WISCONSIN LEGISLATIVE AUDIT BUREAU
AUDIT SUMMARY

Report 02-12

July 2002

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT

The Milwaukee Metropolitan Sewerage District is responsible for providing sewage services to the City of Milwaukee and most of Milwaukee County, as well as to several municipalities in surrounding counties. Wastewater from local sewer systems flows into the District's system of collector sewers before it is treated or temporarily stored in 19.4 miles of tunnels at depths of up to 325 feet, which are known as the Deep Tunnel. Both the collector sewers and the Deep Tunnel are part of a comprehensive, multi-year, $2.3 billion sewer improvement program that the District began in 1986 to comply with federal water quality standards by reducing the amount of untreated sewage discharged into local waterways.

Sewer Overflows Have Not Been Reduced to the Extent Anticipated

The Deep Tunnel has reduced both the number and the volume of sewer overflows in the Milwaukee area. The average discharge of untreated wastewater has been reduced by 7.2 billion gallons annually, which is an 81.3 percent reduction from estimated pre-tunnel levels. Nevertheless, at the time of construction, the Deep Tunnel was expected to virtually eliminate sanitary sewer overflows, which discharge waste from homes and businesses, and to limit overflows from sewers that combine sanitary sewage and stormwater to an average of 1.4 per year. Contrary to these expectations, there has been an average of 4.9 sanitary sewer overflows and 3.0 combined sewer overflows annually since the Deep Tunnel went into operation.

In total, the District has discharged 13.2 billion gallons of untreated wastewater since the Deep Tunnel began operation in 1994: 12.3 billion gallons from combined sewer overflows, which were allowed under an operating permit issued by the Department of Natural Resources (DNR), and 936.7 million gallons from sanitary sewer overflows.

Sewer Overflows Have Multiple Causes

A combination of factors has resulted in more overflows than were expected, including large storms in recent years, stormwater infiltration into sewers, capacity issues in the Deep Tunnel and the District's sewers and treatment facilities, and operational policies that have exacerbated overflows. Approximately 64 percent of the overflow since 1994 was discharged because the District's system could not capture wastewater generated by storms of a size it was designed to handle.

Capacity has been limited by a 17.4 percent increase in water inflow and infiltration into the sewer systems of the municipalities served by the District, a problem caused by siphons that limit the amount of wastewater conveyed to one of the District's two treatment plants, sediment deposits in

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the Deep Tunnel, and policies and strategies adopted by the District and its private contractor. For example, a total of 107 million gallons of untreated wastewater was discharged since June 1999 during six overflows that occurred because the contractor had temporarily turned off Deep Tunnel pumps while switching to a lower-cost source of electricity.

Plans to Increase Capacity and Reduce Flooding Will Be Costly

To address the limitations of its sewer system, the District plans to spend $786.4 million on projects that include constructing 116.0 million gallons of additional storage capacity for sanitary sewage, improving its conveyance system, purchasing equipment to improve its ability to predict storage capacity needs, and increasing treatment plant capacity.

In addition, to reduce the amount of stormwater entering its sewer system, the District has funded $2.1 million in local demonstration projects and adopted new limits that are intended to reduce inflow and infiltration by 5 percent district-wide through 2010. It also requires municipalities to include runoff management systems as part of their development plans.

Through 2001, the District spent $133.8 million for watercourse improvement projects that are expected to reduce flood damage and sewer overflows and to improve water quality. The costs of these projects have been higher than the District anticipated. For example, the Lincoln Creek flood control project, which is in the Milwaukee River watershed, cost 63.9 percent more than original project estimates. The District plans to spend a total of $410.0 million for watercourse improvement projects through 2010, including $131.3 million for the Milwaukee River watershed and $192.0 million for the Menomonee River watershed.

Water Quality Has Improved in Parts of the District's Service Area

Our review of water quality monitoring data suggests water quality has generally improved within the City of Milwaukee and the Village of Shorewood, where stormwater and sanitary sewers are combined. However, water quality outside of the combined sewer area has not improved substantially since 1994. Furthermore, despite improvements within the combined sewer area, a DNR report indicates neither Lake Michigan nor Milwaukee-area rivers currently meet designated water quality standards specified in federal and state law. Other sources of pollution, including nonpoint sources, continue to adversely affect water quality in the District's service area.

The District May Not Have Met All Conditions of Its Permit

Our review of overflow data indicates that in four instances between 1994 and 2001, the District did not submit timely reports to DNR on sewer overflows that released approximately 90,000 gallons of untreated wastewater into Milwaukee-area waterways. The District ultimately reported these overflows in a quarterly report to DNR. In addition, based on our review of available information, the District exceeded groundwater standards for coliform bacteria in at least 29 wells since 1995, and the Deep Tunnel was filled to a higher level than the permitted maximum five times since 1994. These isolated violations of permit conditions did not result in formal enforcement actions by DNR.

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AN EVALUATION

Milwaukee Metropolitan Sewerage District

02-12

July 2002

2001-2002 Joint Legislative Audit Committee Members

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July 30, 2002

Senator Gary R. George and
Representative Joseph K. Leibham, Co-chairpersons
Joint Legislative Audit Committee
State Capitol
Madison, Wisconsin 53702

Dear Senator George and Representative Leibham:

At the request of the Joint Legislative Audit Committee, we have completed an evaluation of the Milwaukee Metropolitan Sewerage District. The District is a special-purpose municipal corporation that provides sewer services to the City of Milwaukee and most of Milwaukee County, as well as to all or parts of a number of municipalities in surrounding counties.

