduce or eliminate the chemicals required for precipitation This removal of BOD and suspended solids is equivalent to, or better than, the results of the conventional activated sludge process Biological removal may be the most economical process for phosphorus removal other than land treatment However, cost-effectiveness analysis will make these determinations on a case-by-case basis

The *land treatment* process is another option for phosphorus removal Land treatment involves putting wastewater onto land rather than discharging it into lakes and streams Phosphorus and other nutrients are separated from the water by growing plants or soil processes as the water passes through.

Land Treatment

Advantages

- Recycling of nutrients such as phosphorus, nitrogen, and organic matter
- Increased crop production
- Recreation and open space potential
- Retention of water in watersheds
- No chemical sludge

Disadvantages

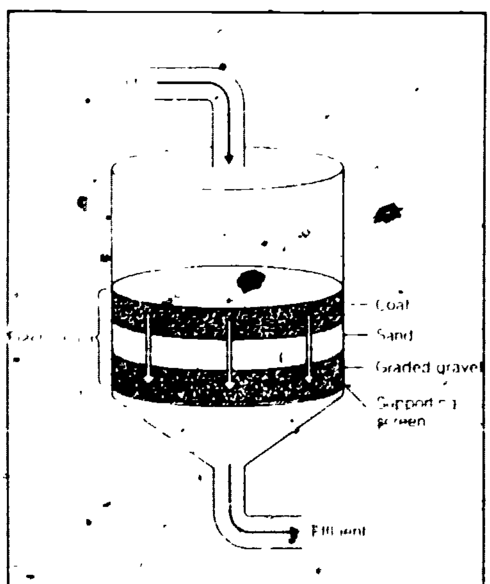
- Scarcity of suitable sites
- Relatively large land requirements
- Seasonal operation may be necessary in colder climates

Filtration

The process of passing wastewater through a granular bed such as fine sand and/or coal to remove suspended matter is called *filtration*. Modern wastewater filters are often made up of a mixture of two or three different materials (coal, sand, and garnet are commonly used) of varying sizes and densities. These materials form a multimedia filter which is coarse at the upper surface and becomes uniformly finer with depth. Efficient filtration of a chemically-treated effluent can reduce suspended solids to almost zero and phosphorus to 0.1 mg/L or less.

Wastewater is passed downward through the filter until the filter becomes clogged with material removed from the wastewater. The filter is then cleaned by reversing the flow (called backwashing). The backwash water is then returned to the head of the treatment facility.

Microscreening is another type of filtration. Microscreens are cylindrical drums covered by a metallic filter fabric. They rotate slowly in a tank with two compartments, so that water enters a drum from one end and flows out through the filtering fabric. The waste solids are retained on the surface of the rotating screen. These solids are flushed from the screen and collected in a hopper or trough inside the drum for return to the secondary treatment plant. Microscreens can usually reduce the suspended solids concentration in activated sludge effluent from 20-25 mg/L to 8-10 mg/L.



Multimedia filter

Filtration

Advantages

- Control of suspended solids in secondary effluent
- Additional removal of phosphorus and suspended solids in coagulation-sedimentation processes
- Increased treatment reliability
- Easily automated and time-tested
- Minimal operator attention
- Minimal space requirements

Disadvantage

- Processing of backwash wastes

Carbon Adsorption

Even after secondary treatment, coagulation-sedimentation, and filtration, some organic materials that are resistant to biological breakdown will remain in the effluent. One removal method for this material involves activated carbon. *Activated carbon* is a finely-ground carbon with a very large surface area. Organic contaminants are removed by adsorption, which is the attraction and accumulation of one substance (waste) on the surface of another (carbon). After the adsorption capacity has been reached, the carbon can be restored by heating it in a furnace at a temperature sufficiently high to drive off the adsorbed materials.

Activated carbon is utilized in two forms, powdered and granular. The powdered carbon is mixed with the wastewater for several minutes to allow adsorption to occur. It then is removed by settling — usually with the assistance of a coagulant. The carbon adsorption is achieved by passing the wastewater through long columns or beds of the carbon.

Treatment preceding carbon adsorption can be varied, depending on the desired final effluent quality. Carbon adsorption often follows processes such as secondary treatment, coagulation/sedimentation, and filtration. By combining these processes, a colorless, odorless, sparkling-clear effluent can be produced. It can be free of bacteria and viruses, and can contain a BOD of less than 1 mg/L and an organic concentration of less than 10 mg/L. This water quality is suitable for many purposes.

Another approach called *independent physical-chemical treatment* also uses carbon. In this method biological secondary processes are eliminated altogether. Carbon is the sole means of removing organic substances. The raw wastewater is usually coagulated and settled (and sometimes filtered) before it is passed through the carbon system. This approach provides a degree of treatment better than biological secondary treatment followed by carbon adsorption. The approach is useful in meeting temporary treatment requirements or in cases where space is very limited. The process is usually more costly than the biological secondary processes.

Carbon Adsorption

Advantages

- Removal of organic materials passing through biological secondary treatment processes
- Accommodates wide variations in flows, wastewater quality, and concentration of toxic materials
- Minimal space requirement carbon process
- Needs minimal space

Disadvantages

- Relatively expensive
- High energy requirement for carbon regeneration
- Equipment for carbon regeneration and reuse is ill-suited for small plants and requires very careful operator control

Nitrogen Control

Nitrogen plays a fundamental role in the aquatic environment. However, if excessive amounts of nitrogen are discharged into waterways, serious pollution problems can result. During conventional biological wastewater treatment, almost all the nitrogen in the wastewater is converted into ammonia and/or nitrates. Although ammonia in wastewater has low toxicity for humans, it can consume dissolved oxygen in the receiving water, damage aquatic life, corrode copper fittings, increase the chlorine requirements for disinfection. On the other hand, nitrates at high concentrations may be toxic to infants.

Ammonia nitrogen can be reduced in concentration or removed from wastewater by several processes. These processes are:

- Biological nitrification and denitrification
- Land treatment
- Physical-chemical methods such as ammonia stripping and selective ion exchange

Biological Nitrification and Denitrification

In this process nitrogen-containing matter such as protein is broken down in two biological steps. First, the nitrogenous matter is converted into nitrates (nitrification) by providing oxygen in the proper amount. The nitrification step is usually accomplished by using activated sludge, a trickling filter, or a rotating biological contactor. It may follow or be combined with secondary treatment for the removal of BOD. This action may accompany the biological conversion of the nitrates into nitrogen gas (denitrification). In many cases, carrying out only the nitrification step may be adequate to meet effluent requirements.

New biological processes that accomplish nitrification, denitrification, and the biological removal of phosphorus have been recently developed and patented. However, these processes have not yet been used extensively on a plant-size scale

The efficiency of biological nitrification is usually 80 to 90 percent conversion of ammonia to nitrate. The combined nitrification-denitrification process can remove up to 80 percent of the total nitrogen

Land Treatment

Land treatment of wastewaters can provide moisture and nutrients necessary for crop growth. Wastewater usually contains substantial amounts of nitrogen and phosphorus that are useful for crop production. The natural processes remove the nutrients by plant growth, and the water is returned to the hydrologic cycle. The wastewater is treated on the soil by slow rate irrigation, overland flow, or infiltration-percolation

> **Biological Nitrification**
>
> **Advantages**
>
> - Design and operations similar to secondary treatment processes
> - Low sludge volumes
> - Minimal air or water quality side effects
>
> **Disadvantages**
>
> - Large space requirements relative to secondary treatment
> - Vulnerable to upsets by toxic substances, equipment failures, or operator error
> - High energy usage

Physical-Chemical Methods

A process that removes gaseous ammonia from water by agitating the water-gas mixture in the presence of air is called *ammonia stripping*. Ammonia nitrogen in secondary effluent can be converted to ammonia gas by raising the pH to high (alkaline) values. The gaseous ammonia can then be released by passing the high pH effluent through a stripping tower. The use of lime permits the simultaneous coagulation of suspended solids and the removal of phosphorus, while at the same time adjusting the pH for the stripping process

The concentration of ammonia emitted from the tower is very low — well below odor levels, and does not cause air pollution problems. However, lime scaling and energy requirements make the process unattractive. This type of system was abandoned at the Lake Tahoe, California, advanced wastewater treatment facility

> **Ammonia Stripping**
>
> **Advantages**
>
> - Simple technology
> - Minimal space requirements
>
> **Disadvantages**
>
> - Decreased efficiency in cold temperatures
> - Inoperable in freezing conditions
> - Lime scaling in tower
> - High electrical energy use

In *selective ion exchange*, ammonium ions in solution are exchanged for sodium or calcium ions. The process operation resembles a water softener, except that the material being removed is ammonium nitrogen rather than water hardness. The bed must be regenerated periodically so that its capacity to remove ammonia is restored. The process is very efficient. It can remove 95-97 percent of the ammonia nitrogen

Selective Ion Exchange

Advantages

- High removal efficiency
- Immune to temperature variations
- Useful fertilizer product
- Controllable process
- Minimal space requirements

Disadvantages

- Complex equipment and operations
- High capital costs
- Disposal of waste product

Concerns About Advanced Treatment

Much thought needs to be given to the planning of advanced wastewater treatment (AWT) systems.

