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REPORT BY THE

Comptroller General

OF THE UNITED STATES

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RELEASED

Large Construction Projects To Correct Combined Sewer Overflows Are Too Costly

Progress in stemming pollution and flooding caused by combined storm sewer and sewage systems has been slow. Neither the Federal Government nor local communities can supply the enormous funds required for the large construction projects usually needed. The Environmental Protection Agency estimates that almost $26 billion will be needed to curb pollution caused by sewer overflows and at least $62 billion to prevent flooding.

New techniques are needed if cities are to solve their problems soon. A concept known as best management practices offers promise. Under this concept, a community attempts various inexpensive measures before considering costly solutions.

GAO makes recommendations to the Congress and the Environmental Protection Agency to encourage use of low-cost techniques.

UNITED STATES GENERAL ACCOUNTING OFFICE

CED-80-40
DECEMBER 28, 1979

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-166506

The Honorable Charles H. Percy
Ranking Minority Member
Committee on Governmental Affairs SEN06600
United States Senate

Dear Senator Percy:

This report, the second one prepared in response to your request of March 9, 1978, discusses nationwide combined sewer pollution and flooding problems.

The report highlights the slow progress in stemming pollution and flooding caused by combined sewer overflows. Perhaps the chief impediment to progress is that neither the Federal Government nor local communities can provide the enormous sums--estimated by the Environmental Protection Agency conservatively at $88 billion--necessary to build the large structural projects usually proposed. The report calls for a new, less expensive approach to the problem.

As agreed with your office, after you publicly announce its contents, we will furnish copies of this report to the Chairmen, House Committee on Government Operations, House and Senate Committees on Appropriations, House Committee on Public Works and Transportation, and Senate Committee on Environment and Public Works. Copies will also be sent to Senator Adlai Stevenson, Representative Les Aspin, the Environmental Protection Agency, the Office of Technology Assessment, and each of the 15 municipalities included in our review.

The report was discussed with Environmental Protection Agency officials, and their comments were considered in preparing the final report.

AGC00024

Sincerely yours,

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE RANKING MINORITY MEMBER SENATE COMMITTEE ON GOVERNMENTAL AFFAIRS

LARGE CONSTRUCTION PROJECTS TO CORRECT COMBINED SEWER OVERFLOWS ARE TOO COSTLY

D I G E S T

In many U.S. cities, stormwater and waste flow through the same sewer systems. Heavy rains cause sewer overflows, polluting waterways and flooding streets and basements. (See pp. 1 and 12 to 15.)

Little progress has been made toward solving combined sewer problems, primarily because insufficient funds are available to build large-scale projects to separate the sewers--the solution usually proposed. The Environmental Protection Agency estimates conservatively that almost $26 billion is needed to fund what it defines as the pollution control portion of these projects. It estimates that it has spent $2.1 billion on the combined sewer problem during the past 7 years. In fiscal year 1979, expenditures were approximately $690 million--or less than the impact of inflation on the $26 billion, to say nothing of the additional $62 billion estimated for urban flood control. (See pp. 16 to 23.)

Ten of the Nation's 20 largest cities have combined sewers. Further, of 15 major cities with combined sewer systems that GAO visited, less than half have started construction projects to solve their problem and for many that have, it is questionable whether projects underway will ever be completed. The same could also apply to hundreds of smaller communities with combined sewers. (See pp. 7 and 12 to 22.)

CED-80-40

Tear Sheet. Upon removal, the report cover date should be noted hereon.

Since sufficient money for large-scale solutions is not forthcoming, a different approach must be taken. One promising concept, referred to as best management practices, involves examining and trying alternative techniques before embarking on a large-scale, structural solution. While no such technique alone provides the same degree of improvement offered by structural changes, a number of techniques together could minimize overflows and reduce the size of the construction project if one is eventually needed. (See pp. 25 to 28.)

Alternative techniques include

--measures to reduce the flow of rain or pollutants into the system, such as storing rainwater on rooftops, in grassy areas, or in parking lots; disconnecting downspouts; or keeping streets clean;

--devices to increase the flow of sewage through the system, such as sewer inlet restrictors, remotely controlled regulators, and injections of chemicals to reduce friction; and

--devices to regulate and treat sewage at overflow points. (See pp. 28 to 35.)

Many of these techniques have proven their value in mitigating pollution and/or flooding from combined sewers; however, they are not widely used. As a general rule, they will not achieve the degree of improvement that can be expected from restructuring the system. Yet, they can provide relief at far less cost. (See pp. 28 to 39.)

Perhaps the chief reason alternative solutions have been ignored is the inflexibility of national and State water quality goals. The desire to make waterways fit for fishing and swimming, as mandated by the Federal Water Pollution Control Act, often dictates a large-scale, structural solution as the only way to eliminate most pollution from overflows. More flexible water quality goals are needed to encourage the use of low-cost techniques. (See pp. 40 to 41.)

Another obstacle to the use of alternative technology is the Environmental Protection Agency's position that the Clean Water Act provides that Federal grants are available only for construction-type projects, thus excluding many best management practices such as in-stream aeration, sewer cleaning, street-sweeping, creating ponds in parking lots, and disconnecting downspouts. (See p. 44.)

Furthermore, the Environmental Protection Agency has given combined sewer overflow abatement, when compared to treatment plants, a low priority. The Agency's rationale is that more and faster progress in cleaning up the Nation's waterways can be accomplished by concentrating its efforts on constructing new or upgrading existing municipal treatment facilities to secondary treatment standards. Since the Agency estimates that at least $25 billion still needs to be spent on treatment plant construction or upgrading, it appears the combined sewer problem will continue to receive low priority. (See pp. 44 to 46.)

An additional problem, from the communities' perspective, is the absence of Federal involvement in solving flooding problems caused by combined sewers. While the Environmental Protection Agency can fund projects to correct combined sewer pollution problems, it cannot get involved in flooding problems caused by the same system. Likewise, the U.S. Army Corps of Engineers, the agency traditionally involved in flood control projects, is prohibited by the Office of Management and Budget from funding projects to prevent flooding by combined sewers. Community officials point out that both flooding and pollution are caused by the same system and it is inefficient to devise separate solutions. (See pp. 46 and 47.)

If the Nation is going to solve the problem, changes are needed. Federal spending can be increased to correct combined sewer problems, but that solution is unrealistic given the extensive demands of various programs for limited Federal dollars. What clearly is needed is a way to bring about a lower cost solution without losing sight of national water quality objectives. Best management practices provide such an opportunity if water quality goals are adjusted to permit more extensive use of such an approach. (See pp. 48 to 50.)

RECOMMENDATIONS

The Congress should provide more flexibility in water quality goals, encourage the use of alternative low-cost approaches, and permit the Federal Government to play a role in preventing flooding caused by combined sewers.

The Administrator, Environmental Protection Agency, should emphasize the use of inexpensive techniques and require communities to make maximum use of lower cost alternatives before funding large-scale, structural projects. While these techniques may not provide a total solution, it is time to realize that the current approach is not working. Funds in the magnitude required are not available and probably never will be. (See p. 51.)

AGENCY COMMENTS

Oral agency comments were obtained and appropriate changes made in the report. The Environmental Protection Agency generally agreed with GAO's conclusions and recommendations, except that it says the current policy of no involvement in flooding is correct and that urban flooding costs should be borne by the local community. The Environmental Protection Agency also does not want to get involved in funding low-cost approaches that would normally be considered operating and maintenance costs.

Contents

ABBREVIATIONS

ACEC	American Consulting Engineers Council
A/E	architectural and engineering
BMP	best management practices
CEQ	Council on Environmental Quality
EDA	Economic Development Administration
EPA	Environmental Protection Agency
GAO	General Accounting Office
O&M	operating and maintenance
OMB	Office of Management and Budget

CHAPTER 1

INTRODUCTION

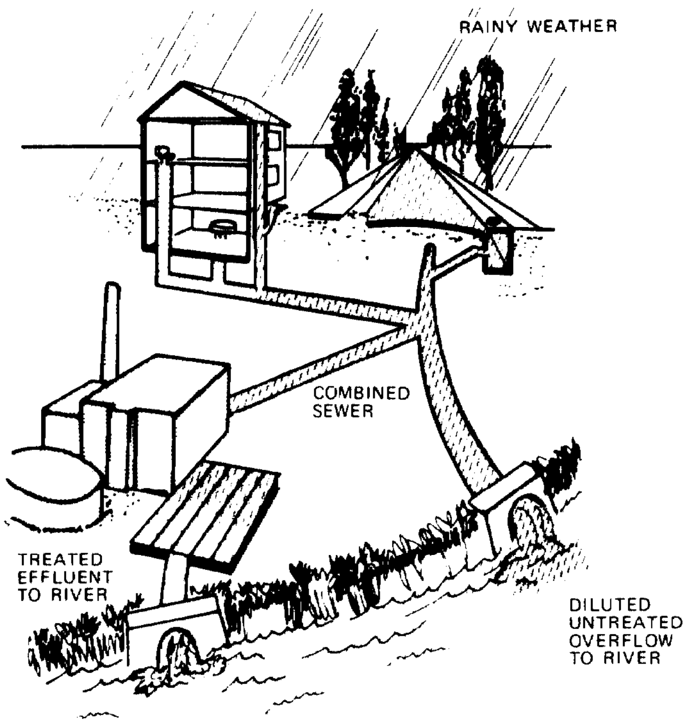
Combined sewer systems are found throughout the United States, though they are more prevalent in the Northeast and the Midwest. During rains, combined systems often cannot handle the flow of water, causing polluted water overflows into rivers and lakes and flooding in streets and basements.

WHAT ARE COMBINED SEWERS?

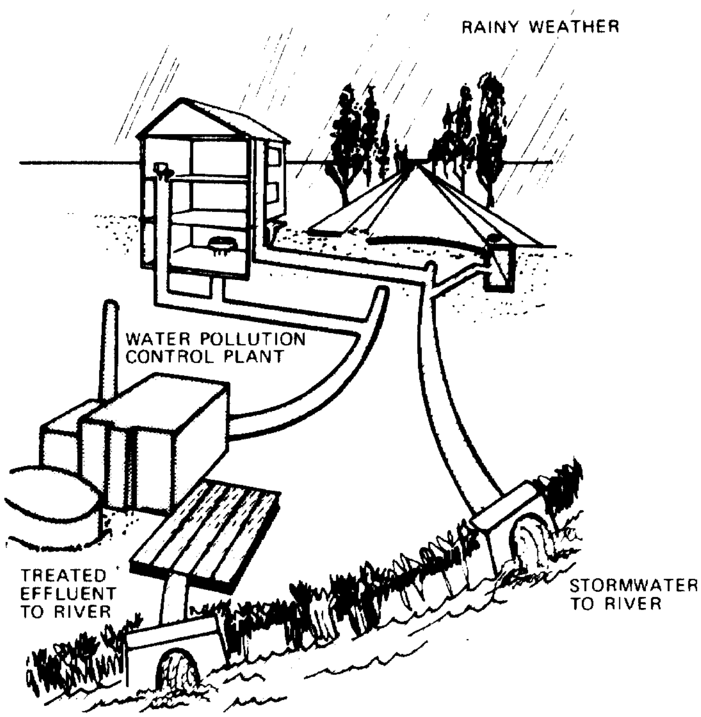
"Combined sewers" is a term given to a sewage system that carries both sanitary sewage and stormwater through the same pipe to a treatment facility. Such systems are usually found in older communities, whereas newer communities generally have separate sewer systems. In a separate system, one pipe carries sanitary sewage to the treatment facility and and another pipe carries stormwater directly to the area waterways, bypassing the treatment facility. The illustration on page 2 shows the difference between the two systems during wet weather.

Comparison Of Combined And Separate Sewer Systems During Rainy Weather

Combined



Separate



Source: District of Columbia, Department of Environmental Services

Combined systems primarily provide an outlet for sanitary sewage with minimal protection against overflows and flooding caused by stormwater. During dry weather a combined system handles the community's sanitary sewage flow. Depending on the community, this load could vary from 10 to 80 percent or more of the system's capacity, with 15 percent considered normal. When it begins to rain, rainwater enters the system and, depending upon the system's dry weather flow, its capacity, and the volume of rainfall, it can quickly become overloaded.

Once a system overloads, the water can

--overflow directly into the area's rivers and streams through overflow outlets that bypass treatment facilities,

--backup through the sewage system into basements, toilets, laundry tubs, etc.,

--backup into streets, viaducts, and low-lying land if stormwater inlets and sewers are unable to handle the inflow of water.

At the same time, water may be building up in the area's streams and drainage ditches from the same rainfall. This buildup can also contribute to flooding.

Critical to preventing pollution caused by combined sewer overflows is treatment plant capacity. It does no good to increase water conveyance to the treatment plant if the plant cannot handle the increased flow. When a plant is unable to handle the flow, the excess sewage simply bypasses the plant and flows directly into area waterways. Thus, solutions to combined sewer problems must take into account both conveyance and treatment plant capacity.

WHY CAN'T SYSTEMS HANDLE THE PROBLEM?

Combined systems are generally old--most were constructed in the early 1900s when the prevailing approach to handling stormwater and sanitary sewage favored combined systems. By the 1940s, the view had switched to separate systems as the best way to handle them. Thus, most older communities find themselves saddled with combined systems.

Over the years, combined systems simply have not been able to handle the demands placed upon them. Why?

--As communities grew, more demands were placed on sewage systems, without adequate additions or enlargements.

--As urban construction continued, open ground that absorbed rainwater was covered by pavements or buildings, thus narrowing the places where stormwater could be absorbed into the soil.

--Sewers have deteriorated over the years. In many communities the systems are simply worn out: pipes have deteriorated and broken and regulators have become inoperable, often allowing excess ground water and stormwater to infiltrate the system.

--Regular and preventive maintenance have been neglected. Some communities have not done the maintenance needed to prevent blockage from tree roots and other obstructions, silt buildup, etc.

As a result, many communities' combined sewer systems simply cannot cope with the increasing demands placed upon them.