The District's $2.3 billion sewer improvement program, including the 19.4 mile Deep Tunnel and related improvements, has significantly reduced both the number and the volume of sewer overflows, and the District has not violated the combined sewer overflow provisions of its wastewater discharge permit since 1994. However, the program has not achieved the results anticipated when it was designed. Sanitary sewer overflows continue, and more than twice the predicted number of combined sewer overflows has occurred since the Deep Tunnel began operation. Since 1994, a total of 13.2 billion gallons of untreated wastewater has been discharged into Milwaukee-area waterways because of a combination of large storms, stormwater infiltration into sewers, capacity issues in the Deep Tunnel and the District's sewers and treatment facilities, and operational policies that have exacerbated overflows. For example, a total of 107 million gallons of untreated wastewater was discharged since June 1999 during six overflows that occurred because the District's contractor had temporarily turned off Deep Tunnel pumps while switching to a lower-cost source of electricity.

The District is in the process of implementing a $786.4 million building program that is intended to reduce sewer overflows by constructing additional wastewater capacity, increasing treatment plant capacity, and improving the performance of the sewer system. It also plans to spend $410.0 million on watercourse improvement projects. To date, completed projects have had significantly higher costs than the District anticipated.

We found that the District's sewer system and the Deep Tunnel have reduced the amount of pollutants entering waterways, and water quality has improved within the combined sewer area. However, water quality outside the combined sewer area has not improved since 1994 because of sewer overflows and nonpoint and other pollution sources. Neither Lake Michigan nor Milwaukee-area rivers currently meet designated water quality standards specified in federal and state law.

We appreciate the courtesy and cooperation extended to us by the District's staff during the course of our audit. The District's response is Appendix 5.

Respectfully submitted,

Janice Mueller
State Auditor

JM/PS/ss

Summary

The Milwaukee Metropolitan Sewerage District is a special-purpose municipal corporation that provides sewer services to the City of Milwaukee and most of Milwaukee County, as well as all or parts of a number of municipalities within Waukesha, Ozaukee, Racine, and Washington counties. Each municipality served by the District owns and operates its own sewer system. Wastewater from the local sewer systems flows into the District's system of collector sewers, known as the metropolitan interceptor sewer system, before it is conveyed to one of two treatment plants or to 19.4 miles of temporary storage tunnels at depths of up to 325 feet, which are known as the Deep Tunnel. The District also maintains a total of 153 overflow points from which untreated wastewater may be discharged into local waterways during periods of heavy precipitation.

The interceptor system and the Deep Tunnel are part of the District's Water Pollution Abatement Program, a comprehensive, multi-year, $2.3 billion sewer improvement program that was begun in 1986 to comply with stricter federal water quality standards. Since 1994, when the $716.0 million Deep Tunnel was put into operation, concerns have been raised about both its performance and the continued discharge of untreated wastewater from the District's system into Lake Michigan and other Milwaukee-area waterways. Therefore, we evaluated sewer overflows, the District's efforts to reduce overflows, changes in water quality in Milwaukee-area waterways, and the District's compliance with a wastewater discharge permit issued by the Department of Natural Resources (DNR).

The Deep Tunnel has reduced both the number and the volume of sewer overflows in the Milwaukee area. Before 1994, the District had reported an average of 50 overflows annually. In the eight years since the Deep Tunnel began operating, there have been 39 sanitary sewer overflows and 24 combined sewer overflows. (Mechanical failures caused 11 of the sanitary sewer overflows, and inappropriate sewer connections caused 3 of the combined sewer overflows.) The District estimates that the Deep Tunnel has captured more than 40 billion gallons of wastewater and prevented 240 sewer overflows since 1994. The average annual volume of sewer overflows has been reduced by 7.2 billion gallons annually, or 81.3 percent from estimated pre-tunnel levels.

Nevertheless, at the time of construction, the Deep Tunnel was expected to virtually eliminate sanitary sewer overflows. It was also expected to significantly reduce combined sewer overflows by allowing an average of only 1.4 combined overflows per year. Contrary to these expectations,

there has been an average of 4.9 sanitary sewer overflows and 3.0 combined sewer overflows annually since the Deep Tunnel went into operation. The combined sewer overflows, which were allowed under the terms of the District's permit, discharged 12.3 billion gallons of untreated wastewater into Milwaukee-area waterways since 1994. Sanitary sewer overflows discharged an additional 936.7 million gallons of untreated wastewater.

In total, the District has discharged 13.2 billion gallons of untreated wastewater since 1994. Of that amount, approximately 36 percent, or 4.8 billion gallons, was released because five large storms generated more wastewater than the Deep Tunnel's designed storage capacity of 405 million gallons. That capacity was based on the storm of record for the Milwaukee area, which occurred in June 1940 and generated approximately 6 inches of rain in a 48-hour period. The largest overflow occurred in June 1997, when 8.1 inches of rain fell over a 36-hour period in some areas served by the District.

More significantly, approximately 64 percent of the District's total discharge of untreated wastewater since 1994, or 8.4 billion gallons, occurred because the District's sewer system and the Deep Tunnel have proven to be insufficient to capture wastewater generated by smaller storms. For example, the water from a storm in April 1999 that generated a maximum of 3.3 inches of rain over a 36-hour period produced an overflow of 784.1 million gallons of untreated wastewater.

In addition to storm size, other factors contribute to continuing sewer overflows, including:

- water inflow and infiltration into municipalities' sewer systems, which has increased by 17.4 percent over 1980 levels;
- a capacity problem caused by siphons that limit the amount of wastewater conveyed to the District's Jones Island Wastewater Treatment Plant;
- sediment deposits in the Deep Tunnel, which have reduced its capacity by approximately 0.5 percent, or 2.1 million gallons; and
- policies and strategies adopted by the District and United Water Services Milwaukee LLC, which contracts to operate and maintain the District's two wastewater treatment plants and its sewage conveyance system.