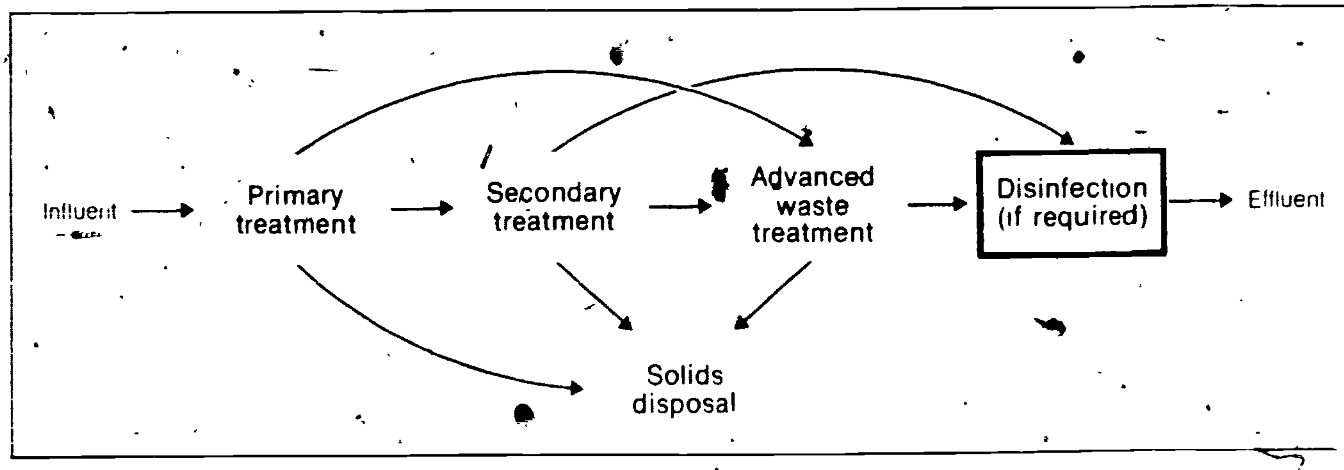
The advisory group can contribute by asking the following questions at the start of the discussions:

- **Have community-wide options such as wastewater flow reduction and changed water uses been explored that will diminish the need for AWT?**
- **Is AWT *really* needed to meet surface water quality standards?**
- **Has land treatment been considered as an alternative to AWT?**
- **Can the community afford the on-going chemical and energy expense of AWT?**
- **Are there sufficient disposal sites in the area for AWT sludge?**
- **Will the treatment facilities have competent personnel for dealing with complex AWT processes?**
- **Will the community's welfare be endangered if an AWT process fails? What recourse will the community have?**

Evaluation of Advanced Treatment Alternatives

System	*Treatment Reliability*	*Land Requirement*	*Capital Cost*	*Energy Requirement*	*Operating Cost*	*Climate Impact*
Phosphorus Removal						
Chemical precipitation	H	L	L	M	H	L
Biological removal	L	L	M	M	M	L
Land treatment	H	H	M	M	L	H
Nitrogen Control						
Nitrification	M	L	M	M	M	L
Ammonia stripping	M	L	H	H	H	H
Ion exchange	H	L	M	L	H	L
Land treatment	H	H	M	M	L	H
Organic Matter Removal						
Carbon adsorption*	H	L	H	H	H	L
Preferred Rating:	**H**	**L**	L	L	L	**L**

Relative Ratings: H H Medium M Low L



Disinfection

The last step in a treatment plant is sometimes the addition of a disinfectant to the treated wastewater to kill pathogenic (disease-causing) bacteria and viruses. This process differs from sterilization, which is the killing of all living organisms. The addition of chlorine gas or some other chemical form of chlorine is the process most commonly used for wastewater disinfection in the United States. The wastewater then flows into a basin, where it is held for about 30 minutes to allow the chlorine to react with the pathogens. Some concern about the formation of chlorination by-products as potential carcinogens exists, but the use of chlorine has proven to be a very effective means of disinfecting both wastewaters and water supplies.

Many European countries use ozone rather than chlorine for disinfection. Ozone is an energetic form of oxygen that readily reacts with many substances. In the United States, ozone generators are used to purify air, among other uses.

Sludge Handling

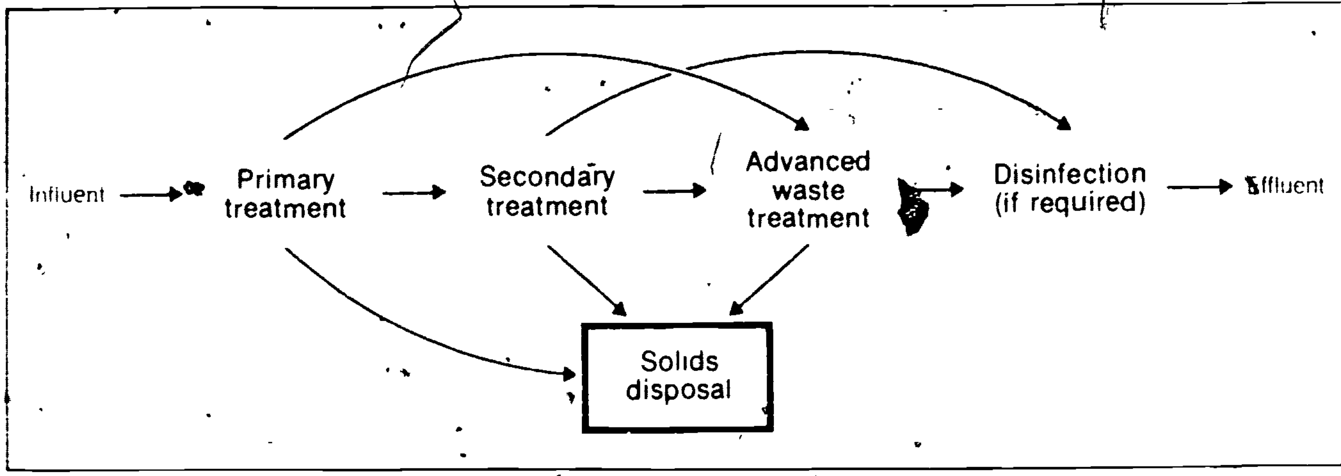
In purifying wastewaters another problem is created — sludge handling. The sludge is made of materials separated from the raw wastewater. It consists primarily of organic substances and solids such as the precipitates produced in some advanced treatment. Whatever the wastewater process, there is always something that must be burned, buried, treated for reuse, or disposed of in some way.

Except when land treatment is used, higher degrees of wastewater treatment usually result in larger amounts of sludge that must be handled. *The satisfactory treatment and disposal of sludge can be the single most complex and costly operation in a conventional wastewater treatment system. Without sludge treatment, even the best wastewater treatment process is incomplete.*

The basic operations of sludge treatment are:

- Conditioning
- Thickening
- Stabilization
- Dewatering
- Disposal

88



Although various combinations of equipment and processes are used in treating sludges, the basic alternatives are fairly limited. The ultimate depository of the sludge materials could be either land, air or water. Current policies discourage disposal practices such as ocean dumping. Air quality considerations require air pollution equipment as part of the sludge incineration process so that sludge cannot be discharged into the air. Thus, the sludge in some form eventually will be returned to the land.

Sludge Conditioning

Several methods of *conditioning sludge* to ease the separation of the liquid and solids are available. The principal ways involve chemicals, or heat and pressure.

Chemical coagulants such as ferric chloride, lime or organic polymers are commonly used. Ash from incinerated sludge has also found use as a conditioning agent. These substances are mixed with the sludge just ahead of the thickening or dewatering processes. Chemical sludge conditioning is used at hundreds of municipal treatment plants.

Another conditioning approach is to heat the sludge at high temperatures and pressures. Under these conditions, much like those of a pressure cooker, water bound in the solids is released.

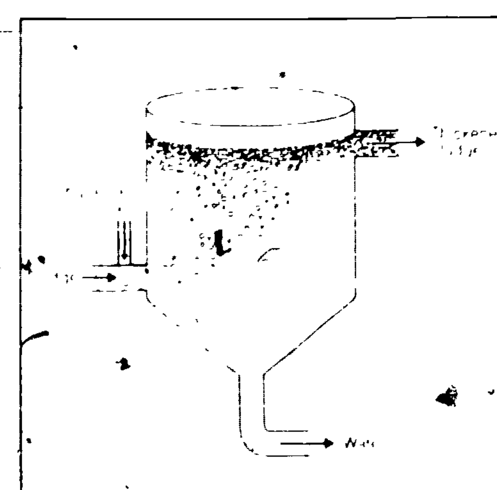
Another method involves the application of heavy doses of chlorine to the sludge. This is a relatively new approach. Because of the acidic effects of the chlorine, it also stabilizes the organic sludges.

Sludge Thickening

After the sludge has been conditioned, it is often thickened before further processing. Thickening is usually accomplished in one of two ways:

- Solids are floated to the top of the liquid
- Solids are allowed to settle to the bottom

The goal is to remove as much water as possible before the final dewatering or disposal of the sludge.



Flotation thickening

89

Flotation Thickening

Advantage

- Separation of light particles of activated sludge from wastewater

Disadvantages

- Compressed air requirements
- Control difficulties

In *flotation thickening*, air under pressure is injected into the sludge to float solids to the top of liquid. The process typically increases the solids content five times. *Gravity thickening*, essentially a sedimentation process similar to those which occur in all settling tanks, allows solids to settle to the bottom. Gravity thickening also can increase primary sludge solids by five times. The current trend is towards using gravity thickening for primary sludges, and flotation thickening for activated sludge. The thickened products are then blended for further processing.