Sewer systems are generally designed to convey flows from 5- to 10-year storms. 1/ Any storm with rainfalls greater than the 5- to 10-year storm could be expected to overload the system, resulting in overflows and flooding. While a sewer system may have been designed originally to handle the 5- to 10-year storm, increased urbanization and other problems discussed above have greatly reduced the combined sewer system design capacity. Thus, rather than the 5-year storm, the system may be able to handle only a 1-year storm. Obviously, reduced system capacity means increased frequency and extent of system overflows.

1/A concept that assumes a system could handle any storm that statistically would occur only once every 5 to 10 years.

WHAT'S SO BAD ABOUT COMBINED SEWER OVERFLOWS?

The Council on Environmental Quality (CEQ) 1/ concluded in its December 1978 report that combined sewer overflows severely degrade the Nation's water quality. In addition, inadequate combined systems in many communities are a major cause of flooding, including sewage backups into basements.

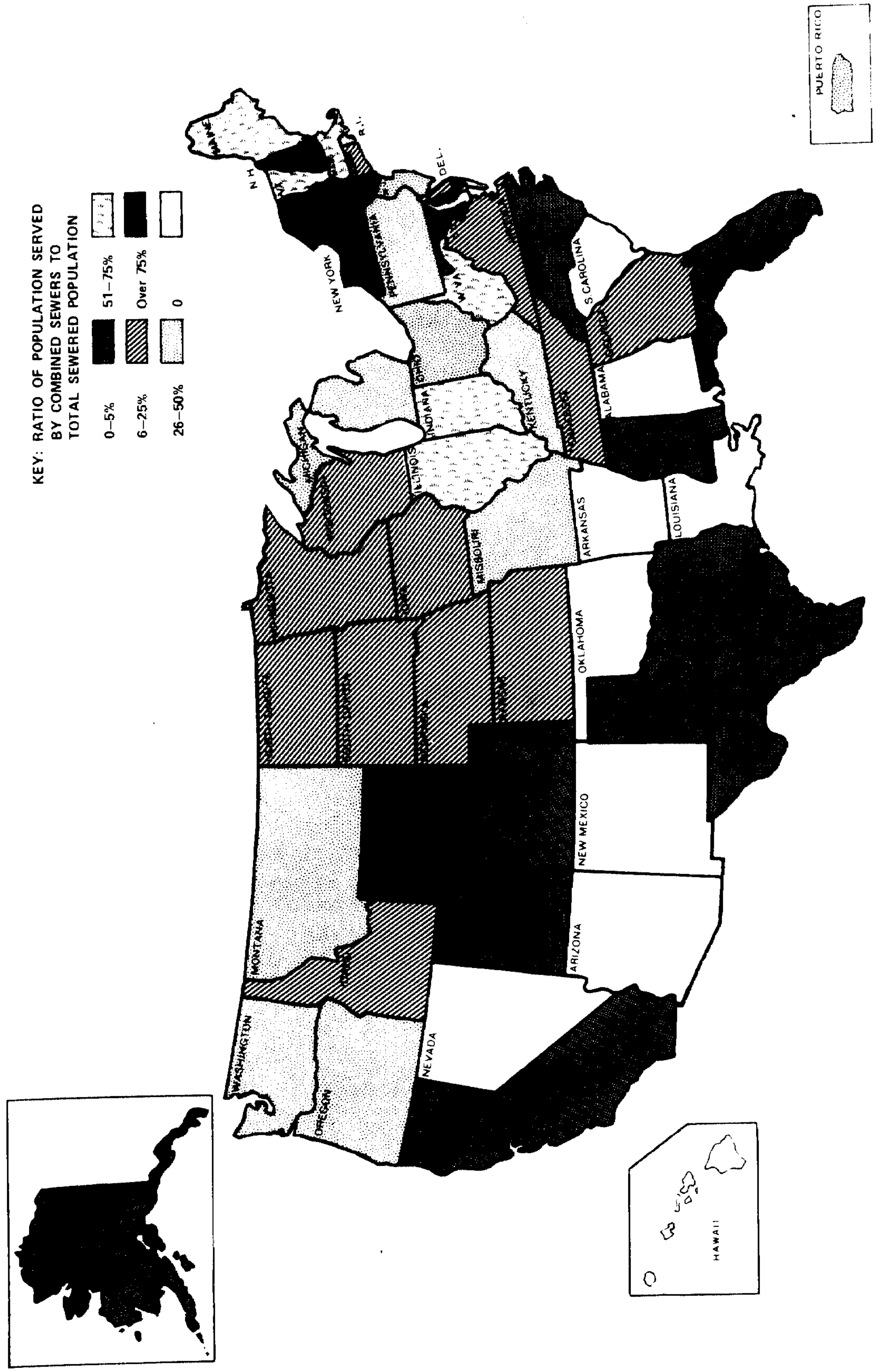
Combined systems mix rainwater with the raw sewage already flowing in the pipes. The result is a mixture that can best be described as repulsive, smelly, and polluted with various organisms. A typical combined sewer system may be carrying human wastes, disease-causing organisms, toxic chemicals, heavy metals, oil, grease, and other undesirable contaminants. When such a system overloads, this mixture flows directly into area waterways through overflow outlets and/or backs up into basements and streets. In contrast, overflows from separate stormwater systems do not involve surface discharges without raw sewage. However, separate stormwater systems also convey significant amounts of pollutants.

COMBINED SEWERS ARE WIDESPREAD

No area of the country escapes the combined sewer problem. According to the Environmental Protection Agency (EPA), at least 1,100 combined or partially combined sewer systems serve about 40 million people in the United States. 2/ Combined sewer systems are found from Oregon to New York--in large and small communities--though they are most prevalent in the densely populated and highly industrialized areas of the Northeast and Midwest, as shown by the illustration on page 6. (App. I lists by State the number of communities with combined or partially combined sewers.)

1/CEQ was established in the Executive Office of the President by the National Environmental Policy Act of 1969 to formulate and recommend national policies to promote the improvement of environmental quality. CEQ, among other things, assists the President in preparing the annual environmental quality report to the Congress.

2/One sewer system may serve numerous communities. For example, EPA would count the Metropolitan Sanitary District of Greater Chicago as one system. Yet within this district, 54 politically separate communities have combined or partially combined sewer systems.


KEY: RATIO OF POPULATION SERVED BY COMBINED SEWERS TO TOTAL SEWERED POPULATION
0–5%
6–25%
26–50%
51–75%
Over 75%
0
PUERTO RICO
HAWAII
MAINE
N.H.
R.I.
DEL.
NEW YORK
PENNSYLVANIA
W. VA.
S. CAROLINA
ALABAMA
LOUISIANA
ARKANSAS
OKLAHOMA
NEW MEXICO
ARIZONA
NEVADA
OREGON
WASHINGTON
MONTANA
MISSOURI
KENTUCKY
INDIANA
OHIO
ILLINOIS
MICHIGAN

The Nation's largest cities are particularly affected by combined sewers. As shown below, 10 of the 20 largest cities have either combined or partially combined sewer systems.

20 largest cities (note a)	Partially or totally combined sewer system	Separate sewer system
New York, N. Y.	X	
Chicago, Ill.	X	
Los Angeles, Calif.		X
Philadelphia, Pa.	X	
Houston, Tex.		X
Detroit, Mich.	X	
Dallas, Tex.		X
Baltimore, Md.		X
San Diego, Calif.		X
San Antonio, Tex.		X
Indianapolis, Ind.	X	
Washington, D.C.	X	
Phoenix, Ariz.		X
Memphis, Tenn.		X
San Francisco, Calif.	X	
Milwaukee, Wis.	X	
Cleveland, Ohio	X	
Boston, Mass.	X	
New Orleans, La.		X
San Jose, Calif.		X

a/Based on Department of Commerce 1976 population estimates.

FEDERAL INVOLVEMENT IN COMBINED SEWER SYSTEMS

EPA is the primary Federal agency involved with combined sewer systems; however, its responsibility extends only to the waterway pollution caused by such systems. Under Public Law 92-500, EPA may grant up to 75 percent of the cost for the pollution control portion of sewer projects. Eligible projects include sewage treatment plants; interceptor sewers; and sewage collection systems, both combined and separate. If, however, a project's major purpose is to control flooding, it would not be eligible for EPA funding.

EPA funds projects based on priority lists prepared by each State. These lists, which are revised annually, are based on population affected by the project, severity of problems, and Federal and State criteria. Priority is given to sewage treatment facilities and other elements of the treatment system. Combined sewer overflows and other sewer problems generally have low priorities. Projects on the priority lists far exceed available funds.

EPA's grant process is divided into three steps:

--Step 1 is the preparation of a facility plan for which EPA will fund 75 percent of the cost. This plan is usually prepared by an architectural and engineering firm hired by the community. The plan normally discusses the problem, proposes solutions, and estimates the cost of the proposed solutions. The plan should also evaluate alternative solutions. Once EPA approves the facility plan, the community can move to the next step.

--Step 2 is the design stage. The EPA grant, up to 75 percent of cost, under this step is used to prepare detailed engineering plans and specifications for the project approved in the facility plan. EPA approval is again required before the next step.

--Step 3 is the construction phase. EPA is authorized to grant up to 75 percent of the cost of constructing the approved project.

EPA's proposed fiscal year 1980 authorization for construction grants (all three steps) for water pollution control projects is $3.4 billion. However, most of these funds go to construction of treatment plants, not for collection systems (combined sewers are collection systems), since in EPA's view more progress can be made in improving the quality of the waterways by concentrating on treatment facilities.

Since a combined sewer system often causes both pollution and flooding, EPA uses cost-curves to determine how much to fund projects. EPA officials said they would fund a multipurpose project to the point where the curve shows that each additional dollar spent will be more flood related than pollution related. For example, pollution is the heaviest after rainfall begins, as the initial surge of water (1) tends to scour off pollutants that are clinging to the walls of conveyance pipes, (2) picks up sediment in the pipes, and (3) washes off contaminants from the street. After a period of rain, 1 hour or less in many systems, the pollutant load is reduced and EPA considers controls to stop additional overflows beyond this point to be more flood related. Thus, the additional capacity would be considered flood control rather than pollution control and therefore not eligible for EPA funding.

Recent legislation

One important piece of legislation affecting the combined sewer problem is the innovative and alternative provisions section of the Clean Water Act of 1977. This act clearly established the Congress' intent to encourage the development and use of alternative and innovative technology in wastewater treatment. While the act primarily mentions treatment facilities, EPA officials state that its provisions would clearly apply to combined sewer treatment facilities. EPA officials also said that it is not clear whether the act applies to combined sewer collection systems. An important provision of the act allows EPA to grant up to 85 percent of the project's cost, instead of the normal 75 percent, to communities that use alternative and innovative technology in their projects.

Other Federal agency involvement

The Department of Housing and Urban Development and the Economic Development Administration (EDA) also provide funds for combined sewer systems. However, such funds are limited and are made only as adjuncts to each agency's primary program. For example, EDA's primary purpose is to attract new industry and encourage business expansion in economically hard-pressed areas. Therefore, EDA would only provide funds for combined sewers if it felt that local industry or business would be stifled without adequate sewage collection systems. Our report on Chicago's Tunnel and Reservoir Project discussed this situation in detail. 1/

Urban flooding

While a number of Federal agencies are involved in urban flooding projects, no one agency is specifically concerned with flooding caused by combined sewer systems. Traditionally, the U.S. Army Corps of Engineers has handled urban flood control projects. The Federal Government has assumed responsibility for flood control, but it has not assumed responsibility for urban drainage projects. The key is whether combined sewer overflows are classified as urban drainage or urban flooding. In January 1978 the Department of the Army and the Office of Management and Budget (OMB) agreed on criteria to use in defining urban drainage and flood control. One provision of this agreement was that sanitary sewage or stormwater runoff conveyed in manmade structures would not be classified as flood control if it goes to treatment facilities. Since combined sewers carry runoff to treatment facilities, they are classified as urban drainage and therefore, according to OMB, they are ineligible for Federal funding by the Corps.

SCOPE OF REVIEW

We reviewed the problems of combined sewer system flooding and pollution from both a national and international perspective to determine the severity of the problem and identify the use of innovative, lower cost solutions. We visited 15 U.S. metropolitan areas--including 8 of the Nation's 20 largest cities--served by combined or partially combined sewers and 6 foreign countries. In two prior reviews, we assessed the actions taken by the Chicago metropolitan area to solve flooding and pollution problems caused by combined sewer overflows. 2/

1/"Combined Sewer Flooding and Pollution--a National Problem. The search for solutions in Chicago: Funding for Local Flooding Problems Is Extremely Limited," (CED-79-77, volume 4, May 15, 1979).

2/"Combined Sewer Flooding and Pollution--A National Problem. The Search For Solutions in Chicago," (CED-79-77, May 15, 1979). "Metropolitan Chicago's Combined Water Cleanup and Flood Control Program: Status and Problems," (PSAD-78-94, May 24, 1978).

To obtain additional understanding of the problem and further identify alternative techniques for the control of combined sewer problems, we reviewed various reports and research publications and interviewed officials at

--Environmental Protection Agency headquarters and regional offices in Atlanta, Georgia; Chicago, Illinois; and New York, New York;

--EPA's Environmental Research Information Center in Cincinnati, Ohio;

--EPA's Municipal Environmental Research Laboratory in Cincinnati, Ohio, and Edison, New Jersey,

--State environmental resources agencies in Illinois, New York, Pennsylvania, and Wisconsin; and

--the Council on Environmental Quality, Washington, D.C.

Various innovative approaches are being used or have been proposed in several European countries and Canada to control combined sewer problems. To explore the feasibility of these techniques, we met with officials from local governments, university professors, equipment manufacturers, and engineering consultants in the United Kingdom, Sweden, Federal Republic of Germany, Norway, France, and Canada.

Officials of each of the 15 cities included in our review were given the opportunity to review our information on their communities. Changes requested by these officials were incorporated into the report where appropriate. We also discussed the report with EPA headquarters officials and obtained their comments, which were incorporated into the report where appropriate.

Appendix III lists the consultants used on this assignment.