Both the District and United Water Services have made efforts to eliminate sanitary sewer overflows, minimize combined sewer overflows, and avoid overfilling the Deep Tunnel. We found, however, that efforts to eliminate sanitary sewer overflows have resulted in larger combined sewer overflows than would have otherwise occurred. Furthermore, we estimate that 107 million gallons of untreated wastewater was discharged into waterways from June 1999 through June 2001 because United Water Services had temporarily turned off Deep Tunnel pumps while switching to a lower-cost source of electricity. The contractor saved approximately $515,000 by switching power sources during that period.

The District plans to address limitations of its sewer system by spending $786.4 million to increase capacity through projects that include:

- construction of 116.0 million gallons of additional storage capacity for sanitary sewage, which is an increase of 28.6 percent over the Deep Tunnel's current designed capacity of 405 million gallons;
- improvements to the District's conveyance system;
- the purchase of enhanced storm tracking and real-time flow monitoring equipment that should improve the District's ability to predict storage capacity needs; and
- increases in treatment plant capacity of 27.1 percent at the Jones Island treatment plant and 23.1 percent at the South Shore Wastewater Treatment Plant;

Furthermore, in part to reduce the amount of stormwater entering the District's sewer system, the Deep Tunnel, and treatment plants, the District has:

- adopted new inflow and infiltration limits and funded $2.1 million in local demonstration projects, in an effort to reduce inflow and infiltration by 5 percent district-wide through 2010;
- adopted rules that require municipalities to include runoff management systems as part of any development plans; and
- planned to spend $410.0 million for watercourse improvement projects that are intended not only to reduce flood damage to structures and to improve water quality, but also to reduce the inflow of stormwater into the sewer system.

More than three-quarters of expenditures for current and planned watercourse improvement projects are associated with watersheds of the Milwaukee and Menomonee rivers. We reviewed financial data for both completed watercourse improvement projects and those yet to be completed and found that actual costs have been significantly higher than was projected. For example, the nearly completed Lincoln Creek project, which was designed to protect approximately 2,000 homes and businesses in the City of Milwaukee and portions of the City of Glendale and the Village of Brown Deer, was projected to cost $70.4 million but has a current estimated cost of $115.4 million, which is a 63.9 percent increase.

Similarly, the District's cost projections for a watercourse improvement project to protect 425 properties and 315 structures on the Menomonee River from a 100-year flood have more than doubled since 2000, and much of the work associated with the project has yet to be completed. The District estimates that through 2020, a 100-year flood in the Menomonee River watershed would result in $13.2 million in damages to structures. Its August 2000 plan for the area had a projected cost of $83.1 million, and its most recent estimate of total project costs is $192.0 million, which is $108.9 million more than originally projected. Thus, in addition to raising concerns about the District's ability to accurately predict and limit total project costs, this project raises concerns about balancing the costs of watercourse improvement projects with anticipated savings from flood damage.

The District will soon begin work on its comprehensive 2020 Facility Plan, which will review a broad array of alternatives for reducing future sewer overflows, preventing flooding, protecting the environment, and improving water quality. The plan is expected to be completed in 2007. To accomplish its stated goals of protecting public health and the environment, preventing pollution, and enhancing the quality of area waterways, the District will need to evaluate its tax rate and capital spending levels, prioritize spending to balance the need for additional storage capacity with funding for watercourse improvement and other capital projects, consider the effects of planned capital projects on its costs, and continue to review staffing levels.

We reviewed changes in water quality in Milwaukee-area waterways to determine whether the decrease in the number and volume of sewer overflows has reduced the amount of pollution entering the water. Our review of water quality monitoring data suggests water quality has improved within the combined sewer area, but water quality outside of the combined sewer area has not improved substantially since 1994. Furthermore, despite improvements within the combined sewer area, a DNR report indicates neither Lake Michigan nor Milwaukee-area rivers currently meet designated water quality standards specified in federal

and state law. Other sources of pollution, including nonpoint sources, continue to adversely affect water quality in the District's service area. Finally, the best available data indicate the Deep Tunnel may adversely affect groundwater quality in limited areas.

Wastewater discharge permits issued by DNR affect many aspects of the District's operations. The permit under which the District is currently operating includes effluent limits for its two wastewater treatment plants; requirements for sludge disposal and the production of Milorganite, a fertilizer made from sludge; guidelines for operating the Deep Tunnel; restrictions on combined and sanitary sewer overflows; and provisions for surface and groundwater monitoring.

Although both sanitary and combined sewer overflows have occurred since the Deep Tunnel went into operation in February 1994, the District has never violated the terms of its permit related to combined sewer overflows. The permit allows either up to six combined sewer overflows per year, or the capture and treatment of at least 85 percent of the total annual wet-weather wastewater collected in the combined sewer area. Although the District has had 24 combined sewer overflows since 1994, there have never been more than 6 in a year. As noted, the District has also had 39 sanitary sewer overflows since 1994. Its permit prohibits sanitary sewer overflows unless they result from equipment damage, temporary power interruption, or excessive storm runoff, or unless they are unavoidable and necessary to prevent loss of life or severe property damage.

DNR officials have alleged that at least 8 of the 39 sanitary sewer overflows, which resulted in 471 million gallons of untreated sanitary sewage being discharged into Milwaukee-area waterways, violated the District's permit. In March 2002, DNR and the Wisconsin Department of Justice filed a lawsuit against the District in Milwaukee County Circuit Court. The District maintains that all of these overflows were unavoidable and, therefore, allowed under the terms of its permit. DNR and the District have entered into a stipulated settlement of the lawsuit under which the District has agreed to implement a number of initiatives to reduce future overflows.