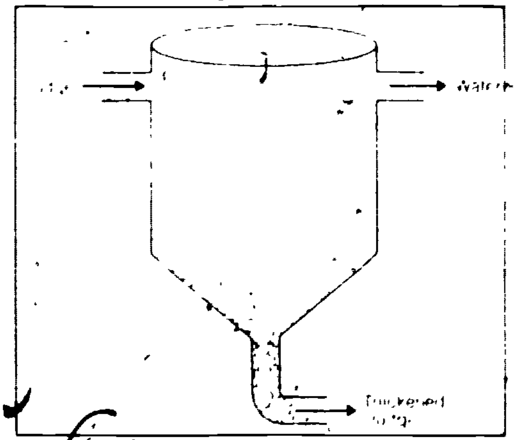
Gravity Thickening

Advantage

- Simple operation

Disadvantages

- Occasional odor problems
- Difficulty in separation of light particles



Gravity thickening

Small, rotating drum screens have been introduced recently for thickening sludge. These screens are similar to a large kitchen strainer. Polymer-conditioned sludge is fed to the inside of the drum. Water passes through the screen and is returned to the wastewater treatment process. The thickened sludge falls from the open end of the strainer.

Sludge Screening

Advantage

- Small space requirements

Disadvantage

- Requires careful operational controls

Sludge Stabilization

Sludge stabilization biologically breaks down the organic solids so that they are more stable (less odorous and less putrescible), are easier to dewater, and have less mass. If the sludge is to be dewatered and burned, stabilization normally is not used. Many municipal plants do not use incineration. Instead they rely on sludge digestion to stabilize the organic sludges before final disposal. Two basic processes are in use: anaerobic digestion, and aerobic digestion.

Anaerobic digestion involves the breakdown of solids in an environment that is devoid of oxygen. Most modern anaerobic digesters use tanks in a two-stage process. In the first stage biological digestion occurs. The second stage is used for storing and concentrating the digested sludge. The second operation may be an open tank, an unheated tank, or a sludge lagoon. As the organic solids are broken down by anaerobic bacteria, liquids and gases are formed. A relatively clear liquid, called supernatant, can be withdrawn and recycled to the treatment system. Methane and carbon dioxide also are formed. The digester gas containing methane is a usable fuel. It is used principally for heating the first digestion tank. It also can be used for boiler and internal combustion engines that are, in turn, used for pumping sewage, operating blowers, and generating electricity. An efficiently operating anaerobic digester converts about 50 percent of the organic solids to liquid and gaseous forms

Anaerobic Digestion

Advantages

- Production of a useful by-product, methane
- Reduces the final volume of sludge for disposal

Disadvantages

- Sensitive to variations in amounts of sludge and toxic materials
- Increased safety requirements
- Results in a supernatant with high concentration of pollutants that must be treated

Aerobic digestion is accomplished by injecting air into the organic sludges Its most extensive use has been in relatively small activated sludge plants However it is receiving increased attention for larger facilities For example, the Metropolitan Denver Sewage Disposal District uses aerobic digestion for sewage flows over 100 mgd Solids reduction efficiency is similar to the anaerobic processes

Aerobic Digestion

Advantages

- Stable operation, not sensitive to upset
- Results in relatively clean supernatants

Disadvantages

- Requires considerable amount of electricity
- Difficulty in thickening solids by gravity settling
- Generates no useful product such as methane

Sludge Dewatering

Water may be extracted from sludge by various approaches

- Sandbeds
- Vacuum filters
- Centrifuges
- Pressure filters

The most widely used method of sludge dewatering involves drying the sludge on *sandbeds*. These beds are especially popular in small plants because of their simple operation and maintenance They usually consist of a layer of sand placed over gravel Sludge is drawn from the digester, placed on the sandbed, and allowed to stand until it is dried by drainage and evaporation In good weather the solids can be concentrated several-fold within six weeks At that time, the sludge will resemble moist soil Sandbeds are sometimes enclosed by glass in greenhouse-type structures to protect the sludge from rain, and thus shorten the drying period This arrangement is also a form of solar heater

As the number of secondary treatment facilities grow, the use of more compact and more efficient mechanical-dewatering systems is increasing These systems include vacuum filters, centrifuges, and pressure filters

Sandbed Dewatering

Advantages

- Simple operations
- Low energy usage

Disadvantages

- High space requirement
- Vulnerable to weather

A *vacuum filter* consists of a cylindrical drum covered with a filter medium or fabric, which rotates partially submerged in a vat of conditioned sludge. A vacuum is applied inside the drum to extract water, leaving behind the solids, called filter cake, on the filter medium. Vacuum filtration of sludge results in a sludge cake dry enough for disposal in a landfill, or by application to the land as a relatively dry soil conditioner.

Vacuum filtration is the most popular mechanical sludge-dewatering method for municipalities, with over 1,500 installations. While this method requires more skilled operation than a drying bed, it has the advantages of occupying much less space and being more controllable.

> ### Vacuum Filtration
>
> **Advantages**
>
> - Not vulnerable to weather
> - Small space requirements
>
> **Disadvantages**
>
> - Skilled operations requirements
> - High electrical energy consumption

Centrifuges are also a popular means of dewatering municipal sludges. A centrifuge uses centrifugal force to separate sludge solids from the liquid. Polymers used for sludge conditioning are also injected into the centrifuge. The solids are spun to the outside of a bowl from which they are scraped. The liquid is returned to the head of the facility for further treatment.

> ### Centrifugation
>
> **Advantages**
>
> - Minimal space needs
> - Large separational forces for small particles
> - Not vulnerable to weather effects
> - Relatively odor-free operation
>
> **Disadvantage**
>
> - Extensive maintenance requirements

Pressure filtration is also an effective means of sludge dewatering that is finding increased use in the United States. Sludge is dewatered by pumping it at high pressure through a filter or a belt running between rollers. A very dry sludge cake results. Although popular in Europe for years, pressure filtration only recently has undergone extensive use in the United States. Interest has been spurred by recent improvements in equipment. However, the capital costs are high.

Ultimate Disposal

Several options exist for the final disposal of sludge. Sometimes it can be used as a soil conditioner or low-grade fertilizer. It also may be burned or disposed of through wet air oxidation.

Fertilizer and Soil Conditioner

Municipal sludge contains essential plant nutrients and useful trace elements. It thus has potential as a fertilizer or soil conditioner. Before serving these uses, the sludge is usually stabilized by digestion or some other process to control microorganisms and odors. After stabilization, the sludge can be used as a fertilizer or soil conditioner in several alternative forms:

- Liquid sludge directly from the stabilization process
- Dewatered sludge
- Dewatered and dried sludge
- Composted sludge

Many municipalities apply liquid sludge to croplands. This sludge is not used for root crops or crops consumed raw by people because of health considerations It is frequently used for pastureland or corn, wheat, and forage crops Small towns often haul the sludge in trucks that also spread the sludge on the land. Large cities usually find pumping the sludge through pipelines to the disposal sites to be the cheapest method of sludge transportation

To reduce the volume of material handled, dewatering is sometimes used before applying the sludge to the land. In small treatment plants, sludge removed from drying beds is often stockpiled for use by the community or by local citizens Larger cities may use mechanical dewatering systems, with the sludge cake hauled to the disposal sites where it is plowed into the ground

The drying of dewatered sludge by heat further reduces the volume Several major U S cities, including Houston and Milwaukee, dry their sludge for use as a soil conditioner

Sludge Reduction

If sludge use as a soil conditioner is impractical, or if a land site is not suitable for the disposal of dewatered sludge, communities may turn to the alternative of sludge reduction Sludge reduction involves decreasing the mass of solids through methods such as incineration and wet air oxidation

Incineration completely evaporates the moisture in the sludge, and burns the organic solids to an ash To minimize the amount of fuel used, the sludge must be dried as completely as possible before incineration Incinerators have the advantage of small space requirements, but suffer from long start-up periods complex operations, and high energy costs

Incineration

Advantages

- Almost complete destruction of sludge
- Small space requirement

Disadvantages

- High capital cost
- High fuel cost
- Extensive maintenance requirements
- Air pollution potential

The *wet air oxidation* process is based on the principle that a substance capable of burning can be broken down in the presence of very hot water under pressure The oxidized solids and liquid can be separated by settling, vacuum filtration or centrifugation

Wet Air Oxidation

Advantage

- Very small space requirement

Disadvantages

- High capital cost
- Highly-skilled operators needed to handle maintenance and safety problems
- Produces highly polluted liquid that must be recycled or treated

Advanced Treatment Sludges

The chemical coagulation-sedimentation process in advanced waste treatment produces large volumes of chemical sludges. No other advanced process creates a significant sludge problem. If lime is used as a coagulant, the sludge can be dewatered by the usual separation techniques (vacuum filters, centrifuges, and filter presses). The sludge can then be passed through an incinerator in a process called recalcining. This process drives off water and carbon dioxide, leaving behind a reusable form of lime. This method reduces both the amount of new lime that must be purchased as well as the volume of residues for final disposal. The lime sludge is dewatered and buried in cases where recalcining is too expensive.

If salts of iron or aluminum, such as alum or ferric chloride, are used as the coagulant, these chemicals at this time cannot be recovered and reused for phosphorus removal. These sludges, then, are dewatered, with the same alternatives for disposal as the organic sludges from secondary treatment.

Planning for Sludge Disposal

In facility planning, sludge disposal is often ignored during the initial evaluation of wastewater treatment alternatives — a disastrous mistake. The monetary cost of sludge disposal about equals the cost of treating the wastewater alone. Relevant questions for advisory groups include:

- **What effluent and/or sludge quality is needed for the long-term use of disposal techniques?**
- **What are the sludge disposal options and their related costs?**
- **How will the disposal techniques affect the environment?**
- **Does the choice match the preferences of the community?**

Land application is a good alternative for sludge disposal. However, potential hazards exist when joint industrial-municipal treatment is used. Industrial wastes may contain heavy metals or other toxic substances that limit the disposal of sludge on land. Properly controlled sludge may be applied to land without problems developing. The advisory group may help locate available land disposal sites, and lead public discussion of the best method of sludge disposal for the community.