CHAPTER 2

SOLVING THE COMBINED SEWER PROBLEM--AN ELUSIVE GOAL

Discharges from combined sewer systems are a major factor in both waterway pollution and flooding--particularly in urban areas. Combined sewer overflows pollute some of the Nation's most important and historic waterways. Urban flooding is not as widespread but is still prevalent in some of our major cities, including Buffalo, New York; Chicago, Illinois; Cincinnati, and Cleveland, Ohio; and Minneapolis-St. Paul, Minnesota.

Yet, despite its magnitude, the combined sewer problem is far from being solved. Less than half of the 15 metropolitan areas we visited have started on solutions to the problem; and of those projects that have begun, many, such as Chicago, may never be completed. Also, completion dates, assuming construction proceeds on schedule, often were estimated to be in the mid-1980s or later.

Why has progress been so slow and why is the outlook so bleak? There are many reasons, but the essential one is not enough Federal money. The most frequently used solution is to concentrate on separating the combined sewers, which by its very nature consumes vast amounts of funds.

POLLUTION AND FLOODING--TWIN EVILS OF COMBINED SEWERS OVERFLOWS

In most of the 15 metropolitan areas we visited, combined sewer overflows significantly impaired water quality. The flooding problem was not as widespread, and concern about flooding varied; it was important to officials in communities constantly faced with citizens' complaints about flooding, not so important in areas where flooding is not considered a problem.

Comments from selected officials clearly illustrate the waterway pollution problem, as shown below

--According to the Metropolitan Sanitary District of Greater Chicago, overflows from hundreds of combined sewer outlets account for approximately 45 percent of the pollution in area rivers and streams and also contribute to pollution in Lake Michigan.

--New York State officials have classified combined sewer overflows and urban stormwater runoff as one of the State's highest priority water quality management problems.

--According to environmental consultants for Rochester, New York, combined sewer overflows violate water quality standards of the Genesee River and contribute to the overall bacteriological contamination and resultant health hazard found at the public bathing beaches on Lake Ontario.

--Consultants for San Francisco noted that every time it rains, the volume of combined rain runoff and sanitary sewage exceeds treatment plant capacity and the excess flows untreated into the San Francisco Bay and the Pacific Ocean. Each year San Francisco suffers 80 such overflows--containing bacteria, grease, debris, and human wastes--and must close beaches an average of 125 days per year.

While pollution is clearly a major problem, the seriousness of urban flooding is more difficult to pin down since there is a lack of solid information on flood damage. However, as noted in our report on Chicago's tunnel and reservoir project (CED-79-77, May 15, 1979), flooding in the Chicago area caused an estimated $71 to $102 million in damage to single-family homes during the last 5 years--and untold inconvenience and disgust. Flooding resulting from sewer backups is a significant problem as it can cause serious health problems. Flooding, whatever the form, results in damage, inconvenience, injuries, and even death.

The following table shows the situation as viewed by officials in each of the 15 metropolitan areas. As the table shows, some of the Nation's most historic and significant waterways are harmed by combined sewer overflows. While the precise degree of water contamination was not available, most officials or their consultants believed that overflows were a serious source of pollution, causing violations of water quality standards and/or restricting public recreation.

Pollution and Flooding From Combined Sewer Systems for Selected Metropolitan Areas

Metropolitan area	Average yearly combined sewer overflows	Waterways affected	Type of flooding experience and severity
Atlanta, Ga.	120	Chattahoochee and South Rivers	Street flooding during severe storms.
Boston, Mass.	60 to 70	Charles, Mystic, Chelsea, and Neponset Rivers; Boston Harbor; and Dorchester Bay	Severe basement sewer backup in Port Norfolk area of Boston.
Buffalo, N.Y.	38	Niagara and Buffalo Rivers	Basement sewer backup affects 30 percent of homes in certain areas Street and viaduct flooding occurs 30 to 40 times per year throughout the city.
Chicago, Ill.	100	Chicago River and Sanitary and Ship Canal System, Calumet System, and Des Plaines River Systems (note a)	Basement sewer backup scattered ranging from 2 to 43 percent depending on community. Street, viaduct, and overbank flooding severe in about 50 percent of the 54 suburban communities with combined sewers.
Cincinnati, Ohio	Almost every rain	Mill Creek, the Little Miami River, and various other rivers and streams which eventually flow into the Ohio River	Basement sewer backup is widespead throughout low-lying areas of combined sewer system.
Cleveland, Ohio	80 to 100	Lake Erie, Cuyahoga River	Basement sewer backup and street flooding is widespread.
Detroit Mich. (note b)	30 to 50	Primarily the Rouge and Detroit Rivers	Infrequent basement sewer backup. Street and alley flooding sporadic.

Metropolitan area	Average yearly combined sewer overflows	Waterways affected	Type of flo
Milwaukee, Wis.	50	Lake Michigan and Milwaukee River	No flooding
Minneapolis and St. Paul, Minn.	10 to 30	Mississippi River	Basement se severe in
Philadelphia, Pa.	Almost every rain	Delaware and Schuylkill Rivers	Basement se percent o
Rochester, N.Y.	60 to 70	Genesee River, Irondequoit Bay, and Lake Ontario	Basement se occurs du precipita
San Francisco, Calif.	80	San Francisco Bay and Pacific Ocean	Basement ba not a sig
Seattle, Wash.	40	Various freshwater streams, lakes, bays, and canals; tidal rivers; the marine waters of Puget Sound and Elliott Bay	Some baseme flooding
Syracuse, N.Y.	60 to 70	Onondaga Lake, Ley and Onondaga Creeks' and Harbor Brook	Basement se considere
Washington, D.C.	Unknown	Potomac and Anacostia Rivers and Rock Creek	Basement se however, in severa combined

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a/In addition, when Chicago area rivers are close to overflowing, control locks allow p to flow into Lake Michigan. These backflows occur on the average of once yearly and about 132 million gallons of water.

b/Includes city of Detroit only.

WHAT SOME AREAS ARE DOING ABOUT THE PROBLEM

In looking at what the 15 metropolitan areas are accomplishing, several conclusions are readily apparent:

--Projects underway tend to be structurally intensive, 1/ multimillion dollar efforts.

--For many communities that have begun projects, solutions to the problem are many years away.

--Full funding for many proposed projects is tenuous at best.

--Some communities will not even complete their study of what to do until 1981 or later.

Atlanta, Georgia

The city of Atlanta has received three EPA grants for facility plans that relate to the combined sewer problem. City officials said much of their program is still in the planning stages and specifics are lacking. However, they have received the following grants:

--A grant of approximately $1 million to prepare a facility plan for wastewater management for three treatment plants located in two river basins. Part of the plan applies to combined sewer overflows. The combined sewer plan has been completed and is in the design phase. City officials anticipate--if funds are obtained--building a $45 million combined sewer overflow storage and treatment facility. They hope to have the facility completed by 1985. The project would store the "first flush" of the overflow, which would receive subsequent treatment at an existing wastewater treatment plant.

--A facility grant for another basin, $70,000 of which applies to combined sewer overflows. This plan is supposed to be completed by October 1980. City officials anticipate that the recommended action will involve screening and disinfection of combined sewer overflows.

1/ Projects that primarily involve extensive construction activity, i.e., tunnels, new sewers, treatment facilities, etc.

--A facility grant for another basin, $108,000 of which applies to control of combined sewer overflows. This plan is expected to be completed by June 1980. The recommended plan includes screening and disinfection of combined sewer overflows.

Boston, Massachusetts

The Boston Metropolitan District Commission, under a $3.4 million EPA grant, is in the process of determining actions needed to improve its combined sewer system. Boston officials anticipate the study will be completed by March 1980. A prior study, directed at achieving clean water goals for the area which identified combined sewer overflows as a significant source of pollution, was completed in March 1976 and recommended major upgrading of the metropolitan sewerage system. This study recommended construction of 52 major projects at a cost of $855 million. Four of these projects addressed the combined sewer problem at an estimated cost of $270 million. This study, which included combined sewer overflow abatement, and the facilities planning was criticized by four Federal agencies as structurally intensive, so the commission decided to explore other abatement plans. Boston has also constructed two combined sewer overflow treatment facilities and a third is under construction. These facilities, which are estimated to cost $15 million, will provide for increased storage and disinfection of combined sewer overflows.

Buffalo, New York

The Buffalo Sewer Authority has received an EPA grant of $1.8 million to study its combined sewer overflow problem. Buffalo expects to complete its facility plan in 1982. A 1973 study estimated the cost of solving the problem at $361 to $391 million using structurally intensive solutions, such as a tunnel, sewer separations, and treatment plant expansions.

Chicago, Illinois

The Metropolitan Sanitary District of Greater Chicago has embarked on a pollution and flood control plan that could cost $11 billion by 1983. This plan consists of 131 miles of underground tunnels, three open-pit storage reservoirs, treatment plant upgrading, local sewer upgrading, and various other projects. Estimated completion date of the total project is 1990 at the earliest. Funding for the total project is uncertain.

Cincinnati, Ohio

The Metropolitan Sewer District of Greater Cincinnati drafted segments of a facility plan for combined sewer overflows in 1977, but EPA did not approve them. EPA contended that the plan was not valid because of the lack of sampling and modeling necessary to determine what control measures were actually needed. EPA funding was received in 1979 to conduct the necessary sampling and modeling. The sewer district expects to have the combined sewer overflow portion of its facility plan completed in 1981. Sewer district officials cannot estimate whether the facility plans will meet EPA approval. No final cost estimates or required actions can be determined at this time.

Cleveland, Ohio

The Northeast Ohio Regional Sewer District has proposed a $170 million pollution control project for combined sewer overflow abatement using computers to maximize insewer and offline storage capacity. Funding is uncertain, since State priorities are directed toward treatment facilities and the district is unable to fund the project. However, EPA has approved $11.6 million for facilities that are part of the overall plan. Bids for $9.4 million for these facilities are currently being advertised.

The city of Cleveland has also proposed a $472 million flood control project, primarily involving relief sewers. Sewer construction costing approximately $17 million is already underway. However, the city's poor financial condition precludes further funding for flood relief.

Detroit, Michigan

The Detroit Water and Sewerage Department's facility plan for combined sewer overflows is now underway, and an interim report is due in May 1980 with a final report due in June 1981. Preliminary cost estimates range from $150 to $500 million, depending on the type of project ultimately proposed. Sewerage department officials said that since the plan is still in formulation they could only speculate on the type of projects that might be proposed; projects could be scheduled to start during 1982.

Detroit's Water and Sewerage Department's financial condition has inhibited progress. Relief sewer construction to control flooding, estimated to cost $377 million, has been deferred for lack of funds. A proposed user charge system to help fund needed pollution construction was stymied by a suburban community's suit to halt service charge increases.

Milwaukee, Wisconsin

The Milwaukee Metropolitan Sewer District is reviewing various alternatives to control combined sewer overflows. Consultants recommended sewer separation, costing $501 million. Another alternative is to construct deep tunnels, costing from $770 million to $1.3 billion.

The sewer district's plans are tenuous because of continuing litigation. In 1970 the States of Illinois and Michigan sued Milwaukee for polluting Lake Michigan. The Federal district court found in favor of Illinois and Michigan and required Milwaukee to, among other things, (1) eliminate all combined sewer overflows, (2) create storage capacity of sufficient volume to contain overflow from the largest storm on record, and (3) treat all wastewater according to advanced wastewater standards. The Federal appeals court on April 26, 1979, upheld the lower court decision except that Milwaukee would not have to upgrade treatment plants to provide advanced wastewater treatment. Milwaukee has appealed the decision to the Supreme Court.

Minneapolis-St. Paul, Minnesota

Since the early 1960s, Minneapolis has spent about $60 million to partially separate its combined sewers in conjunction with its street repaving program. About 85 percent of the sewers are now separated or partially separated. According to officials, this action has significantly reduced basement backup flooding; however, they could not estimate a percentage since they did not have good data on the extent of flooding before the project.

Since 1959 St. Paul has spent about $50 million to install relief sewers and partially separate combined sewers. Local officials say that combined sewer backup flooding has been significantly reduced as a result of this program, but several major areas still have a serious backup problem whenever it rains. More than $300 million will have to be spent to address these remaining problems. St. Paul officials anticipate starting this project by the fall of 1979, using local funds. As of November 1979, completion date is indefinite.

The Metropolitan Waste Control Commission completed in 1969 a $1.75 million, computer-based sewer regulator system. This system included inflatable, remote-controlled rubber bags installed at 15 major locations and, according to commission officials, resulted in a 60-to 70-percent reduction in combined sewer overflows. Currently, the Metropolitan

Waste Control Commission, in a joint effort with Minneapolis, St. Paul, and South St. Paul, is making a combined sewer overflow study. The study is expected to be completed by June 1980 and should provide a plan to attack the waterway pollution caused by combined sewer overflows.

Philadelphia, Pennsylvania

The City Water Department plans to approach Philadelphia's combined sewer problem in two phases. The first phase, estimated to cost $20.2 million, will consist of a computerized control system to collect rain and sewer data and maximize sewer storage by the use of existing interceptor regulators. This phase is expected to reduce combined sewer overflows by 50 percent. The second phase is a proposal to construct large storage and conveyance facilities. However, plans are so tentative that officials could not estimate a cost, the extent of resulting improvement, or the anticipated start date. Federal funding for the projects is uncertain because of the low priority the Pennsylvania Department of Environmental Resources gives to the combined sewer problem. Water department officials feel that even if Federal funds are not available, they would still fund a scaled-down version of phase I.

Rochester, New York

The Rochester Pure Waters District has developed a two-pronged program to abate combined sewer overflows and backups. The first part of the program involves the implementation and evaluation of best management practices (BMP) with a total cost of approximately $12 million. The second part of the program, estimated to cost $400 million, is of longer duration and only partially approved by EPA. This portion involves the construction of some 20 miles of deep rock tunnels, interceptor sewers, and combined sewer overflow treatment facilities. EPA has approved a grant for 5 miles of the tunnels, with construction to begin in late 1979 and completion estimated for 1984. The remaining 15 miles of tunnels, the interceptor sewers, and treatment facilities have not received EPA approval.