Our review of overflow data indicates that in four instances between 1994 and 2001, the District appears not to have submitted timely reports to DNR on sewer overflows that released approximately 90,000 gallons of untreated wastewater into Milwaukee-area waterways. The District ultimately reported these overflows in a quarterly report to DNR, which did not issue a notice of noncompliance.

Based on our review of available information, it appears that the District failed to meet other conditions of its permit on several occasions. For example, groundwater standards for coliform bacteria have been exceeded in at least 29 wells since 1995, and the Deep Tunnel was filled

to a higher level than the permitted maximum five times since 1994. Isolated violations of permit conditions such as these do not automatically result in formal enforcement actions; historically, DNR has instead relied on informal administrative enforcement procedures, permit compliance schedules, and its authority to deny requested sewer extensions to achieve compliance with permit conditions.

Sewer overflows occur throughout Wisconsin. Between 1996 and 2001, 288 communities reported a total of 988 overflows, resulting in 564.1 million gallons of wastewater being discharged to Wisconsin waterways. DNR's strategy for bringing the large number of communities in Wisconsin with sanitary sewer overflows into compliance with federal and state requirements includes identifying and mapping every sewer overflow location in the state, working with communities to improve reporting of overflows, and addressing the problem of clean water inflow and infiltration into sanitary sewer systems. DNR also intends to take steps that will require communities that experience chronic sanitary sewer overflows to address their underlying causes.

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The District provides sewer services to municipalities within and beyond its boundaries.

The Milwaukee Metropolitan Sewerage District is responsible for providing sewer services to 18 municipalities within its boundaries and is authorized by statute to provide the same services to areas beyond its boundaries. Currently the District's boundaries include:

- all of Milwaukee County with the exception of the City of South Milwaukee and small areas of the cities of Franklin and Oak Creek;
- the portion of the Village of Bayside that is in Ozaukee County; and
- those portions of the City of Milwaukee that are in Waukesha and Washington counties.

In addition, the District provides sewer services by mutual agreement to all or parts of ten municipalities within Waukesha, Ozaukee, Racine, and Washington counties.

The District is a special-purpose municipal corporation defined in s. 200.23, Wis. Stats. Since 1982, it has been governed by the Milwaukee Metropolitan Sewerage Commission. Seven of the Commission's 11 members are appointed by the Mayor of the City of Milwaukee, including 3 who must be elected officials. The remaining four commissioners, including three who must be elected officials, are appointed by a committee of the chief elected officials of municipalities within the District other than the City of Milwaukee. The elected officials appointed by the Mayor of the City of Milwaukee serve one-year terms; all other commissioners serve three-year terms. The Commission appoints an executive director, who has responsibility for managing the District's 225.5 full-time equivalent (FTE) employees.

In response to stricter federal water quality standards, and as part of a comprehensive sewer improvement program known as the Water Pollution Abatement Program, the District began in 1986 to construct 19.4 miles of tunnels, at depths of up to 325 feet, for the temporary storage of stormwater and sanitary sewage. Construction of these tunnels, which are commonly referred to as the Deep Tunnel, was completed in 1993 at a cost of $716.0 million. Since 1994, when the Deep Tunnel was put into operation, concerns have been raised about its performance and the continued discharge of untreated or partially treated wastewater into Milwaukee-area waterways, including the Milwaukee, Kinnickinnic, and Menomonee rivers and their tributaries, as well as Lake Michigan.

Therefore, at the direction of the Joint Legislative Audit Committee, we analyzed:

- sewer overflows, including sanitary overflows that discharge both untreated waste from households and businesses, as well as combined sewer overflows that discharge stormwater and sanitary sewage;
- the District's policies, procedures, and processes for determining when untreated or partially treated wastewater may be released into Milwaukee-area waterways;
- the District's plans to reduce or prevent overflows and diversions of sewage in the future, including the estimated costs associated with these plans;
- changes in water quality in Milwaukee-area waterways, including which pollutants have adversely affected water quality;
- the adequacy of current and future efforts to evaluate the integrity and the condition of the Deep Tunnel; and
- the District's efforts to comply with its wastewater discharge permit and the regulatory and enforcement actions taken by the Department of Natural Resources (DNR).

In conducting our evaluation, we interviewed officials of the Milwaukee Metropolitan Sewerage District, DNR, the federal Environmental Protection Agency (EPA), the contractor operating the District's sewage treatment system, and other interested parties. We reviewed programmatic data related to the District, including operating and capital budgets, program expenditures, contracts, procedure manuals, plant operating records, and reports regarding operation of the District's wastewater treatment system prepared by consultants hired by the District. In addition, we analyzed water quality monitoring data collected by the District and other government agencies, and we reviewed reports from consultants and government agencies that have assessed water quality in Milwaukee-area waterways.

Water Pollution Abatement Program

The 1972 Clean Water Act required improvements to the District's sewage treatment system.

The need for major improvements to the District's sewage treatment system originated in 1972, when amendments to the federal Clean Water Act required states to enforce stricter standards for sewage disposal. In Wisconsin, DNR is responsible for enforcing these federal standards.

To meet the requirements of the Clean Water Act, DNR promulgates administrative rules for municipal and industrial wastewater treatment systems, reviews and approves facilities plans for these systems, and issues permits that limit the amounts of various pollutants that may be present when treated wastewater is discharged into lakes and rivers. In 1976, after DNR ordered the District to reduce the amount of sewage discharged into Milwaukee-area waterways to meet the new, stricter discharge limits, the District sought court action to prevent the discharge limits from being enforced. In 1977, both parties agreed to a court order that required the District to prevent overflows from sanitary sewers and to greatly reduce overflows from combined sewers.