Selection of Processes

The array of treatment processes is extensive. A major portion of facility planning involves choosing one of them.

Over a hundred different techniques, options, and processes exist for wastewater treatment. In determining the best solution to a wastewater problem, these alternatives should be evaluated carefully in light of specific local conditions. Among the factors that should be considered are

- Wastewater amount and characteristics (domestic, commercial, and industrial uses)
- Effluent requirements
- Environmental effects
- Public acceptance
- Resource consumption
- Sludge handling
- Process complexity, reliability, and flexibility
- Implementation capability
- Monetary costs

The bottom line for most people is how much a system costs. Both nonmonetary and monetary costs are involved. Environmental, social, and indirect effects such as land development are the principal nonmonetary considerations. Monetary costs consist mainly of capital, operations, replacement, and management expenditures. The costs should be presented in a form that has meaning for the taxpayer, such as dollars per household per year. These costs, especially for operations, are increasing rapidly due to escalating energy costs.

Need More Information?

Environmental Pollution Control Alternatives: Municipal Wastewater Publication Number EPA-625/5-76-012. Washington, DC. U S Environmental Protection Agency, May 1976 79 pp Order Number 5012

This document is an excellent non-technical discussion of available municipal wastewater treatment processes. It describes the processes, gives costs and energy requirements, and discusses their efficiency, advantages, and disadvantages. It is available from CERI, Technology Transfer, U S. Environmental Protection Agency, Cincinnati, OH 45268. Give the order number and publication title when ordering

Innovative and Alternative Technology Assessment Manual MCD-53 Washington, DC U S Environmental Protection Agency, September, 1978 388 pp

This document contains fact sheets for 117 different wastewater treatment process variations Each fact sheet describes a process and its modifications It discusses technology status, applications, limitations, equipment manufacturers (list only), environmental impacts, and references. Process diagrams and costs are also given It is available from the General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225 Give the document number MCD-53 and the title when ordering

Proceedings from National Conferences on Shopping for Sewage Treatment How To Get the Best Bargain for Your Community or Home Draft Washington, DC U S Environmental Protection Agency, April and June 1978 120 pp

This document is a collection of small papers presented at two conferences in Denver, CO, and Washington, DC The papers mainly pertain to wastewater treatment technologies, and citizen involvement in the facilities planning process Brief comments concerning other topics are also included It is available from the Office of Water Program Operations, U S Environmental Protection Agency, Washington, DC 20460

VanNote, Robert H et al *A Guide to the Selection of Cost-Effective Wastewater Treatment Systems* Publication Number EPA-430 9-75-002 Washington, DC Office of Water Programs Operations, U S Environmental Protection Agency, July 1975 229 pp Order Number PB-244-417 2BE

This document presents information which can be used to determine the alternative municipal wastewater treatment schemes that will meet specific effluent guidelines Procedures and information which can be used in determining the cost of each alternative are also given It costs $28 a copy, a 15 percent discount is given for orders of 20 or more copies It can be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

Chapter 6
Small Systems

Charles A Cole

Small is Big

What would you say if your home wastewater treatment system cost $10,000? That's the individual household cost of some recent municipal wastewater treatment systems Even though these systems are largely subsidized by federal grants, that's still a lot of money You would probably answer that an onsite system wouldn't cost that much and, if you live in a community that is not densely developed, you'd be right!

Annual household sewer fees exceeding $200, $300, or even $500 occur in some small communities These high costs are due to debt retirement expenses for extensive sewer collection systems, or operation and management of sophisticated treatment plants They can lead to political upheavals, confrontations at public meetings, injunctions, suits, and refusals to connect onto sewer systems

In addition to the potential for cost saving, there are also many environmental benefits of onsite treatment One is keeping water in the local area to recharge the groundwater In addition to lowering water and sewer bills, small systems can help to prevent urban sprawl, preserve prime farmland, conserve energy, and save materials

In 1940 about half of the United States population was sewered In 1977 the amount had increased to 71 percent This trend led people to believe that onsite systems were antiquated In addition, poor design, installation, and maintenance of many onsite systems caused failures. However, the extremely large per capita costs of many central systems are causing communities to take a serious look at small-scale solutions With proper planning, design, construction, and maintenance these systems can work under many circumstances

Alternatives

Small wastewater systems may or may not be appropriate, depending upon the characteristics of the community Treatment alternatives include, but are not limited to, approaches using septic tanks and soil absorption systems, aerobic treatment tanks, sand beds, sand mounds, evaporation and evapotranspiration beds, waterless toilets, onsite recycle systems, and cluster systems Alternatives for collecting and transporting wastewaters are small-diameter gravity sewers, pressure sewers, and vacuum sewers

These systems for small wastewater flows may qualify for federal grants under Section 201 of the Clean Water Act of 1977 In fact, they may represent alternative technologies which will increase the federal share of construction costs by ten percent from 75 to 85 percent States are required to set aside two percent of the federal construction grant allotment to fund innovative and alternative projects The Clean Water Act also requires states with rural populations of 25 percent or more to set aside four percent of their construction grant allotment for small communities In addition to individual treatment and alternative collection systems, septage (solids in septic tanks) treatment qualifies as an alternative technology These options are eligible for a 15 percent cost preference, meaning they can cost 1 15 times more than the most cost-effective conventional system and still receive 85 percent federal funding Funding for any of these individual or onsite systems must go to a public organization

Common Small-System Alternatives

Onsite Technologies

- Septic tanks and soil absorption systems
- Aerobic treatment tanks
- Sand filters
- Mound systems
- Evapotranspiration beds
- Evaporation beds
- Waterless toilets and greywater systems
- Onsite recycle systems
- Cluster systems

Septage Treatment and Disposal

- Septage treatment (Aerated lagoon, anaerobic-aerobic processes, composting, chemical treatment)
- Septage disposal (Land spreading, subsurface application, burial)

Collection and Transport

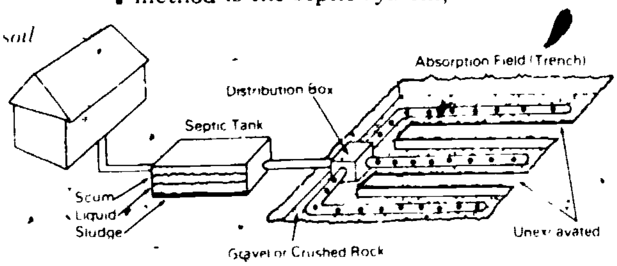
- Gravity sewers
- Pressure sewers
- Vacuum sewers

Onsite and Small-System Technologies

In homes each person on the average generates 50 to 70 gallons of wastewater per day. This wastewater can be disposed of by either central treatment works or by onsite facilities.

Onsite systems include treatment followed by disposal. The treatment consists of primary, secondary, and sometimes advanced stages similar to those of a central facility. The most prevalent onsite method is the septic system, which consists of a septic tank and soil absorption field. The septic tank usually accomplishes primary treatment or sedimentation. A soil absorption field carries out the secondary treatment and disposes of the water. Higher levels of treatment are gained by the use of sand filters, and are usually mandatory for discharges into surface waters. The following paragraphs look at the septic tank, as well as other types of onsite and small community systems.

Septic tank with soil absorption field



Septic Tank and Soil Absorption Systems

Household wastes pass from the house into a large water-tight tank where solids separate from the liquid. The solids (sludge) that settle to the bottom decay over many months. The remaining liquid (effluent) flows from the tank into an absorption field (drainage bed), where it is disposed of through perforated pipes. Soil bacteria decompose the organic wastes left in the liquid. In a properly operating system most pollutants are removed from the water before it seeps into the groundwater or surface water. This process is called leaching. Systems which are properly installed in good soils will operate satisfactorily for twenty or more years.

Septic System Management

The primary considerations in deciding the location of an absorption field are the soil profile (layers), limiting zone (flow barriers), and soil permeability (seepage rate). The soil profile should be analyzed by a person knowledgeable in soil science. The soil should be neither too tight (clay), nor too porous (gravel). At the time of the profile analysis, the limiting zones such as impervious clay or rock should be determined. Contamination of the groundwater occurs if the effluent does not come into contact with an adequate amount of soil. In addition, if impervious layers occur in the immediate vicinity of the absorption field, untreated sewage will rise to the surface and cause health or nuisance problems. The perc or percolation test is a popular way to evaluate soil permeability, but it alone is not an adequate measure of site suitability.

Some rules of thumb are: keep systems a minimum of 50 feet from surface water, 100 feet from wells, and ten feet from building and property lines. On parcels that have both wells and septic tanks, a minimum lot size of one acre is often recommended, even with soils most suitable for onsite systems. Site standards and codes vary among the states and localities.

Design and Installation

The size of septic tanks and absorption fields depends on the number of persons using the system. The number of bedrooms is a good approximation. Typically, a four-bedroom house has a septic tank of 1,000 gallons capacity. The size of the absorption field depends on the soil profile, limiting zone, and percolation rate. One thousand square feet of surface area is typical for a four bedroom house and clay soils. The field is usually at least 24 inches above groundwater or the impervious zone, and is covered with at least six inches of soil. During installation every effort must be made to prevent compaction of the soil. Compacted soil blocks or slows down the flow of wastewater into the soil.