San Francisco, California

The city and county of San Francisco developed a $1.48 billion tentative wastewater plan, of which $1.1 billion (in December 1977 dollars) is for combined sewer overflows. This plan provided for constructing tunnels, new sewers, and pumping stations; upgrading treatment plants; and installing pipelines to transport treated overflows far into the Pacific Ocean (a disposal method known as ocean outfall). As of

May 31, 1979, projects totaling about $100 million were under contract for outfall consolidation, transport and pump stations.

The entire project is scheduled for completion in mid-1986. City/county officials anticipate EPA funding for 75 percent; the State for 12-1/2 percent, and the city and county the remainder. Local officials are hopeful but uncertain as to whether the entire plan will ultimately get EPA approval.

Seattle, Washington

To reduce pollution, the Municipality of Metropolitan Seattle (METRO) has installed remotely controlled regulators at a cost of about $9 million. The city of Seattle also embarked on a companion program to reduce flooding and overflows by separating its combined sewers at a cost of approximately $69 million. Installation of the regulators is complete, and sewer separation was completed in about 78 percent of the designated areas in August 1979.

The combined effect of these two programs has been to reduce Seattle area combined sewer overflows by one-half, from about 2 billion to 1 billion gallons per year. The sewer separation program, which concentrated on those areas that had flooding problems, has eliminated most of the flooding.

To control combined sewer overflows further, METRO and the city have proposed five control projects for the area's highest priority waterways. Four of the projects, estimated to cost about $29 million, were deemed eligible for EPA funding and are awaiting grants for the design phase. These four projects primarily involve constructing regulator stations and a range of holding facilities including inline and offline storage. EPA has denied funding for the remaining project because of the lack of documentation of benefits that would result from control of overflows. Based on the State's 5-year project priority list, construction of the first of the four projects is expected to commence in 1982 with construction of the remaining projects in 1983-84.

Syracuse, New York

The Onondaga County Department of Drainage and Sanitation is studying various alternatives for controlling combined sewer overflows. A facility plan was submitted for EPA review in June 1979 that provides for a two-phase approach:

--Phase I is estimated to cost $10 million and encompasses the best management practices approach. (See pp. 24-35.) This project could be completed by 1982, assuming prompt EPA approval. The department's consultant does not anticipate complete 75-percent EPA funding since many BMP items are not approved by EPA for funding.

--Phase II is a $70 million effort and involves construction of eight satellite combined sewer overflow treatment facilities using swirl regulators and high rate disinfection. Completion of this phase is estimated to be 1988 or 1989.

Washington, D.C.

The District Department of Environmental Services has contracted for a study to develop a plan for controlling combined sewer overflows. The study will be completed in 1981. A 1973 study estimated that it would cost from $312 million to $457 million to capture and treat 98 percent of the average annual overflows and reduce the average number of overflows to less than one a year.

COMBINED SEWER SOLUTIONS--COSTLY AND SLOW

Two conclusions are evident in the current approach to the combined sewer problem--an overwhelming amount of dollars are needed, and the problem will not be solved in the near future.

EPA's 1978 needs survey shows that, to achieve water quality objectives, almost $26 billion would be required to prevent or control combined sewer overflows nationwide. This figure does not include the cost of controlling flooding caused by combined sewers or urban stormwater runoff since EPA is not responsible for flood control. EPA estimates that an additional $62 billion would be needed to control urban flooding. However, other sources have estimated that to control the combined sewer overflow problem may cost more than $100 billion.

Even the $26 billion estimate to handle the combined sewer overflow problem is suspect. One of our consultants believes that figure is very conservative and that actual costs could be much higher. Several factors raise questions about the reliability of the estimate. For example:

--The amount shown for the entire State of Illinois is less than Metropolitan Chicago alone plans to spend on combined sewer overflows.

--The 1978 estimate is $5 billion greater than the 1976 estimate despite 2 years of expenditures on combined sewer problems. EPA attributes the increase primarily to more comprehensive and accurate information sources as well as identification of a larger combined sewer area.

--The estimate is in 1978 dollars and thus does not reflect the impact of inflation. Often, when projects are finally approved and contracted, costs far exceed estimates, sometimes by two or three times.

EPA spending is not keeping pace with community needs. EPA estimates that by October 1979 it will have spent approximately $2.1 billion on the combined sewer problem since passage of Public Law 92-500 in 1972. Expenditures for this problem in the most recent fiscal year were about $690 million, or considerably less than the impact of inflation. Assuming an inflation rate of 7.5 percent annually, annual expenditures of about $2 billion would be required just to keep up with inflation.

Many of the communities we visited are estimating that a total solution will not be achieved until Federal funding is received. The latter is a big "if" as one theme running throughout our discussions with communities was the tentativeness of EPA funding.

CHAPTER 3

A NEW APPROACH IS NEEDED

The current approach to solving the pollution aspect of the combined sewer problem requires vast amounts of capital. At the same time, it is evident that the amount of funds required will probably not be available. EPA estimates that $26 billion would be needed to solve the pollution aspect of the problem; if flooding is included, the cost could reach over $100 billion.

It is obvious that changes are needed if this nationwide problem is to be solved. We could sharply increase Federal spending on combined sewer problems, but that seems unrealistic given the extensive demands of various programs for limited Federal dollars. Rather, it appears that a less capital-intensive solution is needed. In the Clean Water Act of 1977, the Congress encouraged greater use of more cost-effective alternative and innovative approaches to the problem.

One management approach that is receiving increased attention is often referred to as best management practices. Under this approach lower cost, nonstructural alternatives are tried first and large, expensive projects are built only if needed. While many communities have had success using alternative techniques, many others have ignored them for a variety of reasons. (See ch. 4 for a discussion of impediments to BMP.)

THE CONGRESS RECOGNIZED THE NEED FOR LESS COSTLY ALTERNATIVES

In the Clean Water Act of 1977, the Congress clearly encouraged the development and use of alternative and innovative technology for treating the Nation's municipal wastewaters. Basically, the act provides for

- --increasing the Federal share of costs from 75 to 85 percent for the design and implementation of municipal water treatment technology that improves cost-effectiveness in meeting water quality goals and

- --insuring risk through 100-percent grants for modification of facilities where alternative and innovative technology is tried and fails.

EPA officials said that while the act primarily mentions treatment facilities, its provisions would also apply to combined sewer treatment and control facilities. Less clear in their minds is whether EPA can fund combined sewer collection systems under this act. In a manual implementing the act, EPA noted:

> "* * * alternatives to conventional treatment and discharge, and innovative designs leading to greater cost and energy savings have been strongly encouraged by the provision of increased federal assistance * * *."

EPA also recognized the need to change its approach, as it observed that the new emphasis toward innovative solutions presents a challenge for contemporary planners and engineers to depart from the traditional structural approach.

EPA officials said that since instructions implementing the act were not issued until late 1978, the initial funds were not available until 1979. As of October 1979, EPA has approved $43.4 million in grants under the act's innovative and alternative provisions section. EPA officials reemphasized that the primary purpose of the act was for alternative treatment facilities and that to their knowledge, as of September 1979, no grants for combined sewers collection systems have been made under this section.

BEST MANAGEMENT PRACTICES-WHAT DO THEY INVOLVE?

The BMP approach is starting to attract attention as communities recognize its potential for lower cost action. BMP means different things to different people. EPA defines it as the use of nonstructural control and corrective measures as opposed to structural alternatives. EPA notes that BMP focuses on controlling overflows at the source, whereas structural alternatives parallel the conventional practice of building facilities such as new sewers and large storage facilities.

We feel the definition should be broader. Another definition of BMP provides that a community should first work its way through the lower cost alternatives, evaluate the results, and consider structural projects only if needed. This approach offers a less costly way to reduce combined sewer overflows and flooding.

An expanded BMP approach can be broken into a number of phases. The following breakdown describes key elements of a total management approach. We recognize that many elements could be done concurrently and that this breakdown oversimplifies the BMP approach. However, we feel it illustrates an important direction in which to move toward solving combined sewer problems.

Define the problem to be solved

Before a solution can be devised, a community must clearly define what it wants to achieve. For example, the community's goal may be to reduce combined sewer overflows so that the receiving waterways will meet the area's water quality goals. Or the goal could be to reduce basement backup flooding in a specific area. At any rate, before lower cost solutions can be devised, a community must clearly understand what it is trying to accomplish.

Assess the existing system

The key to developing a lower cost alternative approach is to obtain a thorough knowledge of the existing system; such as, where the lines are located, what shape they are in, where bottlenecks occur, how much treatment plants can handle, and where and when overflows and flooding occur. In its 1978 needs survey, EPA noted that a sewer system inventory should be the first objective of any combined sewer overflow pollution abatement project.

Developing such an inventory is no simple task. Unfortunately, many communities do not know what sewers they have or the location of all overflows because plans have been lost and expansions and/or changes were not incorporated into existing plans. This problem is illustrated by comments in a report by a large sanitary district with numerous communities:

> "The data available varied from nonexistent to excellent. A few communities had complete sewer maps and atlases which provided location, sizes, slopes and other information needed to analyze their sewer systems. Others had absolutely no information, except that carried in the heads of their sewer superintendent and other maintenance personnel."

The report also noted that some communities had a single map that was updated periodically yet, when reviewed, was found to be very unreliable. EPA officials emphasized that the lack of adequate information on existing systems is a major problem.

Along this line, the "New York Times" in a 1978 article noted:

> "America's large, old cities face a hidden and largely ignored problem under their streets--an unchartered maze of aging water mains, sewer lines and other subterranean facilities that have deteriorated to the point where they threaten public health and safety."

Gather drainage area and rainfall data

Important in reaching a solution is the need to obtain and analyze data on the community's topography and rainfall. Some of this data would include the ability of the ground to absorb moisture, the use of land, frequency and magnitude of precipitation, and the level and characteristics of dry weather flow and wastewater in the sewers.

Optimize existing facilities

The sewage system in many communities has deteriorated over the years due to lack of maintenance and failure to expand as the community develops. Often such systems are filled with silt and debris, thereby reducing the original capacity--sometimes drastically. In such cases, merely cleaning the system may produce excellent results. For example, in one community the consulting engineering firm concluded that a thorough cleaning of the existing system could increase its capacity by 38 percent and might reduce the frequency of combined sewer overflows by the same percentage.

EPA officials noted, however, that while cleaning may be effective for controlling sewer backups, it is not nearly as effective in controlling sewer overflows in a typical system. But many communities have atypical systems. Optimization essentially involves getting the maximum performance out of the existing system without resorting to massive expenditures.

Evaluate and implement alternative approaches

Once the necessary framework has been laid, the community would be able to evaluate and implement the alternative approaches discussed below. However, the community must recognize that, generally, no single alternative by itself is likely to solve the problem.

Structural-intensive solutions

After implementing alternative techniques and evaluating their results, the community would be in a position to determine if more costly structural approaches are required. Such a determination must of course weigh the degree of improvement gained for the cost. One advantage of doing low-cost measures first is that if a structural intensive project is ultimately required, it will likely be scaled down from the original concept because the alternative techniques may well have achieved significant improvements.

WHAT ARE THE ALTERNATIVES AND HOW DO THEY WORK?

Alternatives to structural-intensive solutions range from people running out to place rugs over sewer inlets when it starts to rain to multimillion-dollar computer control techniques. No one method is a panacea for all combined sewer problems, yet a combination of various options may relive a community's problems.

Combined sewer overflows exist in suburban communities such as Golf, Illinois (population 492), as well as metropolises such as Chicago and New York City. Finding solutions in such diverse communities is not easy. For example, rain patterns, terrain, and sewer design all play an important part. Also, regulatory constraints, jurisdictional conflicts, funding limitations, and local attitudes affect a community's approach to the problem. Finally, techniques applicable to newer suburban areas may not be applicable to older, highly developed areas.

Nevertheless, alternatives exist that would enable communities as diverse as Golf and New York City to take a less costly approach to the problem. These approaches are generally categorized by EPA as source control, collection control, and treatment control. However, there is no clear agreement as to whether certain measures are source or collection control approaches. Thus, we may call a certain technique a source control where someone else would classify it as either a collection or treatment control. (App. II briefly discusses many of the various alternatives proposed or tried in the United States, Canada, and Europe.)

Source controls

Source controls include measures and techniques that reduce pollution and flooding by stopping or delaying rainwater from entering a sewage system and by preventing pollutants from entering the combined sewer system. The theory is that if rainwater can be delayed or held back until the collection system can handle it, then pressure on the system will be eased. Also, if pollutants are removed before they enter the system, overflows that do occur will be less contaminated.

Generally, source control techniques are more useful in controlling floods, though EPA recognizes several as having pollution control benefits. Actually any technique that reduces or slows the water entering the system increases the chances that the water will be treated, reducing pollution. Source control is an effective and economical method of control, though the degree of improvement will vary from community to community.

There are numerous source control techniques, ranging from storage ponds to sophisticated restrictors, including

--ponding rainwater in parking lots, grassy areas, etc.;

--street cleaning;

--combined sewer flushing;

--downspout disconnection;

--porous pavement;

--rooftop reservoirs; and

--flood control ordinances; for example, restrictions on building in flood-prone areas.

Some examples of source control techiques are discussed below.

Ponding and storage

According to EPA officials, storing rainwater temporarily on rooftops and in ponds until the collection system can handle the water is seldom considered as an alternative. Essentially ponding and storage involves the use of grassy land, parking lots, factory roofs, etc., as holding basins to slow the inflow of water until the collection system and treatement plants can handle it. Examples include

--designing the parking area of a large shopping complex so the water would pond in a given area, thus slowing the flow into the sewage system;

--directing runoff onto grassy and recreational areas;

--providing small dikes, retention basins, or sodded areas around offices and shopping centers that will fill up during rain and let the water slowly seep into the ground;

--using ordinances to require, as an example, that factory buildings be required to hold on their roofs a specified amount--depending upon structural capability of the building--of water.