To meet these objectives, the District created its Water Pollution Abatement Program, a comprehensive, multi-year sewer improvement program that was designed to virtually eliminate sanitary sewer overflows and to greatly reduce combined sewers overflows. In 1981, DNR approved the District's master facilities plan to implement the program, which provided for:

- upgrading the District's sewage treatment plants;
- improving and replacing the existing sewage conveyance system; and
- selecting an alternative to discharging sewage overflows into Milwaukee-area waterways.

To accomplish the last provision, the District considered two approaches. One called for creating separate storm sewers and sanitary sewers, and treating the two waste systems separately. The other called for preserving the combined sewers and treating both sanitary sewage and stormwater. With the approval of DNR and the EPA, the District eventually chose the second approach, which officials at that time estimated would cost approximately $469.0 million less than sewer separation.

The Water Pollution Abatement Program cost $2.3 billion to complete.

The total cost of the Water Pollution Abatement Program, including construction of the Deep Tunnel and upgrades to two wastewater treatment plants and the District's sewer and conveyance system, was $2.3 billion. As shown in Table 1, local, state, and federal funds financed the District's sewer improvement program.

Table 1

Water Pollution Abatement Program Expenditures
(in millions)

Funding Type	Expenditures*	Percentage of Total
Local	$ 958.3	42.3%
State:		
Grants	598.4	26.4
Loans**	218.2	9.7
Total state funding	816.6	36.1
Federal***	489.5	21.6
Total, all funding types	$2,264.4	100.0%

* Does not include $603.8 million in interest costs incurred through capital cost financing.
** The District will eventually pay back all state loans with locally generated revenue.
*** Represents various EPA grants.

The District received $218.2 million (9.7 percent) of program funding as loans from the State's Clean Water Fund Program, which provides financial assistance to municipalities through loans and limited grants. Through December 2001, the Clean Water Fund Program had entered into financial assistance agreements with municipalities totaling $1.5 billion. The District is the largest recipient of Clean Water Fund loans and accounts for $384.7 million (25.3 percent) of the loan program's financial assistance through December 2001.

District Operations

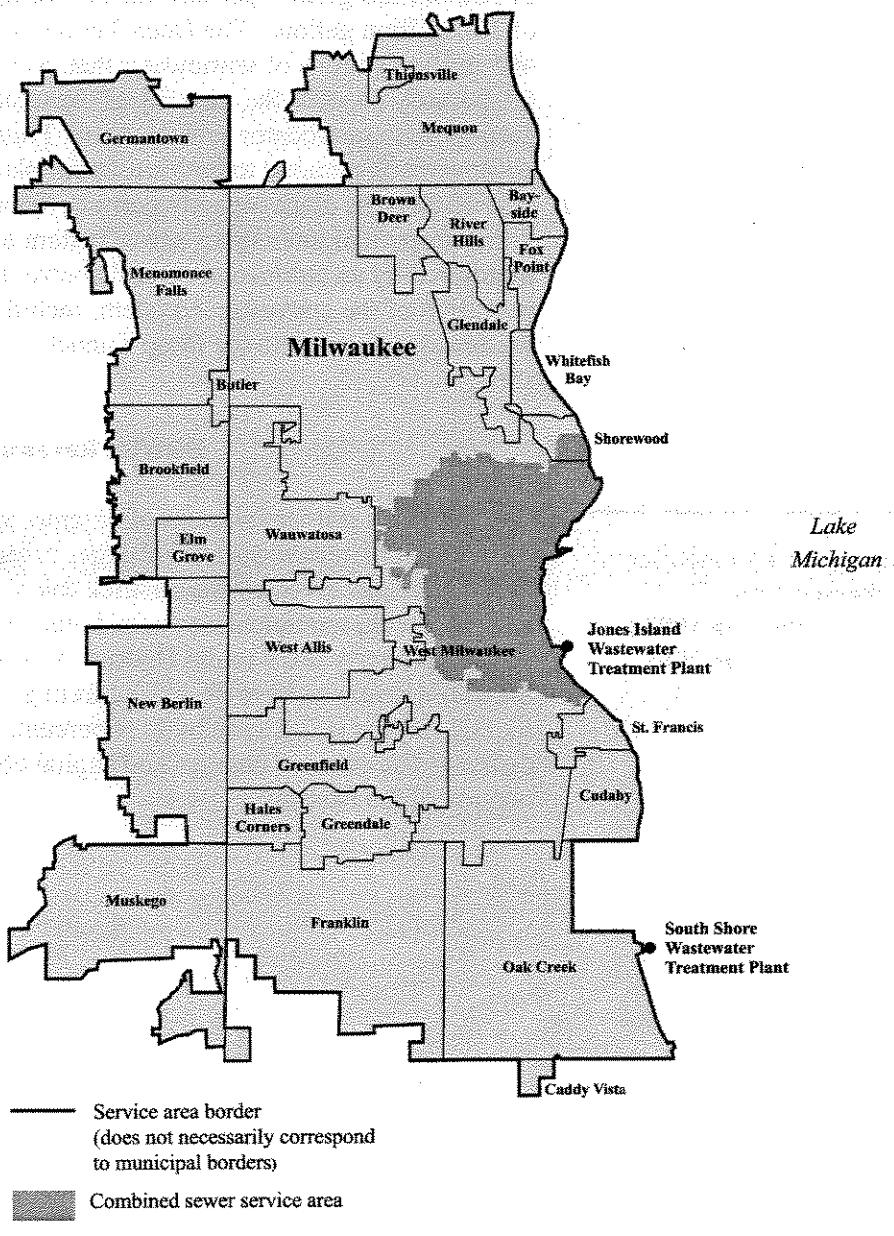
Each municipality owns and operates sewers that flow into the District's collector sewers.