Operation and Maintenance

In many places the homeowner has the responsibility of maintaining a septic system. This pattern is changing, and if *septic systems are to qualify for federal funding, a public body must apply for the grant and take the responsibility for the proper maintenance.*

The septic tank is periodically emptied of accumulated solids. The timing varies with the use and amount of non-sanitary wastes that are generated. For example, garbage grinders add considerable wastes and should not be used. These solids can clog the absorption field if they are not properly removed from the tank. Pumping the septic tank is necessary at least every two to four years. One possibility for disposal is an existing sewage treatment plant that is equipped to handle the extra load. Septage has an extremely high organic content, and may overload a plant or cause odors. Serious consideration should also be given to the separate treatment and disposal of septage. *Facilities to treat septage are eligible for federal funding.*

System Rehabilitation

The surfacing of septic tank effluent on, or near, an absorption field usually indicates failure of the field. The effluent creates a soft spot and promotes vigorous plant growth. Odors or a liquid stream from the failed system may be present. Several approaches for dealing with these absorption field failures include:

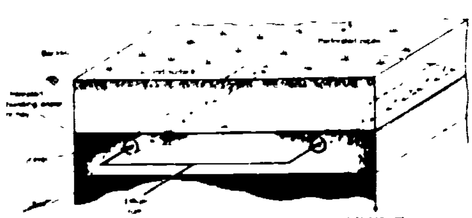
- Water conservation
- Hydrogen peroxide treatment
- New individual or community absorption field

Water conservation is the first approach. Conservation reduces the waste load on the system, as well as rests the bed. At the same time, pumping the septic tank removes solids that contribute to clogging. An empty septic tank provides several days of rest for the absorption field until the tank fills up again.

Another option involves hydrogen peroxide treatment of the absorption field to remove soil surface clogging. However, this alternative requires very careful preparation and analysis of the site. An additional approach is to construct a new onsite absorption field, allowing the old bed to rest and rejuvenate. The old bed then may be alternated with the new one on a periodic basis. *Dual absorption fields, even for new houses, are used in many locations such as Fairfax County, Virginia.*

Aerobic Treatment Tanks

Aerobic treatment uses air to increase the breakdown of organic matter by bacteria. It depends on oxygen in contrast to septic systems which require no oxygen. Aerobic treatment replaces the septic tank, and uses a smaller absorption bed. With further treatment, such as sand filtration and disinfection, effluent from aerobic



Cross section diagram of an absorption field systems can be discharged into surface waters in some states. This option processes wastewater similar to secondary treatment at a central treatment plant. Aerobic systems have costs for electricity, equipment, and maintenance. In addition installation is two to three times more costly than septic systems.

Sand Filters

Effluent from aerobic systems may be cleaned using sand as the filter material. Several variations of sand filters include the buried sand filter, the recirculating sand filter, and the intermittent filter. The buried sand filter usually performs well, and requires minimal operation and maintenance. The recirculating and intermittent sand filters provide more even distribution of the effluent onto the sand. However, equipment with moving parts or siphons is involved, which needs good maintenance. Sand filters are also used with effluent from septic tanks in some locations.

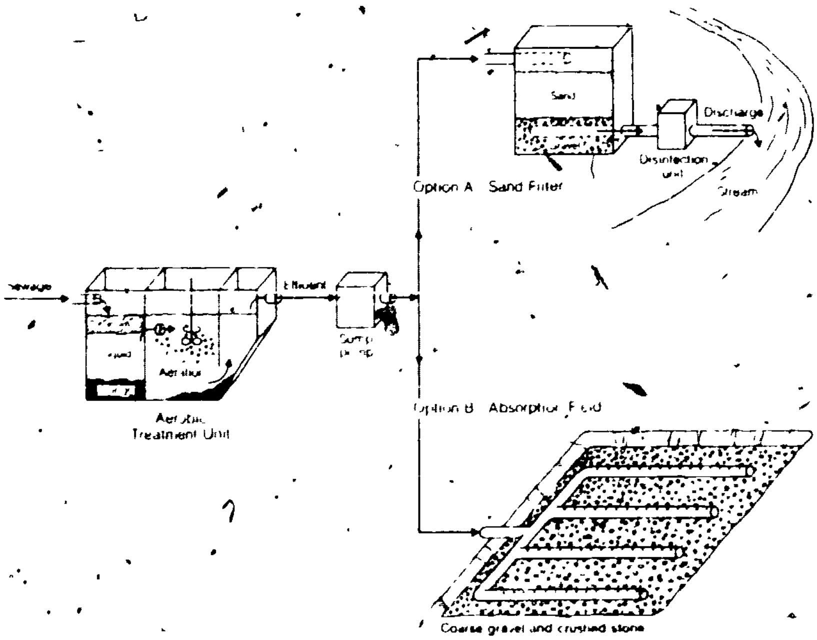
Mound Systems

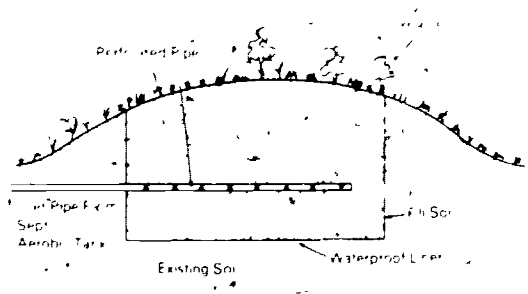
Onsite disposal is often limited by inadequate soils, shallow bedrock, or groundwater. In mound systems, two feet of sandy soil is placed over the original soil surface. An absorption bed is then constructed on top, creating a mound. It thus is similar to subsurface absorption beds used for septic tank effluents. It avoids a high water table or other unfavorable conditions. Sand mounds are expensive to install, but provide treatment on sites where soils are inadequate. This method is especially useful in areas of New England and the northern Midwest.

Evapotranspiration and Evaporation Beds

Onsite alternatives to subsurface disposal include evaporation and evapotranspiration beds (transpiration is the giving off of a plant's moisture through the leaves). They are options in areas where geological or physical constraints occur, or groundwater contamination is possible. The beds are lined with plastic or other waterproof material. Water evaporates or transpires since the plastic liner prevents its downward movement. These beds are used for year-round residences in areas of the country where high evaporation and transpiration rates occur, such as the Southwest. However, they are usable for summer vacation homes in other parts of the country.

An aerobic treatment unit with two treatment and disposal options: sand filter and disinfection unit or soil absorption field.





Evapotranspiration bed for use with septic or aerobic tank

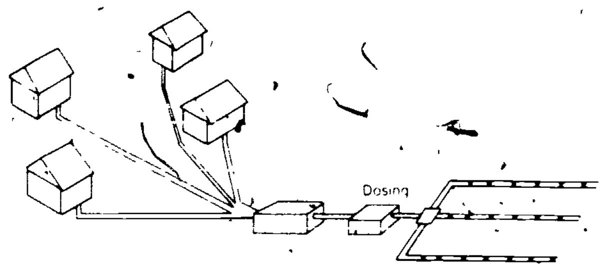
Waterless Toilets and Greywater Systems

Residential wastewater consists of toilet wastes (blackwater) and other wastes (greywater) However, some toilet systems do not use water to carry wastes Waterless toilets are gaining acceptance for construction sites, commercial installations, resorts, and vacation homes They are used increasingly in year-round homes However, widespread residential use lags because these toilets often require changes in the habits of users Some types (composting toilets) produce humus or soil conditioners Installation costs of most waterless toilets are low, but costs increase when a disposal system for the greywater is added Operational costs may be high due to energy consumption or maintenance Since 40 percent of residential wastewater originates from the toilet, waterless toilets have much potential for water conservation

Greywater is low in organic and bacterial pollutants as compared to toilet wastes Nevertheless, it can cause health and nuisance problems and needs some sort of treatment and disposal Some states require similar treatment and disposal for both greywater and toilet wastewater

Onsite Recycle Systems

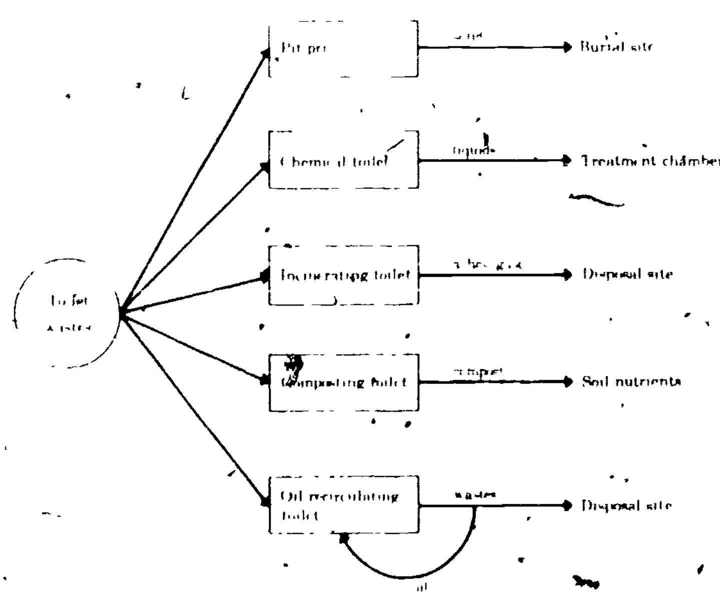
Numerous water recycle alternatives are also possible in the home One type uses bathing and laundry wastewaters for flushing toilets. Another recycles wastewater for landscape irrigation Commercial systems are available for special toilet and washbasin installations Onsite recycle systems reduce wastewater flows by about one-third



Cluster System where several homes share a common treatment and disposal system

Cluster Systems

A relatively recent innovation is the cluster system, a community form of onsite disposal This alternative is considered where space or soils are inadequate for onsite absorption fields Several arrangements are possible The effluent from several houses is conveyed to a small central treatment facility and absorption field Houses can have onsite septic or aerobic tanks, with the effluent transported to a common absorption field Clusters of houses can also use other alternative systems such as pressure and vacuum sewers and sewage treatment lagoons Cluster arrangements are a relatively recent development However, they are being used in many locations