Numerous communities have had success with these approaches. As an example, our report on the Chicago tunnel and reservoir plan (CED-79-77) noted that Arlington Heights, Illinois (population 71,000), has emphasized retention basins. About 28 basins have been completed or proposed. An Arlington Heights official commented that these basins have been effective in reducing flooding--problems and complaints have decreased since their construction. Also many of the basins provide recreational benefits, such as boating and fishing, or are part of multiuse facilities which include tennis courts and football fields.

Another example of this approach is the Skyline urban renewal project in Denver, Colorado. The developers of this project were required to temporarily store stormwater falling on their 80-acre project. The purpose was to detain local runoff to reduce overloading of the storm drainage system in the downtown area until tributary areas have been drained. In general, the project encompasses rooftop storage, plaza ponding, and ponding in open spaces and grassy areas. These techniques were considered successful in eliminating a runoff problem.

Street cleaning

In recent years street cleaning has been recognized as a potential water quality control method. A community's street accumulates all kinds of pollutants--litter, dust, dirt, debris, lead from automobiles, and toxic chemicals. When it rains, these contaminants flow into the sewer system. In a combined system, there is a good chance that such pollutants will be swept directly into the sewer, often flowing untreated into waterways through overflow outlets.

Streetsweeping offers a community the opportunity to remove some of these pollutants before they enter the sewage collection system. Its effectiveness will vary depending on such factors as frequency of street cleaning, efficiency of equipment, and street parking regulations. In many communities, streets are swept on a regular basis, such as once per week. For source control purposes it is not necessary to sweep all streets more frequently but rather to sweep streets where pollutants are concentrated.

Like other source control techniques, streetsweeping should be considered as part of a total program. The benefits, while small in total, can make important contributions to communities' efforts. Representatives of a major engineering firm estimated that an effective street cleaning program could remove 3 to 5 percent of pollutants entering urban collection systems.

Downspout disconnections

Most buildings (residences, stores, etc.) have some system to capture and direct rainwater after it hits the building roof. Normally the system includes gutters along the roof edge and downspouts that carry the water either into the sewer system or onto the ground. If downspouts are connected to the sewer system, they empty large volumes of rainwater into it in a short period. Considerable benefits may be realized by disconnecting downspouts from sewer systems and directing them away from the buildings.

A plumber in an area with severe basement backup problems commented that the one thing to be done, if at all possible, is to disconnect downspouts. That way, the water will be delayed from entering the system and will soak into the ground. The benefits would be a reduction in basement backup and a limited reduction of pollution.

Numerous communities have had success with this method. Springfield, Illinois, is a prime example. In the late 1950s, Springfield had a severe sewer overloading problem which caused water to backup into basements. In 1966 the Springfield Sanitary District began a major campaign to disconnect downspouts in the combined sewer area and, as a result, the community significantly reduced backups and combined sewer overflows. For example, 1 year after the program started the community had a 40-percent reduction in complaint calls. Another community we visited estimated that a downspout disconnection program could reduce demand on one section of the sewer system by 49 percent, which obviously would lessen both overflows and basement backups.

The major problem with downspout disconnection programs is political; they are not always popular with citizens. In Springfield's case, local government officials did not want to assume responsibility for the program, so the Illinois Legislature revised existing laws to permit the sanitary district to control the program.

Also, downspout disconnection may not be feasible in some neighborhoods or communities. Where lots are small or there is no way to route the water away from houses or neighboring yards' then it makes sense to keep them connected. Unfortunately, we noted a couple of communities that require downspout connection rather than allowing for flexibility.

Collection controls

This approach encompasses techniques that either modify or better use the existing combined sewer system. Collection controls are designed to increase the flow through the system, thus reducing overflows and flooding. Maintenance and repair are an integral part of such an approach. EPA's 1978 needs survey noted that the key to making this approach work is identifying unknown malfunctions of all types, poorly utilized regulators, unused online storage capacity, and pipes clogged with sediment. According to EPA's report, the first objective in any combined sewer overflow abatement project must be extensive inventory of data and mapping of the sewer system. Unfortunately, many communities skip this step and concentrate on the capital-intensive rebuilding projects.

Collection controls range from simple regulator adjustments to sophisticated, inline computer control systems. Results in the United States, Canada, and Europe indicate that these procedures can substantially reduce overflows. Collection controls include

--various flow reduction techniques, such as regulators, restrictors, and unvented manhole covers;

--remote monitoring and control systems; and

--chemical additions to increase sewer capacity.

EPA officials, in discussing collection controls, commented that while increasing conveyance will alleviate urban drainage problems and reduce overflows within the system, they will not necessarily reduce overflows at the outlets. One of our consultants, however, noted that the key factor in collection control is to understand the specific system in a community.

The following paragraphs discuss in more detail several collection control techniques used successfully by various communities in reducing combined sewer overflows.

Flow regulators

The term "flow regulators" encompasses dozens of specific devices. In general, they either regulate flow into a sewage collection system or, after the water is in the system, they regulate the flow to a predetermined rate.

How do they work? Regulators placed at stormwater inlets control the flow of water into the combined sewer system by decreasing the inlet opening, thus causing the water to pond in streets, parking areas, etc. By preventing or slowing the overload, the sewage system is able to cope with the water, thus preventing overflows and basement backups. Placed at specific points within the system, regulators can act as damming devices to utilize storage space that may be available in the existing sewers.

Flow regulators--particularly sewer inlet restrictors--have been used successfully for years and are considered quite effective within their limitations. One such limitation is that if a storm is severe, the regulator will have only minimal effect as there is a limit to the amount of water a community can pond on its streets.

Both Sweden and Norway have had success with flow regulators. Sweden has developed a new method to use storage space in existing main sewers by installing flow regulators as damming devices in the pipes at certain points in the sewer network. This particular regulator requires no power and has no moving parts. It is mounted in the sewer pipe and has openings that permit or restrict water depending upon the flow. These regulators have been used successfully since 1975 in the Stockholm area.

Certain parts of Oslo, Norway, experience basement flooding from inadequate combined sewers. Flooding was reduced substantially by installing source control restrictors in sewer inlets to limit flow into sewers. These restrictors are stainless steel and custom fitted into catch basins to allow runoff to enter the sewer system at predetermined rates. The restrictors have reduced not only basement backup problems but combined sewer overflows as well.

Remote monitoring and control systems

Some cities have had success with computerized sewer monitoring and control systems. Basically, these systems use existing sewers for storage and are based on the concept that rainfall is not equal over an area. For example, heavy rainstorms frequently move across an area, creating enormous demands on the sewage collection system at one location while placing little demand on the system in another area of the community. Since a typical combined sewer collection system is only 10 to 15 percent full during dry weather, excess capacity usually exists. A remote monitoring and control system takes advantage of this situation.

Seattle is perhaps the best example of the success of remote monitoring and control systems. The Metropolitan Seattle service area has 106 combined sewer points, all located within the Seattle city limits. During storms, combined sewage and stormflows exceeded the capacity of both local sewers and interceptors, resulting in widespread overflows and flooding. Overflows were occurring in Seattle about 40 times per year. In 1974 Seattle started operating a computer-augmented treatment and disposal system. The system includes remotely controlled regulators, pumping stations, and a control room with a display map. Monitoring equipment measures the depth of flow in an interceptor, the position of the regulator gates, the occurrence of overflows, etc. By manipulating gates either manually or automatically, the system can direct the flow to certain sections, thus creating additional capacity. This system, together with some sewer separation, has eliminated most sewage backups and reduced overflows to waterways by 50 percent, from 2 billion to 1 billion gallons per year.

Friction-reducing agents

Another technique is the application of polymers as friction reducing agents to increase flow capacity within a sewer system. (Polymer is a water-soluble chemical that becomes very slippery when wet and is effective in reducing wall friction in a sewer pipe, thereby allowing increased flow.) This technique enables the system to handle more water, which reduces combined sewer overflows and basement backup flooding.

Polymers have been used in Dallas, Texas, since 1973. While Dallas does not have a combined sewer system, the basic concept could apply in any system. In Dallas during periods of high sewer flow, polymers are automatically injected into the sewer system. Officials estimate that the use of polymer has doubled flow rate through the pipes and significantly reduced overflows and some flooding in the area of Dallas where it has been used.

Treatment controls

Treatment controls involve devices that treat water at the overflow point and regulate the quantity of water from overflow outlets. Thus, treatment controls generally are concerned with pollution and have only limited impact on flooding. EPA's 1978 needs survey classifies offline storage devices as treatment controls, though others would say such devices are source controls. Offline devices are designed to hold large, intermittent volumes of stormwater for controlled release into treatment facilities.

Only a few types of devices are used to treat water at the overflow outlets; these include swirl regulators, teacup helical concentrators, separators, and high rate filtration devices. Offline devices include various types of holding basins and tanks.

Swirl and helical concentrators normally are located near the overflow outlet and basically provide primary treatment--the separation of solids from wastewater. The flow is directed in a circular pattern or through screens to separate the solids from the water. The result is a large volume of clear (solids are missing) overflows and a low volume of concentrated waste that can be routed to the treatment plant.

These devices have received mixed reviews. In England and France they have not proved effective in reducing pollution. In England a helical bend regulator was unable to remove sufficient solids, whereas in France the swirl regulator pumps could not handle heavy sludge and grit. In contrast, an EPA report on a swirl regulator, based on a prototype installation in Syracuse, New York, concluded that the device can function efficiently over a wide range of combined sewer overflow rates and can separate settleable light weight matter and floatable solids at a small fraction of the time normally required for primary separation. EPA also concluded that the device shows outstanding potential for providing quality and quantity control.

Offline storage devices include storage basins, tanks, and tunnels that are constructed to store water that the system cannot handle during rainfall. When treatment capacity becomes available, this stored water is then pumped into the system and treated.

ALTERNATIVE TECHNOLOGY--THE CHANCE FOR SIGNIFICANT SAVINGS

While each of the alternative techniques has been successful in numerous communities, very few communities have attempted to solve their combined sewer problem through the complete BMP approach. These techniques offer the chance for significant improvement at a low cost. The following two cases illustrate both the promise and the problem of alternative approaches.

<u>Rochester, New York</u>

Rochester, New York, is a city of approximately 263,000 located in western upstate New York. The community has a serious sewer backup problem plus extensive combined sewer overflows--as many as 70 per year--particularly on the Genesee River. The combined sewer overflows are a major factor in the Genesee River and Irondequoit Bay failing to meet State water quality standards.

The consulting firm for Rochester is investigating BMP as a way to approach the problem. In explaining their rationale, the consultants noted that in light of the considerable capital and operating costs associated with capital-intensive storage/treatment alternatives, BMP offers a very attractive solution to the problem.

The consultants concluded that a rational and cost-effective solution was possible by focusing on the source of pollutants and their means of conveyance. This approach would involve application of source and collection system management. They recommended the following source and collection measures as a first phase:

--Improve sewer maintenance.

--Increase streetsweeping in certain areas.

--Install porous pavement in selected areas.

--Implement erosion control measures.

--Improve the main conveyance interceptor leading to a treatment facility.

--Adjust regulators.

The consultants concluded that, in this case, BMP offers the following advantages:

--Addresses pollutant reduction at the source.

--Provides for a more cost-effective solution.

--Ensures greater reliability.

--Involves less intensive allocation of resources.

--Emphasizes optimal performance of existing system.

--Leads to a quick solution.

The following table compares the costs and benefits of the BMP solution with those of a proposed structural intensive tunnel solution.

	BMP	Tunnel
Cost	$12 million	$300 million
Reduction in annual volume of combined sewer overflows	65-70 percent a/	98 percent

a/During the more intense rains, those occurring about one to six times per year, BMP would handle only 10-15 percent of the wastewater as opposed to the tunnel solution, which would remove approximately 98 percent of the wastewater.

The BMP approach is currently being implemented in Rochester as the first phase of a program to clean up the Genesee River and the Rochester Embayment of Lake Ontario, and reduce basement backup. However, since the BMP approach is not as effective in controlling pollutants from intense rains, Rochester still plans to pursue the structural solution of tunnels, interceptor sewers, and treatment plant upgradings because they are necessary to meet water quality goals. Also, the structural solutions will be much more effective in solving basement backup problems. Rochester officials feel that while the BMP approach is important and effective, it cannot provide the degree of relief needed.

The consultants noted that implementing BMP concepts will reduce the combined sewer overflow problem 6-7 years before the structural solution is completed. Further, if total program funding is halted, BMP offers a lower cost solution to reduce the problem.

York, Ontario

The borough of York is a Toronto, Canada, suburb with a population of 140,000 and covers about 9 square miles. York is one of six municipalities that make up the Metropolitan

Toronto area. York has a combined sewer system and in the past has suffered from severe sewer backup along with combined sewer overflows that pollute the Humber and Don Rivers.

In 1968, following a consultant's recommendations, York embarked on a $50 million 1/ program to control flooding and pollution following the traditional philosophy of a structural-intensive solution of sewer separation and storm sewer enlargement. From 1968 through 1976, York spent an average of $646,000 per year, or 22 percent of its annual budget, on this project.

By 1976 the borough council became quite concerned about the tremendous cost of the project and engaged an engineering firm to find an alternative solution. This firm studied four chronically flooded areas and determined that the conventional method of relief sewers was far too costly. A borough official concluded that for these four areas alone it would cost in the millions to provide relief by conventional means, such as additional sewer capacity and tunnels. As alternatives to the traditional construction, the consultant suggested

--using regulators in catchbasins,

--constructing limited-storage underground tanks, and

--either disconnecting downspouts, or installing restrictors in the downspouts

Under this approach, when sewer system capacity is exceeded, stormwater would be temporarily stored in underground tanks or on the surface for slow release into the system. The consulting firm concluded that for $110,000 this approach would provide protection against a 2-year storm. Further, for $830,000, protection could be achieved against a 10-year storm.

York opted for the 10-year storm protection and accepted a final cost of $987,633. The alternative approach was completed in October 1978, except for installation of restrictors in the downspouts.

1/Canadian dollars. All dollar figures shown for York are expressed in Canadian dollars.

Since that date, York has had two fairly intensive storms which, according to a York official, represent a good test of the approach. So far, the system has worked effectively; no flooding problems have been reported in the four areas, while numerous complaints have been received from residents in other areas of York.