Each municipality within the District owns and operates its own sewer system, which flows to a system of collector sewers that is owned and operated by the District. Portions of the systems owned by the Village of Shorewood and the City of Milwaukee are combined sewer systems that convey both sanitary sewage and stormwater. The remainder of the

municipalities in the District's service area own and operate separate stormwater sewers. Figure 1 shows the area served by combined sewers, as well as all municipalities served by the District.

Figure 1

Milwaukee Metropolitan Sewerage District Service Area



The system of collector sewers owned and operated by the District is known as the metropolitan interceptor sewer system. From the metropolitan interceptor sewer system, wastewater is conveyed to one of the District's two wastewater treatment plants or, if capacity would otherwise be exceeded, diverted to the Deep Tunnel.

The Deep Tunnel was designed to store up to 405 million gallons of wastewater.

The District's Jones Island Wastewater Treatment Plant, located in the Milwaukee Harbor, has a designed peak capacity of 330 million gallons per day and an average daily wastewater inflow of 112 million gallons. The District's South Shore Wastewater Treatment Plant, located on Lake Michigan in the City of Oak Creek, has a designed peak capacity of 300 million gallons per day and an average daily wastewater inflow of 100 million gallons. The Deep Tunnel was designed to store up to 405 million gallons of wastewater that, as a result of rain or snowmelt, temporarily exceeds the capacity of the treatment plants or the metropolitan interceptor sewer system. From the Deep Tunnel, wastewater is pumped to both treatment plants over the course of several days, as plant capacity permits. Wastewater flowing within both the metropolitan interceptor sewer system and the local sewer systems is monitored by an automated central control system, which allows remote operation of the conveyance system, including control of the amount of wastewater diverted to the Deep Tunnel.

District Revenues

The District's revenues decreased from $139.0 million in 1997 to $123.2 million in 2001.

The District's primary sources of revenue are taxes levied on property within the District, sewer user charges assessed against all municipalities served by the District, interest income, and capital charges on ten municipalities outside the District's service area that do not pay property taxes to the District. As shown in Table 2, the District's revenues have decreased from $139.0 million in 1997 to $123.2 million in 2001, or by 11.4 percent, largely as a result of decreased sewer user charges and capital charges to communities outside of the District.

Table 2

District Revenues
(in millions)

	1997	2001	Percentage Change
Property tax levies	$ 52.9	$ 62.1	17.4%
Sewer user charges	53.9	43.4	(19.5)
Interest income	10.8	6.7	(38.0)
Fertilizer sales	6.3	5.8	(7.9)
Capital charges*	12.6	2.6	(79.4)
Other**	2.5	2.6	4.0
Total	$139.0	$123.2	(11.4)

* Represents capital charges to communities outside of the District.
** Includes insurance settlements, a payment from the Department of Transportation related to damage caused by the December 2000 failure of the Hoan Bridge, charges to United Water Services, and records request charges.

The District levies a property tax to fund capital improvement projects and debt service. The property tax was the District's largest source of revenue in 2001, representing 50.4 percent of total revenues. Sewer user charges, the District's second-largest revenue source, were 35.2 percent. Sewer user charges fund operating and maintenance expenses. The District assesses sewer user charges on each municipality within its service area based on the level of pollutants in the wastewater, the volume of wastewater the municipalities contribute to the District's system, and the number of sewer connections within each municipality. The municipalities, in turn, directly bill their residential, commercial, and industrial users. The District's sewer user charges decreased 19.5 percent from 1997 to 2001 for all municipalities using its treatment services. Changes in user charges for each of the municipalities served by the District are shown in Appendix 1.

Operating Expenses

The District contracts with a private vendor to operate and maintain its two wastewater treatment plants.

As shown in Table 3, the District's operating expenses decreased from $116.9 million in 1997 to $114.5 million in 2001, or by 2.1 percent. A principal reason for the decrease is that the District entered into a ten-year contract with a private company—United Water Services Milwaukee LLC—beginning March 1, 1998, for the operation and maintenance of the District's two wastewater treatment plants, its conveyance system, and fertilizer production.

Table 3

District Operating Expenses
(in millions)

	1997	2001	Percentage Change
Depreciation expense	$ 49.9	$ 57.8	15.8%
Operations and maintenance	45.3	37.7*	(16.8)
Administration	15.3	13.7	(10.5)
Other**	6.4	5.3	(17.2)
Total	$116.9	$114.5	(2.1)

* Includes $31.9 million paid to United Water Services.
** Includes industrial waste and conveyance monitoring costs and laboratory and research services.

The District paid United Water Services $31.9 million in 2001 to perform these services. Under the terms of the contract, the District retains ownership of all facilities and assets and continues to operate its industrial waste pretreatment program and to be responsible for managing its capital projects; financial administration; water quality monitoring; laboratory and research services; sales and marketing of Milorganite and Agri-life, the organic fertilizers that are byproducts of the wastewater treatment process; administration of a minority business development and training program; and contract compliance.

Largely as a result of privatization, the District's staff has declined by 60.6 percent, from 572.0 FTE positions in 1997 to 225.5 FTE positions in 2002. As shown in Table 4, the largest division is operations, administration, and compliance, which includes contract compliance activities, laboratory services, industrial waste pretreatment, water

quality monitoring, and conveyance monitoring. Since 1997, the District has made organizational changes to its operating structure each year. Appendix 2 shows its organizational chart and staffing levels for 2002, which were approved by the Commission in October 2001.