Waterless Toilets

Septage Treatment and Disposal

Solids (septage) removed from the treatment tanks must be disposed of satisfactorily to prevent pollution and health hazards A common method in the past has been to spread the septage on land New regulations often require pretreatment of the septage and control access to the site during and after disposal by this method Another approach involves dumping the solids into a remote section of a central collection system This practice is usually illegal Such irregular waste loads upset some treatment processes, and may cause poor operation of the facilities

Present methods of disposal often utilize a central treatment facility under controlled practices The disposal processes include aerated holding tanks and odor control systems The wastes are discharged to the plant during low flow periods to cause minimal impact on normal wastewater treatment

Separate septage treatment facilities may use aerated lagoons, anaerobic-aerobic processes, chemical treatment, and composting In aerobic composting, septage is mixed with dry organic matter to control moisture and to permit aeration

Many states today regulate septage hauling, treatment, and disposal

Onsite System Costs

Method	Average Construction Cost	Average Annual Maintenance Cost
Septic tank-soil absorption field with recycle system	$1,000-3,000 $1 775	$ 10-15
Septic tank-sand mound	$3,900	$45
Septic tank-evapotranspiration with recycle system	$4,900 $3,600	$ 10-15
Aerobic treatment-surface discharge	$2,500-5,700	$165-330
Aerobic treatment-soil absorption system	$1,700-5,500	$ 65-225
Incinerating toilet without greywater disposal	$ 600-1,000	$ 85-190
Composting toilet without greywater disposal	$ 700-1,200	$98
Oil recirculating toilet without greywater disposal	$4,000-6,000	$265

Costs of on-site treatment and disposal in 1978

Onsite System Costs

Savings in operation and management (O&M) costs are a major incentive for installing onsite or small systems The O&M costs of small systems are not insignificant, but they are usually cheaper than those of a central facility *East Ryegate, Vermont, is a small community of 140 persons in the Connecticut River Valley In 1977 the annual O&M costs of a conventional central treatment system were estimated to be a total of $6,100 By comparison, O&M cost estimates for small systems for the entire community varied from $900 for onsite treatment to $2,000 for cluster systems*

The costs of the various onsite alternatives depend upon the complexity of the systems and the local conditions Average construction costs in 1978 ranged from $800 for an incinerating toilet without greywater disposal, to $5,250 for an oil recirculating toilet Under some conditions, small-system alternatives may be more expensive than a central treatment system Annual operation and management costs showed even wider differences, from $12 to $265 Monetary costs, of course, must be assessed with environmental and social considerations *It is crucial to determine whether the systems will work under the existing conditions, and whether the users of the system can afford to properly operate and maintain them*

Construction funding for a small wastewater treatment system can come from local bonds, the Construction Grants Program, the Farmers Home Administration, the Economic Development Administration, the Department of Housing and Urban Development, the Community Services Administration, and some state programs

Onsite disposal systems, including septage treatment, are considered alternative technologies under the Construction Grants Program, and are eligible for 85 percent federal funding Conventional methods can qualify for only 75 percent federal funds This increase for alternative technologies can reduce local costs by 40 percent as compared to a conventional system

The advisory group should make sure that onsite alternatives are being adequately evaluated.

In order to obtain federal funding, small communities must consider onsite treatment and disposal, even if they are not chosen as the main methods. This consideration takes place during preparation of the facility plan. The advisory group can play an important role in ensuring that small system alternatives are examined. Even before the alternatives are evaluated, however, a very important task is done: the identification of problem areas in the community.

Communities with problems from existing onsite disposal systems should not automatically abandon the malfunctioning systems. Often only a few onsite problems in a whole residential development will wrongly label the area for central sewage treatment. Many onsite facilities can be renovated or rebuilt using federal grant funds. An advisory group can be sure that the problems and needs are accurately identified early in facility planning. Local health officials and public records can be used to check on groundwater pollution, health hazards, or nuisances. ***Only after verifying the extent of the problem should decisions be made regarding the types of systems to be considered.***

Program Management

In addition to costs and site constraints key factors are community attitudes and local regulations. Many localities do not effectively regulate the construction and maintenance of onsite systems. Other communities prohibit the use of innovative approaches such as recycle systems and waterless toilets. These policies must change if federal funds are to be used. **The advisory group must consider these constraints when evaluating alternatives.**

If onsite disposal is chosen and federal construction funds are received, long-term operation and management must be provided. An institutional and administrative structure must exist, or must be set up to manage these systems. Actual work can be accomplished by contracts, or agreements with an adjacent community or some other group. However, it is the grantee that must see that adequate operation and management are accomplished. An existing wastewater treatment authority is the most obvious

Requirements of Onsite Technologies

Method	*Construction Costs*	*O & M Costs*	*Site/Climate Limitations*	*Energy Needs*
Septic tanks and soil absorption fields	L	L	H	L
Cluster systems	M	M	M	L
Aerobic treatment tanks	H	H	M	H
Sand beds	M	L	M	L
Mound systems	H	L	M	L
Evapotranspiration systems	M	L	H	L
Waterless toilets and greywater systems	H	M	M	M
Onsite recycle systems	H	M	L	M

Key: L – Low, M – Medium, H – High
O & M stands for operation and management

choice. Regardless of the type of structure, public education must be included as part of the management.

A permit program is one way to control septic tanks and other small systems. Permits should cover the issues of siting, design, installation, inspection, and pumping. Personnel in key roles — designers, builders, inspectors, and septage haulers — should be trained and licensed.

Finally, water conservation should be encouraged, or better yet, mandated for onsite disposal. Water conservation permits onsite disposal in many areas in which normal flows would create problems. The local and state regulatory agencies may have water conservation programs, requirements, or ordinances for onsite disposal.
The advisory group should explore these possibilities during facility planning.

Onsite Considerations in Facility Planning

What are the problem areas?

How severe are the problems? Is sewage entering surface waters? Is groundwater pollution a problem?

What are the land use patterns?

What are the population projections?

Is repair or replacement a possibility?

What areas should be sewered, if any?

How will septage be treated?

What options exist for maintaining onsite treatment?

Are ordinances or health code changes needed? Will these involve changes in local government?

What do the various onsite systems cost, particularly in relation to central facilities?

Sewage Collection and Transport

When wastewater can not be treated onsite, some type of sewer system must be used to transport the wastewater to a proper treatment facility. The usual gravity sewers transport sewage by simply permitting wastewaters to flow down slopes. Since these sewers drain all residences, they must constantly drop in height, utilizing sewage lift stations if necessary. This can cause severe environmental damage during construction. Conventional sewers also are very expensive to construct where high water tables and rocky terrain exist. In addition, conventional sewers often are not eligible for federal funding.

It is not always necessary to use large conventional gravity sewers. There are three alternatives for small communities:

- Small-diameter pressure sewers
- Vacuum sewers
- Small-diameter gravity sewers

Small-Diameter Pressure Sewers

Wide use of pressure sewers for pumping flows from individual households is just beginning, therefore experience is limited. *In the latter 1970's, the EPA sponsored detailed evaluations of pressure sewer systems in Albany, New York, Phoenixville, Pennsylvania; Grandview Lake, Indiana, and Bend, Oregon.* Based upon these studies, funding for this type of system will be provided through Section 201 construction grants.

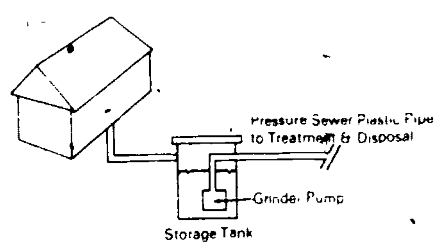
System Description

A pressure sewer system is the reverse of a water distribution system. A water distribution system has one pressure inlet and many outlets, while a pressure sewer has many pressure inlets and one outlet.

Two major types of small-diameter pressure systems are possible. One uses a grinder pump, and the other has a septic tank followed by an effluent pump. Differences also exist in the design of the collection pipe, and the amount of treatment for the pollutants. Neither system requires any modification to household plumbing.

An installation without a septic tank involves a grinder pump to break down large solids, and sends the waste through the small-diameter sewer system. The approach using a septic tank has only a standard sump pump.

Both systems need a storage capacity of at least 200 gallons for emergency use in case of pump breakdown or electrical failure.

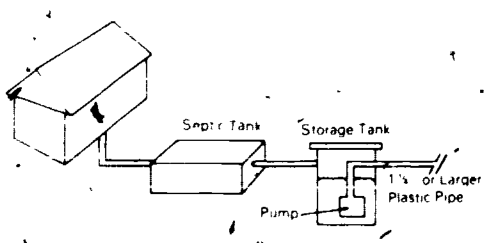


Grinder pump installation for use with a pressure sewer system

Costs

Systems that use numerous pressure facilities with associated mechanical equipment and electrical sensors need careful maintenance The operation and management (O&M) of the septic tanks, pressurization units, and sewers are usually handled by a public agency Historical O&M cost information for pressure systems is sparse However, potentially large savings exist At eight demonstration sites the savings for pressure sewers as compared to conventional sewers range from 24 percent to a hefty 83 percent[1] These savings, in general, result from reduced excavation costs *The Albany, New York, Phoenixville, Pennsylvania, and Grandview Lake, Indiana, demonstration projects kept detailed records High initial maintenance was required until the problems were worked out Thereafter, minimal efforts were needed Glide-Idlevld Park, Oregon, a town of 2,500 persons, found a small-diameter pressure system to reduce overall annual estimated costs by about 50 percent compared to a gravity system*

The environmental benefits of pressure systems are great During installation, there is considerably less disturbance to the residents, and less disruption of the terrain Sewer overflows during operations are less frequent compared to gravity sewers Infiltration and inflow, prevalent in conventional gravity sewer systems, are virtually non-existent in pressure systems This can greatly reduce the amount of wastewater which must be treated