CONCLUSION

These case studies illustrate both the promise and the difficulty of alternative technology. Simply put, alternative approaches generally will not provide the same level of relief as the more costly solutions. Yet they are usually less costly to implement. Each community must face a choice like Rochester's: Is it best to eliminate 65-70 percent of the problem for $12 million or 98 percent for $300 million? The answer depends upon one's perspective.

We have taken the position that, in the interest of economy, it may be necessary to introduce flexibility into the Nation's water quality goals. In those instances where alternative approaches offer adequate solutions--that are less costly than a total solution--these approaches should be followed. After trying the alternatives, a community can assess whether the additional cost of a structural project is worth the final degree of improvement.

CHAPTER 4

OBSTACLES TO OVERCOMING

THE COMBINED SEWER PROBLEM

To overcome the Nation's combined sewer problems, a number of barriers must be addressed. While EPA has identified, categorized, tested, demonstrated, and published information on numerous alternative techniques to control combined sewer overflow pollution, there still seems to be a reluctance to use these techniques. Some communities have had success using a BMP approach that incorporates many of the alternative techniques, but others have found it easier to propose large, costly, structurally intensive solutions rather than to try to be cost effective.

Obstacles that must be dealt with before the Nation can make inroads on the pollution and flooding caused by combined sewers include the

--inflexibility of water quality goals,

--bias toward large-scale projects,

--low priority given combined sewer projects by EPA, and

--lack of clear demonstration, on a system-wide basis, of alternative technology's overall effectiveness.

Community officials also expressed concern about the lack of Federal involvement in flooding caused by combined sewers.

INFLEXIBILITY OF WATER QUALITY GOALS

The Federal Water Pollution Control Act (Public Law 92-500), as amended, provides for an interim national goal by 1983, wherever attainable, of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water. This is often referred to as the "fishable/swimmable" goal. Each State has the responsibility, subject to EPA approval, to set usage classifications for each body of water in the State, bearing in mind the Nation's goal. States vary in the stringency of their classifications. For example, Illinois' lowest classification provides that, as a minimum, all waterways should permit "secondary contact." 1/ New York, on the other hand, classifies certain waterways essentially as industrial channels when the cost of cleaning up a stream would be prohibitive. The difference in classification can make dramatic differences in costs required for pollution control in a waterway.

As a general rule, less costly alternative approaches singularly or in total will not achieve the degree of cleanup that can be expected from the large-scale projects. Thus, to meet State water quality goals, a community must often turn to large-scale construction projects.

An example of this situation is the Chicago metropolitan area. The Metropolitan Sanitary District of Greater Chicago has devised an expensive, structurally intensive plan to control flooding and eliminate pollution. The district holds that while alternative technology merits consideration and can provide some relief, there is no way that such technology can provide the improvement needed to meet Illinois' water quality standards. Thus, district officials feel that the law mandates that they follow whatever approach is necessary to meet water quality goals. This same scenario could be played out in dozens of other communities.

BIAS TOWARD LARGE PROJECTS

The Nation's approach to solving the combined sewer problem has often been to use "brute force." Big projects are built because that is the way things have traditionally been accomplished. Some biases show up in the reluctance to turn to less costly alternative approaches. These include

--EPA's tendency to favor capital-intensive projects;

--architectural and engineering firms' tendency to favor large projects, since their fee is tied directly to a project's cost; and

--the fact that some alternative techniques are ineligible for EPA funding.

1/Contact with the water is incidental or accidental, and the probability of ingesting appreciable quantities of water is minimal. This water use will not permit swimming but protects idigenous aquatic life and allows boating, fishing, and shoreline activities.

Capital-intensive projects are favored

EPA officials recognize that combined sewer solutions tend to be costly, structurally intensive projects. However, they base their position on the complexity of combined sewer problems and the fact that often only a large, capital-intensive project will enable a community to meet water quality goals. EPA officials commented that just because a project is expensive does not mean it is not cost effective. The key, in their opinion, is whether it is the most cost-effective solution available to meet water quality goals.

We did find, however, that EPA is giving greater emphasis to less costly solutions. Yet, at the same time, EPA is approving costly structural projects in other communities. One of our consultants noted that inconsistencies exist between EPA regions in the degree they favor the use of smallscale technology.

Architectural and engineering firms prefer large projects

One of the obstacles to less costly approaches is the influence of architectural and engineering (A/E) firms. Most communities are not able to design sewage collection projects without assistance from firms that have experience in this area. Until December 1975 EPA had no regulations governing the type of contracts communities could use when acquiring design services under EPA grants. Instead, EPA had issued two guidance memos stating its preference for fixed-price, per diem, and cost-reimbursement contracts. The guidance memos, according to EPA, were not enforceable. As a result, most contracts were awarded on the then-standard industry practice--percentage-of-cost type contracts. 1/ Such contracting practices did not provide any incentive to reduce costs because profits escalated as costs escalated.

In December 1975 EPA changed its guidelines to tighten procedures and provide for more control over costs. However, the basic problem remains; the A/E firms have no incentive to recommend less costly solutions to a community's problems. EPA officials recently commented that many combined sewer projects are expensive because A/E firms' fees are based on a project's overall cost. Although the fee is no longer in

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1/A contract whereby the A&E firm's fee would be a stated percentage of the total cost.

direct proportion to the cost of the project, it is still relative to the size of the project. EPA also recognized in its guidelines accompanying the innovative and alternative provisions of the Clean Water Act of 1977, that engineers have traditionally favored structural solutions.

The American Consulting Engineers Council (ACEC) had some disagreement with our position on A/E firms. Specific comments included:

--A/E firms tend to favor reliable structural projects because their reputation may be damaged if the project does not work up to specifications.

--A/E firms recommend large projects when capital funds are available to build them, which is not the same as "A/E firms like large projects," as stated by GAO.

--A/E firms have been consistently discouraged by EPA's interpretation of Federal law from designing anything less than "once-in-a-lifetime solutions" to pollution problems. The heretofore easy availability of Federal moneys held out as an inducement to comply with the law has also contributed to the selection of structural solutions.

--A/E firms' primary objective is to solve a community's problems, and many communities are beginning to realize that Federal funding is no panacea if it produces long-range operating and maintenance costs in exchange for capital subsidization of the basic project.

--EPA's contention that projects are expensive because A/E firms are paid their fees based on the project's overall cost is not valid.

--Engineers have traditionally supported reliable and cost-effective solutions and have recommended structurally intensive solutions when they are the only alternatives available.

Some alternatives are ineligible for Federal funding

The Clean Water Act authorizes EPA to make grants for the construction of publicly owned treatment works. The act defines treatment works as any devices or systems used to store, treat, or recycle and reclaim municipal sewage or liquid industrial waste. Included are interceptor sewers, outfall sewers, sewage collection systems, etc.

EPA officials emphasized that the act provides funding for construction-type projects only. In contrast, BMP makes extensive use of approaches involving nonstructural or limited structural approaches, such as sewer cleaning, street-sweeping, instream aeration, parking lot ponding, and down-spout disconnection. EPA officials also commented that many BMP techniques, such as sewer maintenance, should properly be funded by local communities. While EPA would favor funding of some BMP techniques, such as instream aeration, it would not want to get involved in funding operating and maintenance (O&M) costs. One primary reason is the lack of funds to assume a role in O&M costs.

COMBINED SEWER PROJECTS RECEIVE LOW PRIORITY

EPA's policy is that combined sewer overflows are not discharges from treatment plants and therefore are not subject to the secondary treatment requirement. Nevertheless, since such overflows are a major source of pollution, EPA has issued guidance detailing the circumstances under which municipalities may receive grants for treatment and control of combined sewer overflows.

According to EPA funding assistance may be granted if:

--Funds have already been made available for secondary treatment of sewage under dry weather conditions.

--Combined sewer overflow abatement is needed to protect the beneficial uses of receiving water.

--The combined sewer overflow control method has been found to be the most cost-effective means of protecting the beneficial uses of receiving water. This analysis should compare the costs and benefits of reduced pollution so the optimum size of the project can be determined.

--Costs for pollution control are separated from flood control aspects. EPA will not fund flood control projects even when the flooding (sewer backup, street, and viaduct) is caused by inadequate combined sewers.

EPA requires that funding priority be given to constructing new or upgrading existing treatment facilities to secondary treatment levels before combined sewer projects can be funded. EPA's rationale for this requirement is that municipal and industrial pollution is the greatest direct threat to water quality. Consequently, EPA feels that pollution control municipal treatment facilities offer the best cleanup potential since they focus on the larger problem. They also note that upgrading treatment plants can be accomplished more readily, whereas combined sewer overflow correction may require broad regulatory and institutional changes.

However, EPA has recently placed increased emphasis on combined sewer overflows. In a June 14, 1979, memorandum the Deputy Assistant for Water Programs commented:

"The Agency is concerned that the status of planning and design for correction of CSO (Combined Sewer Overflow) is lagging. The work must receive more detailed attention at all stages and must proceed at a faster rate than is now the case in order to contribute to the achievement of fishable, swimmable water goals of the Clean Water Act."

EPA regions were requested to expedite facility planning (step 1 grants) for combined sewer needs with highest priority given to the 77 metropolitan areas with over $50 million in combined sewer overflow needs. Regions were also requested to encourage States to include step 1 combined sewer projects for other metropolitan areas and withhold, beginning November 1, 1979, step 2 (design) or step 3 (construction) grants until the grantee initiates needed combined sewer planning. (See p. 8 for an explanation of EPA's grant process.)

The net effect of EPA's actions, if followed through, will be to focus increased attention on the combined sewer problem. However, the initiation of step 1 planning does not guarantee that the community will receive funding to accomplish the combined sewer project that might be proposed in the facility plan. State priority lists control funding, and, despite this memorandum, secondary treatment plant needs still have priority over combined sewer projects. In a number of States, secondary treatment needs far exceed available funds. Further, the cost of a number of combined sewer projects far exceed available

EPA resources, making funding difficult even if emphasis is given to such projects. EPA officials agree that funding could be a problem; however, they want to encourage States to get combined sewer projects underway.

EPA estimates that approximately $25 billion in secondary treatment plant construction or upgrading remains to be funded. Given this situation, despite EPA's increased emphasis, it appears that the combined sewer problem will receive only limited funds. Thus, solutions to the problem may be long in coming.

OVERALL EFFECTIVENESS OF ALTERNATIVE TECHNOLOGY HAS NOT BEEN DEMONSTRATED

The Chief of EPA's Storm and Combined Sewer Section, Wastewater Research Laboratory, noted that while individual alternative techniques have been proven in many communities, no community has attempted a systematic approach using only alternative technology. Given this situation, communities are reluctant to try such an approach since they cannot see a clear demonstration of its success.

Another aspect of this problem is the difficulty found in moving alternative technology from the laboratory to actual practice. Even though EPA is developing many of these technologies through its research, it does not require that alternative technology be considered in the construction grant process. EPA research and development officials commented that, while EPA is starting to stress alternative technology, the trend is slow. They note that EPA regulations do not require and do not force communities to consider alternative techniques.

EPA officials also recognize that a gap exists between research and development and the actual use of such techniques by communities. However, they feel that many of these techniques have not been fully proven on a wide scale and communities are reluctant to try solutions that may not work. This is a virtual "catch-22" situation: if alternative techniques are not promoted, they will never be used; if they are never used, they will never be promoted.

THE FEDERAL INVOLVEMENT IN FLOODING

From a community's perspective, one stumbling block to solving combined sewer flooding problems is the lack of a Federal role. EPA, the primary agency responsible for combined sewers, cannot fund flood-related portions of a project. While the Army Corps of Engineers has been the one agency primarily involved in flooding, an agreement with the Office of Management and Budget prohibits it from becoming involved in combined sewer flooding.

When considering solutions, local municipalities would prefer to approach the combined sewer problem from an integrated perspective. EPA can participate in a project that tackles both pollution and flooding as long as it limits its participation to costs allocable to the pollution aspects of the project. In reality, however, because EPA cannot get involved in flooding aspects, projects are artificially divided into separate pollution and flood control projects, which is not always the most efficient way to do things.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Combined sewer overflows are a significant source of waterway pollution, particularly in the urban areas of the Midwest and Northeast. They are also a prime cause of flooding in many communities. Numerous well-known waterways will be unable to meet water quality standards unless the combined sewer overflow problem is resolved.

It is becoming evident that the combined sewer problem is not being resolved quickly. For example, in Chicago it is estimated that it would be 1990 at the earliest before the problem can be solved, and that date is predicated upon extensive Federal funding which may not be forthcoming. Some cities have not even completed studies on what they plan to do about the problem. For example, Washington, D.C., does not anticipate completing its study until 1981. The time between completion of studies and solutions is measured in years, not days.

EPA estimates that it will cost almost $26 billion to solve just the pollution aspects of the combined sewer problem; we believe that even that figure is low. Elimination of urban drainage (flooding) problems caused by combined sewers is estimated by EPA to cost another $62 billion, while others say it will be more than $100 billion. Current Federal authorization for all forms of construction for waterway pollution problems is anticipated to be $3.4 billion annually. Since 1972, EPA estimates that it has spent, through October 1979, approximately $2.1 billion on the combined sewer overflow problem. During fiscal year 1979, EPA spent an estimated $690 million on combined sewers. Given this level of spending, the Nation can never catch up. Inflation at 7.5 percent annually would require expenditures of about $2 billion annually to stay abreast of the problem.

One reason for the low level of EPA support for combined sewer projects is EPA's requirement that funding priority be given to constructing new or upgrading treatment facilities before combined sewer projects can be funded. Since EPA estimates that another $25 billion is needed for treatment plant construction or upgrading, the solution to combined sewer problems is a long way off.

Flooding from combined sewers is considered to be a local problem that must be solved by local communities using their own resources. Local communities feel they do not have the resources to attack the problem. Local officials point out that in combined systems flooding and pollution are caused by the same pipe and it is difficult and costly to devise separate solutions for the problem. But that is what EPA attempts to do. EPA, by law, can only fund pollution projects so it developed a method to determine the pollution control portion of a project. The portion applicable to flooding is thus separated, and often nothing is done since many community officials feel that they do not have resources to fund it on their own.