Table 4

District FTE Positions
2002

Division	Number
Operations, administration, and compliance	112.0
Technical services	56.0
Information and community education	32.5
Executive director	14.0
Legal services	9.0
Commission services	2.0
Total	225.5

In 1997, the District estimated its cost savings from privatization to be $145.8 million over the ten-year contract period. A consultant hired in 2001 to review contract performance estimated that the District had saved $36.5 million over the first three years of the contract, or $1.4 million more than projected. The increased cost savings resulted primarily from increased natural gas prices in 2000, which would have been the District's responsibility if it had not transferred this risk to its contractor.

The District's lobbying expenditures totaled $253,093 in 2001.

The District's spending in two areas has raised concerns. First, some have questioned the amount spent for contracts with private firms and in-house staff who lobby on an array of environmental and financial issues at both the federal and the state level. As shown in Table 5, the District's total lobbying expenditures ranged from a high of $253,093 in 2001 to a low of $159,715 in 1998 and have generally increased over time. Examples of 2001 lobbying expenditures include $25,000 related to a DNR fertilizer land spreading rule, $30,000 related to flood control issues, and $22,750 related to a bill that would have permitted the District to obtain selected construction contracts without the need to use a competitive bidding process in every instance.

Table 5

District Lobbying Expenditures

	1997	1998	1999	2000	2001
Federal Government Issues					
Contractors	$ 92,608	$110,366	$ 62,875	$ 99,111	$ 95,294
District staff*	–	–	2,532	3,328	6,129
Subtotal	92,608	110,366	65,407	102,439	101,423
State Government Issues					
Contractors	60,108	29,699	122,742	78,405	129,369
District staff*	36,615	19,650	28,817	18,483	22,301
Subtotal	96,723	49,349	151,559	96,888	151,670
Total	$189,331	$159,715	$216,966	$199,327	$253,093

* Represents salaries, fringe benefits, and overhead for staff involved in lobbying. Data related to federal government issues were not available for 1997 and 1998.

Second, there has been interest in the amount the District spends on public relations. We reviewed this spending, which includes internal and external communications, such as newsletters and press releases; environmental education activities; community relations, such as meetings with local officials and interest groups; printing; and similar types of activities. In assessing public relations expenditures, we did not include public information efforts associated with the District's household hazardous waste program and marketing Milorganite.

Public relations and related expenditures increased 30.8 percent from 1999 to 2001.

As shown in Table 6, public relations and related expenditures have increased from $394,661 in 1999 to $516,168 in 2001, or by 30.8 percent. However, the area of community relations, which includes meetings with local officials, public education, and special events, reflected the largest increase in costs (320.9 percent) over this period. The second-largest increase, 45.5 percent, was in internal communications, such as a monthly newsletter to update the District's own employees on its activities and accomplishments.

Table 6

District Public Relations and Related Expenditures

Category	1999	2000	2001	Percentage Change
External communications	$101,575	$147,023	$107,611	5.9%
Capital projects	77,350	74,806	85,777	10.9
Administration and management	76,248	74,650	76,475	0.3
Community relations	15,880	36,057	66,836	320.9
Internal communications	42,772	46,563	62,223	45.5
Graphics	63,208	42,678	60,845	(3.7)
Environmental education	0	37,618	41,554	n/a
Other activities	17,628	10,518	14,847	(15.8)
Total	$394,661	$469,913	$516,168	30.8

Planned Capital Expenses

Although all components of the Water Pollution Abatement Program were completed in 1996, the District continues to incur substantial capital expenses for improvements to its existing systems, for watercourse improvement projects intended to prevent flooding, and for debt service on its capital projects. As shown in Table 7, the District has anticipated spending $1.3 billion for capital expenses through 2007, including $458.4 million for additional improvements to its sewage conveyance system, which will add additional conveyance and sewage storage capacity.

Table 7

District Capital Plan, 2001-2007
(in millions)

Projects	Amount	Percentage of Total
Sewage conveyance system	$ 458.4	34.4%
Debt service	442.7	33.3
Watercourse improvements	252.0	18.9
Wastewater treatment plants	123.2	9.3
Other*	54.4	4.1
Total	$1,330.7	100.0%

* Includes facilities planning, a minority business development and training program, environmental insurance, financial planning, and information technology.

The District expects to use a variety of sources to fund these planned projects. As shown in Table 8, $500.5 million (37.6 percent) will come from property tax levies from communities within the District. Municipalities served by but located outside of the District will provide $121.7 million through capital charges assessed by the District. Unlike sewer user charges, both capital charges and property tax levies are based on the total property tax value within each community, multiplied by $1.70 per $1,000 of equalized property value. The $1.70 rate has been in effect since 1997 and is projected to remain at this level through 2007. From 1987 through 1994, when the majority of work related to completion of the Water Pollution Abatement program was done, the rate was approximately $3.00. It should be noted that during the past several years, capital charges have been reduced by credits for watercourse improvement projects.

The District's second-largest source of capital funding is the Clean Water Fund, which is expected to provide $352.4 million in loans through 2007 to help the District fund capital costs. The District will eventually pay these loans back with property tax revenue.

Table 8

Capital Project Funding Sources, 2001-2007
(in millions)

Source	Amount	Percentage of Total
Property tax levies	$ 500.5	37.6%
Clean Water Fund loans	352.4	26.5
General obligation bonds	256.9	19.3
Capital charges	121.7	9.1
Fund balance	47.3	3.6
Interest income	26.3	2.0
Grants*	25.6	1.9
Total	$1,330.7	100.0%

* Represents various EPA grants.