Septic tank effluent pump installation for use with a pressure sewer system

Small-Diameter Pressure Sewers

Advantages

- No infiltration or inflow
- Low costs due to inexpensive plastic pipe and shallow installation depths
- Suitability for hilly terrain, rock outcrops, and high water tables
- Useful where population density is low
- Less disruption of terrain

Disadvantages

- Operation and maintenance costs because of grinders and pumps
- Higher treatment requirements due to concentrated wastes

Advantages of Pressure Sewers

Pressure sewer systems are a viable alternative technology They should be considered by the grantee in any cost-effectiveness analysis of alternative wastewater management systems in rural and suburban communities

Pressure sewers offer advantages over conventional gravity sewers in areas where

- Population density is low
- Severe rocky conditions exist
- High groundwater or unstable soils prevail
- Steep and/or varied terrain is present

The benefits of pressure sewers are lower capital costs, fewer environmental drawbacks, and significantly shorter construction times as compared to conventional gravity sewers However, good management of the system after installation is an absolute necessity for effective pressure sewers

Vacuum Sewers

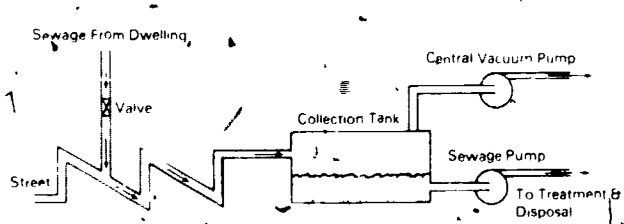
Vacuum sewers are another alternative for wastewater transport in small communities. Vacuum collection systems were patented in United States as early as 1888. However, their first commercial application was in Sweden in 1959. Currently, several firms in the United States are marketing equipment for residential systems. *Modified gravity-vacuum systems are used in residential developments near Alexandria, Virginia, Fort Myers, Florida, and Mathews Courthouse, Virginia*

System Description

All vacuum systems depend on a central source that constantly maintains a vacuum on small-diameter collection pipes Air pushes the wastes into the vacuum line either at the disposal fixture, or at a common gravity collection point in the system Some systems handle the blackwater (toilet waste) separately from the greywater (bathing, washing, and kitchen waste) A collection tank then separates the wastewater from the air When sufficient liquid accumulates in a tank, a sewage pump delivers the accumulated sewage to a treatment site

Vacuum toilets offer great potential for water conservation The amount of water used varies with each toilet model The average water needed for a vacuum toilet is 0 4 gallon, or less than ten percent of a conventional toilet

Systems have different pipe arrangements. Variations are necessary for uphill, downhill, or level runs Plastic pipe is commonly used Because of the complexity of vacuum equipment, operation and management personnel must be highly skilled A backup power supply is also a necessity



Elements of a vacuum sewer system

Costs

Costs, especially for operation and management, are still difficult to estimate Even with conventional systems, 60 percent or more of the cost of wastewater treatment is due to just collecting the sewage. *The estimated cost of a Mathews Courthouse, Virginia, vacuum sewer system was 33 percent less than a conventional gravity sewer system. In addition, these cost estimates did not account for the value of the water conserved by the vacuum system*

Vacuum Sewers

Advantages

- Large water savings with vacuum toilets
- Minimal infiltration and inflow
- Installation ease
- Low cost due to small diameter sewer pipes, and shallow installation depths
- Suitability for rocky terrain or high water table
- Less disruption of terrain

Disadvantages

- Complex vacuum equipment
- Skilled operation and management personnel needed
- Requirement of auxiliary power supply
- Absence of long-term, cost-effectiveness data

Advantages of Vacuum Sewers

Vacuum sewers and pressure sewers have many of the same advantages However, there are some basic differences The advantages of vacuum sewers over pressure sewers are

- Water conservation with use of the vacuum toilet
- Fewer maintenance problems with central vacuum systems as compared to individual grinder pumps
- Less chance for groundwater contamination Leaks are unlikely since liquid is drawn into the system rather than forced out at a pipe rupture

Small-Diameter Gravity Sewers

Small-diameter gravity sewers are a variation of conventional gravity systems They may be utilized where the solids are removed from the sewage prior to transport, using onsite septic or aerobic treatment tanks The effluent flows from the onsite facility are carried through small pipes (up to six-inch diameter) to areas for final treatment and disposal As compared to the usual eight-inch sewers, the small-diameter pipes cost less These systems are sometimes called effluent sewers

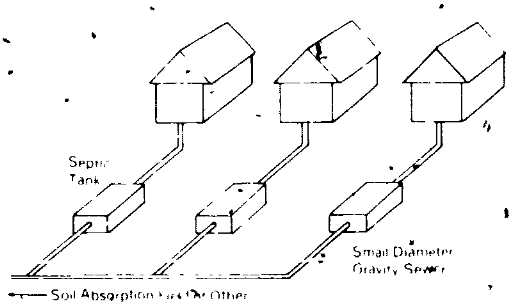
Regulatory Programs

The United States Environmental Protection Agency (EPA), in carrying out the mandate of the 1977 Clean Water Act, encourages alternatives to conventional treatment systems *Small-diameter pressure or gravity sewer systems, and vacuum systems are considered alternative transport methods when utilized in small communities under 3,500 population, or in sparsely populated areas of larger communities They qualify for an increase from 75 to 85 percent of the federal share of planning, design, and construction costs* This is especially important because conventional sewers may be ineligible for funds because of EPA and state policies State and local agencies may limit or prohibit small-diameter pressure and gravity sewers and vacuum sewers They must be contacted to determine the pertinent regulations when these systems are evaluated during facility planning.

Advisory Group Involvement

The advisory group represents the community's interests. These interests include minimal costs of waste disposal systems and maximum environmental benefits. When central treatment is necessary, a large portion of the total investment usually is due to the collection system. The advisory group thus should encourage the consultant to investigate small-diameter pressure sewers and vacuum sewers wherever possible. They may be the most cost-effective methods of wastewater collection and transport.

The advisory group can lead the public discussion about these systems. Important considerations include increased federal funding for these systems and reduced construction impacts. The advisory group must see that the homeowners understand the need for proper operation and maintenance. Without proper upkeep the systems rapidly fail. The advisory group should be sure that a thorough and clear presentation of different costs for collection alternatives is presented prior to the selection of a system.



Small-diameter gravity sewer system

Collection System Factors

• Is the local topography suitable for gravity sewers?

• Do high groundwater, severe rock, or unstable soils exist?

• What are the relative environmental drawbacks of gravity sewers versus the small-diameter gravity or pressure sewers, and vacuum sewers?

• Has adequate planning been made for operation and management of the sewage collection system?

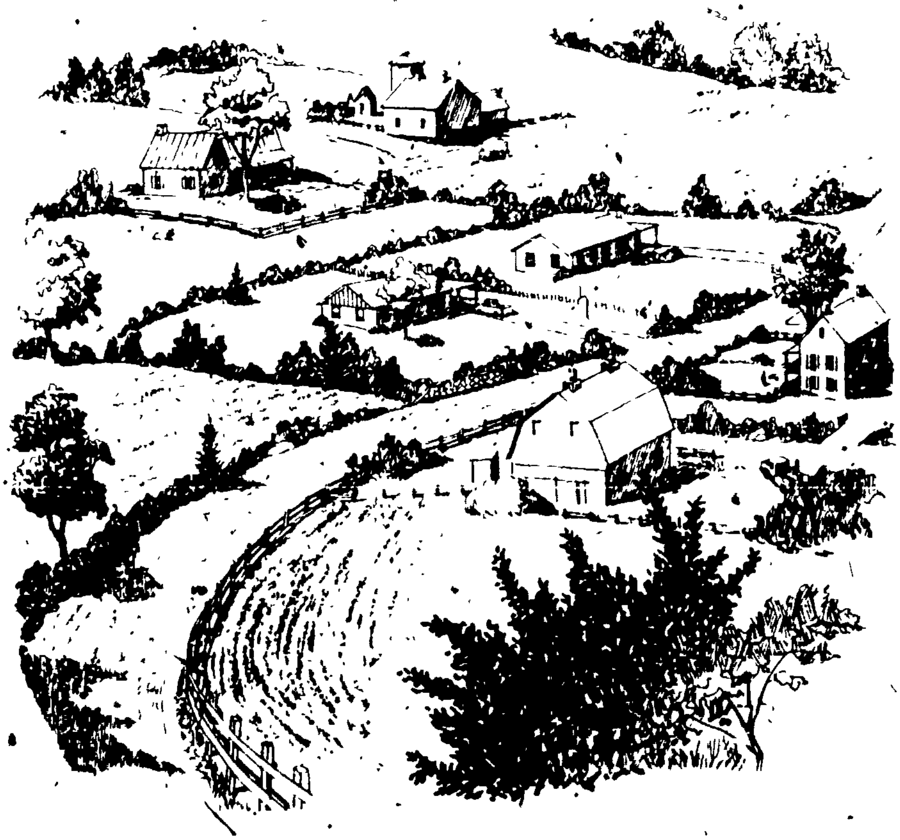
• Do state or local regulations limit vacuum or small-diameter pressure or gravity sewers?

• Taking federal funding eligibility into account, what are the local costs for conventional and alternative sewer systems?

• Is the grantee aware that the small-diameter or vacuum sewers qualify for 85 percent federal funds as alternative technologies?

• Is a listing of O&M possibilities for the community included?

• Are small-system options that can be combined, even with conventional systems, to form a community wide solution included in the evaluation?