The current approach to solving the problem relies on structurally intensive solutions. Structurally intensive can also be translated as high cost. This approach simply is not working, as the funds in the magnitude required are not available. In the Clean Water Act of 1977, the Congress encouraged the use of alternative technology to solve the problem, as it was recognized that alternative techniques offer a lower cost solution and thus provide the opportunity to make better use of our resources.

Unfortunately, while proven alternative techniques abound, they are not widely used for a variety of reasons, including the

--inflexibility of water quality goals,

--bias toward large-scale projects, and

--lack of clear systemwide demonstration of the overall effectiveness of alternative technology.

Perhaps the problem with water quality goals is the most difficult. In pursuing the Nation's goal of fishable/swimmable waters by 1983, the Congress has left it to each State, subject to EPA approval, to set usage classifications for each body of water in the State. This has led to some interesting situations. A waterway in one State might be classified as fishable/swimmable, whereas if it were in another State it might be set at a lower classification. A difference in classification can result in wide cost variations for cleanup.

EPA policy requires that the cleanup strategy adopted must be the most cost-effective strategy to meet the State's standards--not the most cost-effective strategy in the degree of improvement or cleanup. The Chicago tunnel and reservoir project clearly shows this situation. To achieve the goals intially established for the project virtually dictates a large structurally intensive solution. Such an approach tends to rule out lower cost alternative approaches, such as BMP.

What clearly is needed is a way to bring about a lower cost solution without losing sight of our national water quality objectives. At the same time, we must recognize that Federal funds, given the extensive demands of various programs, are not limitless and it would be unrealistic to assume additional Federal funding will be available. Thus, we are not advocating massive new Federal spending programs for pollution and flooding. Rather, we feel that a new aproach needs to be taken so that both problems can be addressed more efficiently.

We feel that best management practices as broadly defined, provides the Nation with the opportunity to get more "bang for the buck." This approach carefully considers low-cost alternative approaches first and then, only if required, considers structurally intensive solutions. Such an approach gives some improvement much quicker than the large-scale approach, and if structurally intensive solutions are ultimately required to meet water quality goals they may be smaller and less costly.

The Congress and EPA are moving in this direction, yet far too many communities and architectural and engineering firms that serve the communities still think in terms of high-cost, structurally intensive solutions. Also, as we have pointed out in testimony 1/ and a previous report, there is a need to provide flexibility in water quality goals that will permit less costly solutions. We are not saying abandon the goals, only that cost must be an important consideration in deciding a strategy.

1/Comptroller General testimony before Subcommittee on Investigations and Review, House Committee on Public Works and Transportation, July 11-13, 1978.

RECOMMENDATIONS

We recommend that the Congress amend the Federal Water Pollution Control Act of 1972 to

--allow for increased flexibility in meeting water quality goals in those cases where it is determined that the cost to achieve such goals is prohibitive;

--allow EPA to fund lower cost nonstructural or limited structural techniques that cannot be funded under current legislation and that are not normally considered operating and maintenance costs; and

--permit Federal funding of flood projects when (1) the flooding is caused by combined sewer systems and (2) the solution is part of a total approach designed to minimize both pollution and flooding in the combined system.

We also recommend that the EPA Administrator:

--Mount a vigorous program of promoting less costly solutions and educating A/E firms, States, communities, and the public on the need for them.

--Require that communities adopt a lower cost approach, including maximum use of innovative and alternative techniques, before funds will be granted for costly structural solutions.

--Develop guidelines outlining an approach that should be followed in combating the combined sewer problem. Such guidelines should, among other things, emphasize BMPs and provide comprehensive guidelines for using alternative techniques.

--Speed the transition of proven new technology from the research and development stage to the construction grant stage.

AGENCY COMMENTS

We received oral comments from EPA on the material presented in our draft report and changes were incorporated, where appropriate, into the final report. EPA generally agreed with the thrust of the report and its recommendations, except for the third recommendation to the Congress.

EPA officials commented that they felt the current Federal policy of no EPA involvement in flooding is correct and that urban flooding should be considered a local problem. EPA officials further stated that, if they got involved in urban flooding, the large costs associated with that problem would dilute the limited funds available to fight water pollution.

While we agree that involvement in flooding would dilute available Federal funds, we believe that it is more efficient to design a single project that attacks both the pollution and flooding problems caused by combined sewer systems. Thus, while we are sympathetic to EPA's concerns, we believe that in the long run the nation would be better served by a policy that would help communities attack both flooding and pollution caused by combined sewers with a single project.

COMMUNITIES WITH COMBINED OR PARTIALLY COMBINED SYSTEMS

State	Number of communities	State	Number of communities
Alabama	-	Missouri	11
Alaska	2	Montana	11
Arizona	-	Nebraska	2
Arkansas	-	Nevada	-
California	4	New Hampshire	22
Colorado	3	New Jersey	17
Connecticut	14	New Mexico	-
Delaware	5	New York	84
District of Columbia	1	North Carolina	3
Florida	1	North Dakota	8
Georgia	6	Ohio	127
Hawaii	-	Oklahoma	-
Idaho	14	Oregon	34
Illinois	109	Pennsylvania	107
Indiana	135	Rhode Island	2
Iowa	19	South Carolina	-
Kansas	3	South Dakota	13
Kentucky	16	Tennessee	3
Louisiana	-	Texas	1
Maine	62	Utah	2
Maryland	11	Vermont	30
Massachusetts	34	Virginia	12
Michigan	115	Washington	34
Minnesota	21	West Virginia	49
Mississippi	3	Wisconsin	28
		Wyoming	1
Total			1,179

Note: The above represents the best data available from EPA. However, EPA officials acknowledge that there are more communities with combined systems than are shown. The understatement is caused by urban areas where one sewer district may serve many communities but EPA records often will show only the principal community.

LIST OF APPROACHES FOR CONTROLLING COMBINED SEWER PROBLEMS

SOURCE CONTROLS

1. Site Grading, Planting of Trees, Elimination of Curbs.

<u>Description</u> - Grading of sites to increase flow distances, use of trees to intercept rainfall, and elimination of curbs along secondary roads to permit waterflow over shoulder will tend to dampen the peak runoff. Use of swales or entire shoulders for flow of stormwater will increase the opportunity for infiltration into ground.

<u>Advantages</u> - Reduce peak rate of runoff. May reduce pollutant concentration, and the low velocity of flow will allow particles to settle. Low cost. Enhances urban esthetics.

<u>Disadvantages</u> - Difficult to implement in already builtup areas. Will require change in building and/or drainage codes.

<u>Reference for additional information</u> - Metcalf & Eddy, Inc., "Urban Stormwater Management & Technology - An Assessment," EPA 670/2-74-040.

American Public Works Association, "Practices in Detention of Urban Stormwater Runoff," Special Report No. 43, 1974.

APPENDIX II

SOURCE CONTROLS

2. Aeration of Lawns.

Description	-	Periodic perforation of lawns can be used to increase infiltration. This practice has been used on golf courses as a means of increasing infiltration and aeration on fairways. Urban lawns have a very low infiltration rate due to mixing and compaction associated with construction activity and the heavy human use after development.
Advantages	-	Economics are very favorable.
Disadvantages	-	Limited to suburban areas having large lawns.
Reference for additional information	-	USEPA, "Processess, Procedures and Methods to Control Pollution - From All Construction Activity," EPA 430/9-73-007, March 1973.

SOURCE CONTROLS

3. Porous Pavement.

Description	-	Porous pavement developed with the objective of highway safety is useful in stormwater management. The pavement allows water to penetrate through it and be temporarily stored in the underlying layer of ordinary gravel. The water slowly filters from the gravel into natural soil.
Advantages	-	Highways using porous pavements are more economical than conventional highways with storm sewers. Highway safety. Preservation of vegetation. Augmentation of ground water.
Disadvantages	-	Needs further testing. May be problematic in cold climates.
Reference for additional information	-	Franklin Institute Research Laboratories, "Investigations of Porous Pavements for Urban Runoff Control," EPA 11033 DUY, March 1972. Rice University, "Maximum Utilization of Water Resources in a Planned Community," EPA Project. Everhart, R.C., "New Town Planned Around Environmental Aspects", Civil Engineering, Vol. 43, No. 9, September 1973.

SOURCE CONTROLS

4. Retention/Detention Basins and Ponds.

Description - Retention basins and ponds provide stormwater storage and result in attenuation of peak flows as well as enhancement of urban environment. Detention basins store stormwater and are emptied at a controlled rate. In both cases excess stormwater is allowed to escape through an emergency spillway.

Advantages - Results in substantial reduction of drainage costs (30 to 60 percent of the cost of conventional drainage systems). Recharges ground water. Costs of basins are low - $300,000 to $700,000 per million gallon-a-day capacity. Reduces chances of street flooding. Improves water quality.

Disadvantages - Several basins will be required. Will need maintenance for removing solids.

Reference for additional information - USEPA, "Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity," EPA 430/9-73-007, March 1973.

USEPA, "Urban Runoff Pollution Control Technology Overview," EPA 600/2-77-047.

Hittman Associates, "The Beneficial Uses of Stormwater," EPA R2-73-139, January 1973.

SOURCE CONTROLS

5. Temporary Inundation of Natural and Recreational Areas.

Description - Recreational areas and other natural areas such as floodways can be used for temporary storage of runoff from adjacent areas. Because of grass cover, recreational areas have high infiltration rates. To minimize aftereffects, the areas should be designed to drain thoroughly. In addition, the grass should be tolerant of periodic inundation.

Advantages - Very low cost.
Can improve visual esthetics.

Disadvantages - Temporary inconvenience to users.

Reference for additional information - McLaughlin, R.C., "Urban Storm Drainage Criteria Manual," Wright-McLaughlin Engineering, March 1969.

Anonymous, "Flood Channels Doubles as Golf Course," Civil Engineering, May 1972.

Urban Technology Associates, "Jordan River Parkway," Consulting Engineer, June 1972.

SOURCE CONTROLS

6. Rooftop Ponding.

Description - Stormwater may be temporarily stored on a flat or slightly sloping roof equipped with detention drains. The drainage outlets are usually designed to release approximately 1/2 inch of water per hour. Approximately 3 to 6 inches of water can be impounded on the roof. To prevent excessive ponding, the outlets are equipped with overflows.

Advantages - Most roofs are designed for a load of 40 pounds per square foot (equal to the weight of 8 inches of water). The approach has favorable economics for industrial and commercial areas, which usually have flat roofs. Water can be used for other purposes--cooling, fire prevention, washing.

Disadvantages - Must be maintained properly to avoid overloading of roofs.

Reference for additional information - Chiang, S.L., "A Crazy Idea on Urban Water Management," Water Resources Bulletin, Vol. 7, No. 1, February 1971.

Shaeffer, J.R., "Stormwater for Fun and Profit," Water Spectrum, Vol. 2, No. 3, Fall 1970.

SOURCE CONTROLS

7. Dry Wells/Linear Dry Wells (Infiltration Systems).

Description - In suburban areas where flat roofs are not possible, dry wells have been used to receive water from roof drains. Infiltration systems (linear ditches dug along highways and filled with stone) are used to control runoff from highways.

Advantages - Results in recharge of ground water. Reduces street flooding and sewer surcharges. Enhances streamflow during low-flow periods.

Disadvantages - Possible contamination of ground water. Requires adequate design and maintenance to prevent frequent clogging.

Reference for additional information - USEPA, "Processess, Procedures and Methods to Control Pollution Resulting From All Construction Activity," EPA 430/9-73-007, March 1973.

SOURCE CONTROLS

8. Parking Lot/Street Ponding.

Description	-	Temporary storage on a remote section of the parking lot can be accomplished by reducing the size of the storm drain inlet, increasing the spacing between inlets, or installing depressed sodded areas. Significant ponding can be achieved in streets by having streets with high crowns or sides.
Advantages	-	Approach is economically very favorable. Reduces peak flow to sewer.
Disadvantages	-	May cause slight inconvenience to the public. Will require change in design codes.
Reference for additional information	-	USEPA, "Processes, Procedures and Methods to Control Pollution Resulting From All Construction Activity," EPA 430/9-73-007, October 1973. USEPA, "Urban Runoff Pollution Control Technology Overview," EPA 600/2-77-049, March 1977.

SOURCE CONTROLS

9. Implement Water Conservation Measures.

Description - This approach includes requiring use of low-flow toilets, fittings for existing toilets, compost toilets, low-flow shower heads, sink faucet aerators, and other water conservation devices. Implementation is achieved through revision or addition to existing town/city plumbing codes and a public education program. This approach would also apply to commercial and industrial establishments, especially high water users such as carwashes.

Advantages - Decreases flow to sanitary sewers and leaching fields. Decreases water consumption. Decreases energy use. Relatively inexpensive. Relatively easy to implement for new buildings. Saves $68 to $137 per house per year, mostly in energy savings.

Disadvantages - Residents will incur costs. Difficult to implement for existing residences, commercial buildings, and industry. Costly for existing buildings.

Reference for additional information - Witt, Michael D., "Water Use In Rural Homes, Small Scale Waste Management Practices," University of Wisconsin, Madison, 1974.

Siegrist, Robert L., et al. "Conservation and Wastewater Disposal," ASAE Publication 5-77, St. Joseph, Michigan 1977.

SOURCE CONTROLS

10. Use of Marshland.

Description - Research has shown that controlled retention of stormwater in marshes results in better vegetative conditions and also enhanced removal of nutrients from stormwater.

Advantages - Preserves marshland. Removes pollutants from stormwater.

Disadvantages - Could pose a health hazard due to accumulation of organic matter and bacteria.

Reference for additional information - EPA Demonstration Project No. 80315, No. 80315, "Evaluation of Stormwater Treatment Methods," Minnehaha Creek Watershed District.

APPENDIX II

SOURCE CONTROLS

11. Stream Channel Storage and Control.

Description - This approach includes measures which detain or retard flow in the stream channels and/or its floodplain. Inchannel measures include increasing flow distance by creating meanders and reduction of velocities through use of check dams or weirs. Side-channel measures include construction of a side-channel parallel to the main channel, which carries stormwater during large storms. Offchannel measures include temporary or permanent impoundments.