108

Onsite Treatment and Cluster Disposal

Fountain Run, Kentucky

Adapted from *Less Costly Wastewater Treatment Systems [illegible] Small Communities*, Proceedings of Conference held April 12-[illegible] 14, 1977 Reston, VA United States Environmental Protection [illegible] 1977 96 pp

Fountain Run, Kentucky, is a small town which decided that reliance on individual sewage disposal was hindering community development. The total population of the area was 436 in 1975 Three quarters lived within the town limits Lot sizes were fairly large, with the average lot covering about one acre.

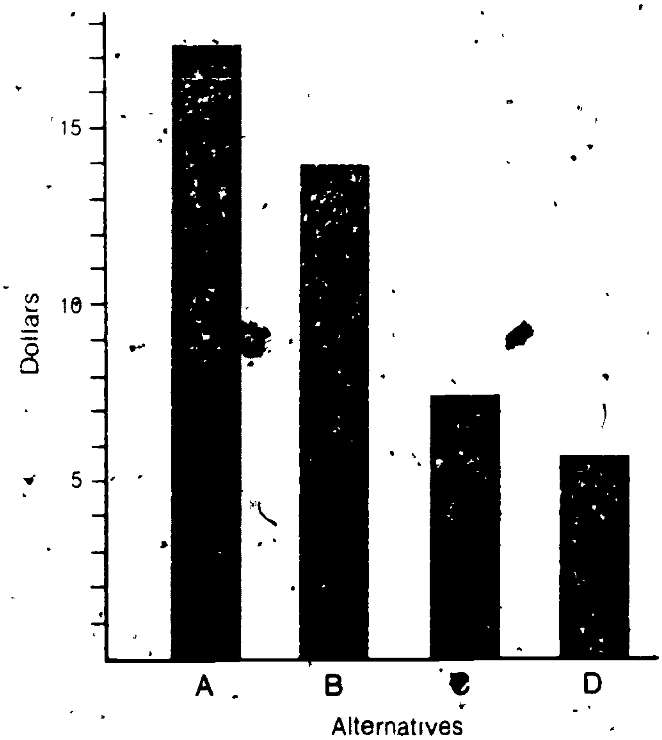
Households and businesses all used onsite disposal Most had septic tanks, but a few used pit privys About 80 percent of existing waste sources were located on soils having good characteristics for subsurface disposal of wastewater

Initially, the wastewater management planning considered only conventional sewers and central treatment Various treatment alternatives were examined Simplicity of operation was a primary goal The conventional treatment process finally selected was a three-cell oxidation pond with land application of effluent The estimated average monthly costs made the community realize that it could not afford such a system, even with federal assistance

Alternatives

The consultants next began considering alternatives apart from the familiar conventional sewers The success of an experimental sewer system installed near Mt. Andrew, Alabama, served as an initial inspiration for Fountain Run Further encouragement was given by the Department of Health in Alabama Both capital and operating costs for Fountain Run were projected to be lower for this "effluent sewer" system, as it was called. However, the average household bill was still high — about $13 per month

It was then decided to divide the service area into small subareas, and to eliminate the central treatment facility, while utilizing effluent sewers and subsurface disposal Each residence would have a septic tank and small-diameter gravity sewers to carry the effluent This approach required a careful evaluation of the location of soils most suitable for subsurface disposal, and the identification of factors which might restrict sewage disposal Costs were developed for septic tanks, dosing (release) tanks, effluent sewers, and disposal systems Several combinations were tried before deciding on an efficient arrangement Ultimately, four alternative systems were evaluated The final system consisted of 22 subarea (cluster) systems having two or more users on shared disposal fields, plus 22 onsite disposal systems



Average Monthly Sewage Bill

Alternative Systems

Alternative	Process Combination
A	Central system
	Conventional sewers Oxidation pond Infiltration-percolation
B	Central system
	Effluent sewers (small-diameter gravity) Oxidation pond Infiltration-percolation
C	Decentralized system
	Effluent sewers Subsurface disposal
D	Onsite systems
	Septic tank Subsurface disposal

Public Participation

A public meeting was held to explain the alternatives to the citizens The District Board of Commissioners, after listening to community concerns, decided on Alternative C, the effluent sewer system with community subsurface disposal Alternative D was not chosen, because of a general feeling that the cost savings would not justify the disadvantages of the option Alternatives A and B were rejected because of the high costs to the users

Design

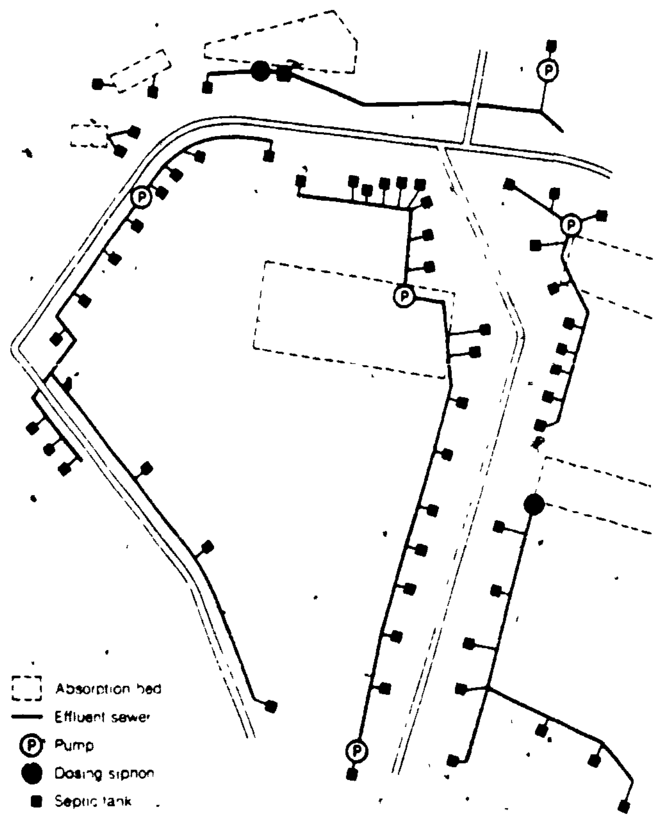
The design of the selected alternative features a septic tank and dosing tank at each location The effluent from the dosing tank discharges into a plastic sewer of 4-inch diameter, and is carried to the subsurface disposal fields No manholes are proposed for these sewers, but cleanout fittings are inserted for flushing the lines to remove sediment The dosing and septic tanks can store wastewater for several hours in case of emergencies caused by clogged lines

Management

The joint absorption beds are located on land owned by the Water District. Land prices are low due to low incomes and the absence of growth pressures. Accessibility to the onsite systems is obtained by utility easements Homeowners give the easements in exchange for a new system that is owned and maintained by the public

Conclusions

The community subsurface disposal concept proposed here is not a new idea, but it has had little application No previous plans have included this particular mix of septic tanks, small-diameter gravity sewers for effluent subsurface disposal, and onsite disposal. This project was under final design in 1980



Fountain Run, Kentucky Subsurface Disposal Plan

Need More Information?

Alternatives for Small Wastewater Treatment Systems Volumes 1, 2, and 3 EPA Technology Transfer Seminar Publication Cincinnati, OH EPA Technology Transfer, October 1977 90 pp, 98 pp, 31 pp

This three volume publication is an excellent reference on small system alternatives for agency personnel, consultants, grantees, and citizen advisers There are a few introductory paragraphs on each topic with additional details useful in decision making Volume 1 deals with onsite disposal, and septage treatment and disposal Volume 2 deals with pressure and vacuum sewers Volume 3 covers cost-effectiveness analysis, including five case histories This document is available as Order No 45238 from U S EPA Environmental Research Information Center, Technology Transfer, 26 West St Claire Street, Cincinnati, OH 45268

Frome, M *Rural Sewage Treatment in Vermont* Books 1 and 2 Montpelier, VT Agency of Environmental Conservation, July 1978 139 pp, 90 pp

Book 1, "A Guide to the Alternatives," is a comprehensive review of sewage treatment Vermont sewage treatment laws conventional septic systems, alternative onsite systems, waterless toilets, and water conservation devices Book 2, "A Planning Manual," presents a planning perspective in a series of questions and statements The questions help reveal problems with onsite disposal and the statements help solve the problems It is available from the Vermont 208 Water Quality Program, Agency of Environmental Conservation, Montpelier, VT 05602

Innovative and Alternative Technology Assessment Manual Draft copy MCD-53 EPA-430 9-78-009 Washington, DC U S Environmental Protection Agency, Office of Water Program Operations, 1978 383 pp

This comprehensive manual on innovative and alternative technologies includes fact sheets on 117 unit processes These fact sheets include onsite disposal methods, small-diameter pressure and vacuum sewers, and septage treatment The methodology by which small treatment systems may be considered for federal funding is also reviewed This report is available through the General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225 Be sure to mention the title of the publication and the MCD number

Planning Wastewater Management Facilities for Small Communities Cincinnati, OH U S Environmental Protection Agency, July 1979 141 pp

This manual presents information and techniques for recognizing and evaluating wastewater management problems frequently faced by small communities It also assists in planning the range of facilities which will solve those problems, giving consideration to costs, community characteristics and growth management It is designed to aid engineers and communities in evaluating and operating various options of wastewater disposal This publication is available through the U S Environmental Protection Agency, Office of Research and Development, Cincinnati, OH 45268

Small Wastewater Systems, Alternatives Systems for Small Communities and Rural Areas FRD-10 Washington, DC U S Environmental Protection Agency, Office of Water Program Operations, 1980 8 pp

This fold-out brochure briefly describes options available for disposal of wastewater in small communities It contains numerous diagrams of alternatives It is available from the General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225 Be sure to mention the title of the publication and the FRD number