Advantages - Possibilities of creating recreational opportunities in an urban area.

Disadvantages - Could be expensive. Will require maintenance and removal of debris and silt.

Reference for additional information - Bartels, Robert M., USDA Soil Conservation Service, "Increase Runoff With Changing Land Use," prepared for Stormwater Detention Design Conference, Hinsdale, Illinois.

Lindley, R.W., "Engineering Design of Detention Facilities," prepared for Stormwater Detention Design Conference, Hinsdale, Illinois.

APPENDIX II

SOURCE CONTROLS

12. Streetsweeping.

Description - Sweeping of streets removes solid contaminants from street surfaces which are washed off by stormwater runoff. Usual broom-type sweepers are reported to remove up to 50 percent of solids (dry weight), while more advanced vacuum-type sweepers may remove up to 93 percent solids by weight.

Advantages - Low cost; costs estimated at $3 to $13 per curb mile, or about $0.75 per acre, or $2 to $12 per pound of biochemical oxygen demand (BOD) expected to be removed. Urban cleanliness.

Disadvantages - Difficult to implement; most contaminents are found near the curb, which cannot be swept if cars are parked along the street in violation of parking regulations. Does not reduce flows to sewers.

Reference for additional information - U.S. Environmental Protection Agency, "Urban Runoff Pollution Control Technology Overview," EPA 600/2-77-047, March 1977.

The Center for the Environment and Man, Inc., "The Upper Housatonic 208 Water Quality Plan," November 1976.

SOURCE CONTROLS

13. Disconnection of Downspouts and Other Sources of Inflow.

Description - This approach includes the enforcement of existing sewer use ordinances and the implementation of new use ordinances, as outlined in the "Manual of Practice No. 3" published by the Water Pollution Control Federation in 1975, to require the disconnection of roof leaders, yard drains, and other sources of inflow into sewers.

Advantages - Reduces flows to combined sewers during rainfall events. Reduces cost to operate pumping stations and treatment plants. Improves water quality.

Disadvantages - Costs: about $300 per house. Users must find alternative methods of discharging the inflow.

Reference for additional information - Federal Water Pollution Control Federation, "Manual of Practice No. 3", 1975.

American Public Works Association, "Practices in Detention of Urban Stormwater Runoff," Special Report No. 43, 1974.

COLLECTION CONTROLS

1. Source Control Regulators.

Description - One type of regulator is a device that is custom fitted into catch-basins to allow storm runoff to enter the sewer system at pre-determined rates. By installing the regulator at strategic locations and sealing some street inlets, the sewers can operate at design capacity and sewer surcharging can be avoided. Excess rainwater is temporarily stored on the street. Underground storage tanks may be installed as part of the process.

Advantages - According to the developers, this regulator has no moving parts and is self-regulating; has no need for maintenance; eliminates sewer surcharging and backup problems; eliminates all need for damming, gating, and energy consuming pumping facilities; permits downstream water overflows to be controlled so treatment capacities can also be controlled; and controls stormwater solids at the catchbasin, thus reducing the amount of solids entering the sewers and treatment plants.

Disadvantages - Regulators could become clogged from solids.

Reference for additional information - Paul Theil Associated Limited, Bramalea, Ontario, Canada; "High Level of Flood Protection at Low Cost," October 1978.

COLLECTION CONTROLS

2. Zoning Improvements to Prevent Additional Sewers.

Description - This approach includes implementation of zoning regulations and ordinances to prevent development of high densities on land which is unsuitable for onsite wastewater disposal, especially in rural areas which are located on the perimeters of towns with overloaded sanitary and combined sewer systems.

Advantages - Prevents overloading the sewer systems. Prevents increased severity of combined sewer overflows in terms of water quality impacts. Disperses pollutant loads rather than concentrating them. Reduces wastewater transportation/treatment costs.

Disadvantages - Prevents certain land uses. Generates more septage (septic tank pumpings), which must be treated.

Reference for additional information - The Center for the Environment and Man, Inc., "Tri-Town Regional 201 Plan for Newton, Southbury and Woodbury, Connecticut," March 1978.

COLLECTION CONTROLS.

3. Inline/Offline Storage in Sewer Systems.

Description - Storage is one of the more cost-effective measures for reducing pollution from combined sewer overflows. Storage can be developed by such offline facilities as tanks, tunnels, and holding basins or inline by use of weirs, inflatable dams, etc., and automatic monitoring of flows in the sewer system.

Advantages - Documented experience. Simple to design and operate. Capable of providing flow equalization. In case of inline systems, provides transmission of sewage. Can provide limited treatment in case of offline storage. Is not affected by highly variable nature of runoff events. May provide flood protection and decrease the need for relief sewers.

Disadvantages - Requires large area. Storage facilities need to be dewatered. Costs are $0.26 to $0.90 per gallon to treat.

Reference for additional information - USEPA, "Urban Runoff Pollution Control Technology," EPA 600/2-77-077, March 1977.

Metcalf & Eddy, Inc., "Urban Stormwater Management & Technology - An Assessment, " EPA 670/2-74-040, December 1974.

COLLECTION CONTROLS

4. Separation of Sewers by Installing Pressure Sewers Within Combined Sewers.

Description - This approach includes the installation of pressure sewers within a combined sewer system to carry sanitary sewage.

Advantages - Though not found cost effective in a 1968 study, with modern technology it may be found cost effective in some areas ($2,500 to $3,500 per house). Reduces the pollutant concentration in overflows or discharge to streams.

Disadvantages - Sewers should be large enough to install a pressure sewer. Affects the hydraulic capacity of the combined systems to carry stormwater runoff.

Reference for additional information - American Society of Civil Engineers, "Combined Sewer Separation Using Pressure Sewers," October 1969.

COLLECTION CONTROLS

5. Catchbasin and Sewer Maintenance.

Description - Routine maintenance, including preventive measures, is essential for a system to operate efficiently. Routine cleaning of catchbasins and periodic flushing of sewers during nonstorm periods can increase the capacity of sewers by eliminating dirt and debris.

Advantages - Restores the full capacity of sewers. Aids in discovery of trouble spots such as areas with possible breaks.

Disadvantages - Could be expensive. Acceptable disposal methods must be established for solid wastes removed.

Reference for additional information - USEPA, "Urban Stormwater Management and Technology - An Assessment," EPA -670/2-74-040, December 1974.

USEPA, "Catchbasin Technology - Overview and Assessment," EPA-600/2-77-051, May 1977.

APPENDIX II

COLLECTION CONTROLS

6. Injection of Polymers to Increase Sewer Carrying Capacity.

Description - Localized flooding and overflows can be eliminated or reduced by injection of polymers into the sewers to create "slippery water." This approach can be used as either a short-term or long-term corrective measure. Polymeric injection increases flow capacity by as much as 2.4 times.

Advantages - Reduction in flooding from sewer surcharges. Increased treatment of runoff. Reduces the need for relief sewers. Little maintenance.

Disadvantages - Needs further testing for effectiveness. Needs further research for its impact on sewage treatment plant operations and the nutrients, fish, and other aquatic fauna found in rivers, lakes, streams, etc.

Reference for additional information -

Columbia Research Corporation, "Flow Augmentation Effects of Additives on Open Channel Flows," EPA R2-73-238, February 1973.

The Western Company, "Polymers for Sewers Flow Control," EPA 11020 DIG, August 1969.

City of Dallas, "Use of Polymers to Reduce or Eliminate Overflows in the Bachman Creek Sewer," EPA Demonstration Project.

Federal Water Quality Administration, "Combined Sewer Overflow Seminar Papers, NTIS, PB-199-361, 1970.

COLLECTION CONTROLS

7. Control of Infiltration and Inflow into Sewers.

Description - Infiltration of subterranean water into sewers and inflow of water into sewers through direct connections into sewers or seepage through manholes increases the frequency and volume of overflow from combined sewer systems. Infiltration and inflow also causes increased treatment costs. Controls include use of polyvinyl chloride (PVC) pipe, lining of sewers, refurbishing sewer joints using modern materials and technology, replacement of manhole covers, and discharge of area drainage onto lawns or swales.

Advantages - Reduces cost of operating wastewater treatment plant. Reduces overflow frequency and therefore improves receiving stream's water quality. Provides additional capacity for carrying sewage.

Disadvantages - Cost of inflow and infiltration control planning studies are as high as $1 to $2 per foot of sewer.

Reference for additional information -

American Public Water Association, "Control of Infiltration & Inflow Into Sewer System," NTIS PB-200-827, 1970.

American Public Water Association, "Prevention & Correction of Excessive Infiltration & Inflow Into Sewer Systems - A Manual of Practice," NTIS PB-203-208, 1971.

Cronk, G.E., "Groundwater, Infiltration & Internal Sealing of Sanitary Sewers, Montgomery County, Ohio," NTIS PB-212-267, 1972.

APPENDIX II

<u>Reference for additional information</u> -

The Western Co., "Heat Shrinkable Tubing as Sewer Pipe Joint," NTIS PB-208-816, 1971.

Sullivan, R.H., *et al*. American Public Water Association, "Analysis of Practice for Preparing an Economic Analysis & Determining Infiltration & Inflow."

Sussex County Council, "Trenchless Sewer Construction & Sewer Design Innovation," Delaware EPA Project.

City of La Salle, "Evaluation of Various Aspects of an Aluminum Storm Sewer System," EPA Project.

Texas Water Quality Board, "Demonstration/Evaluaton of Impregnated Concrete Pipe and Other Methods of Infiltration Control," EPA Project.

Cesareo, D.J. & Field, Richard, "Infiltration Inflow Analysis", *ASCE Journal of Environmental Engineering Division*, Vol. 101, No. 5, October 1975.

APPENDIX II

TREATMENT CONTROLS

1. Apply Instream Aeration Near the Combined Sewer Outfalls.

   Description - This approach provides for aeration of the receiving water immediately downstream from the outfall. The aeration could be furnished by mechanical, diffused air, mobile boat, or cascade techniques.

   Advantages - Improves water quality, especially the dissolved oxygen content. Cost effective in many cases. Little environmental impact.

   Disadvantages - A large number of aerators may be required. O&M is decentralized.

   Reference for additional information - Whipple, W., *et al.*, "Instream Aeration of Polluted Rivers," Water Resource Research Institute, Rutgers University, August 1969.

TREATMENT CONTROLS

2. Solids Separation Using Swirl Concentrator.

Description	-	Storage ponds or basins will remove settleable solids; however, swirl concentrators remove settleable solids at a much higher rate. Tests have shown 50 percent removal of BOD and suspended solids. The capital cost of a 6.8 million-gallon-per-day-capacity prototype in Syracuse was $55,000.
Advantages	-	Requires little space and is relatively inexpensive. Improves water quality of the receiving stream. Decreases flows in the combined system.
Disadvantages	-	Requires improved sewage system inspection and maintenance. Does not remove all pollutants.
Reference for additional information	-	USEPA, "Urban Runoff Pollution Control Technology Overview," EPA 600/2-77-047, March 1977. USEPA, "Swirl Device for Regulating & Treating Combined Sewer Overflows," EPA Technology Transfer Capsule Report.

TREATMENT CONTROLS

3. Multiuse Facilities.

Description	-	Stormwater and combined sewer overflows can be controlled through a multiuse, water-based recreation facility. In case of combined sewer overflows, facilities include treatment systems, usually lagoons.
Advantages	-	Provides retention and/or treatment of stormwater and combined sewer overflows. Provides recreational space in urban setting. Low cost of treatment.
Disadvantages	-	Needs to be well maintained. Requires large land area. Improper maintenance can cause odor and other nuisance problems. Cold weather may cause operation problems.
Reference for additional information	-	Roy F. Weston, Inc., "Conceptual Engineering Report," Kingman Lake Project, EPA 11023 FIX, August 1970. Mahida, V.W., Spalding DeDecker & Associates, "Combined Wastewater Collection and Treatment Facility - Mt. Clemens, Michigan," Presented at the 4th Annual Conference, Water Pollution Control Federation, San Francisco, October 1971 Spalding, DeDecker & Associates, "Post Construction Evaluation Plan-Mt. Clemens, Michigan," 1973. Metcalf & Eddy, Inc., "Urban Stormwater management & Technology An Assessment," USEPA Report No. 670/2-74-040, December 1974.

TREATMENT CONTROLS

4. Develop Areawide Wastewater Management Plans.

Description - Section 208 of Public Law 92-500 requires that a comprehensive water quality plan be developed for an area. The comprehensive plan should include consideration of trade-off between wet weather and dry weather flow treatments. The plan should provide for least amounts of expenditures by the area for a given improvement in water quality.

Advantages - Will result in a lowest total cost alternative. Will benefit from economies of scale. Will benefit from intercomponent efficiences.

Disadvantages - May require intertown agreements. May result in a higher cost to the community than a communitywide alternative. Certain components of the selected cost-effective strategy may not be eligible for Federal funds. The study could be of long duration and expensive.

Reference for additional information - Metcalf & Eddy, Inc., "Urban Stormwater Management & Technology - An Assessment," EPA 670/2-74-040.

The Center for the Environment and Man, Inc., "Water Quality Management Plan For the Upper Housatonic River," 1977.

CONSULTANTS GAO USED ON THIS ASSIGNMENT

The following consultants assisted us by providing background information on combined sewer problems, suggesting and evaluating alternative technology to solve pollution and flooding problems, and reviewing our draft report.

--Center for the Environment and Man, Incorporated. This firm has wide experience in overall water quality and water resources management planning, including planning for combined sewer overflow and other nonpoint source pollution control.

--Mr. Frank J. Drehwing, Vice President, O'Brien and Gere Engineers, Incorporated. Mr. Drehwing has extensive experience with combined sewer overflow programs and problems.

--Dr. Floyd D. Peterson, a consulting engineer with extensive knowledge and experience in planning water pollution abatement programs. He is a past chairman and commissioner of the Washington, D.C., Suburban Sanitary Commission, and has served as Special Assistant for Public Works to President Eisenhower.

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