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Although the Deep Tunnel has significantly reduced both the number and the volume of overflows, it has not achieved the results anticipated when the District's Water Pollution Abatement Program was planned. Sanitary sewer overflows continue to occur, and more than twice as many combined sewer overflows as predicted have occurred since the Deep Tunnel began operation. Several factors contribute to this problem, including large storms in recent years, capacity issues in the Deep Tunnel and the District's sewers and treatment facilities, and operational policies that have exacerbated overflows.

Quantifying Sewer Overflows

The District estimates the Deep Tunnel has prevented 240 sewer overflows since 1994.

Before the Deep Tunnel was completed, the District reported an average of 50 sewer overflows annually. Since the first year of the tunnel's operation in 1994, the District estimates that the Deep Tunnel has captured more than 40 billion gallons of wastewater and prevented 240 sewer overflows into area waterways. Nevertheless, when wastewater flows exceed either the capacity of the Deep Tunnel or the ability of the sewer system to convey wastewater to the tunnel or treatment plants, overflows occur. The District maintains a total of 153 overflow points from which untreated wastewater may be discharged into local waterways: 121 at combined sewer locations, and 32 at sanitary sewer locations. As noted, sanitary sewer overflows discharge untreated waste from households and businesses; combined sewer overflows discharge a combination of stormwater and sanitary sewage.

Although the Deep Tunnel and related projects were designed to virtually eliminate sanitary sewer overflows and all but an average of 1.4 combined sewer overflows each year, both types of overflows have occurred in each year since the Deep Tunnel became operational. As shown in Table 9, there have been 39 sanitary sewer overflows since 1994, or an average of 4.9 annually, and 24 combined sewer overflows, or an average of 3.0 annually. Nevertheless, the District has not violated the provision of its wastewater discharge permit with DNR that allows up to six combined sewer overflows annually. The extent to which it may have violated its permit related to sanitary sewer overflows has never been resolved.

The District believes that when the capacity of its sewer system is exceeded, sewer overflows are preferable and a lesser public health threat than the alternative, which is sewage backing up into the basements of homes and businesses. In addition, these overflows prevent damage to the District's two treatment plants, the Deep Tunnel, and sewer systems.

Table 9

Number of Sewer Overflows*

Year	Sanitary Sewer Overflows	Combined Sewer Overflows	Total
1994	1	1	2
1995	5	1	6
1996	3	4	7
1997	5	2	7
1998	4	2	6
1999	8	6	14
2000	5	5	10
2001	8	3	11
Total**	39	24	63

* During 19 storms, there was both a sanitary sewer overflow and a combined sewer overflow.

** Mechanical failures caused 11 sanitary sewer overflows, and inappropriate sewer connections caused 3 combined sewer overflows.

Since construction of the Deep Tunnel, the District has discharged 13.2 billion gallons of untreated wastewater.

As shown in Table 10, since it began to operate the Deep Tunnel, the District has discharged 13.2 billion gallons of untreated wastewater into area waterways, including 12.3 billion gallons from combined sewers and 936.7 million gallons from sanitary sewers. 1999 and 2000 were years of exceptionally large overflows, primarily as a result of the unusually high rain and snowmelt levels in those years.

Table 10

Total Volume of Wastewater Discharged in Sewer Overflows
(millions of gallons)

Year	Sanitary Sewer Overflows	Combined Sewer Overflows	Total
1994	2.3	171.2	173.5
1995	73.2	773.3	846.5
1996	67.7	674.9	742.6
1997	248.6	1,991.5	2,240.1
1998	79.6	629.3	708.9
1999	271.7	4,105.4	4,377.1
2000	137.5	3,489.7	3,627.2
2001	56.1	464.6	520.7
Total	936.7	12,299.9	13,236.6

The Deep Tunnel has reduced the average annual volume of combined sewer overflows by 78.3 percent.

Despite the continuing overflows, the Deep Tunnel has substantially reduced both the frequency and the volume of sewer overflows. As shown in Table 11, after its completion, the average annual volume of combined sewer overflows was reduced by 5.5 billion gallons per year, or 78.3 percent. Similarly, the average annual volume of sanitary sewer overflows was reduced by 1.7 billion gallons per year, or 93.4 percent.

Table 11

Average Annual Overflow Volumes
(millions of gallons)

	Estimated Pre-Tunnel*	Actual Post-Tunnel	Percentage Reduction
Combined sewer overflows	7,077	1,537	78.3%
Sanitary sewer overflows	1,769	117	93.4
Total	8,846	1,654	81.3

* The estimated average annual volume of wastewater discharged through sewer overflows before the Deep Tunnel began operation was determined by a consultant retained by the District.

Factors Contributing to Overflows

Many factors contribute to sewer overflows, including mechanical failures, such as stray voltage and computer malfunctions that can cause gates to open and discharge sewage into waterways, and faulty sewer system connections. Mechanical failures caused 11 sanitary sewer overflows since 1994, but these resulted in the discharge of only 2.7 million gallons, or 0.3 percent of all sanitary sewer overflows that occurred. In addition, in two instances, inappropriate sewer connections resulted in the discharge of 74,000 gallons of untreated wastewater from combined sewers. This represents less than .01 percent of the total combined sewer overflows.

The remainder of the sewer overflows occurred during wet weather and were caused by:

- the magnitude of storms in recent years;
- the capacity of both the Deep Tunnel and the District's sewer system; and
- operational policies of the District and its contractor.

Storm Size

An increase in the number of large storms has contributed to sewer overflows.

A major factor contributing to overflows in recent years is the increase in the number of large storms that produce wastewater flows exceeding the capacity of the Deep Tunnel and the District's sewage conveyance system. During planning for the Water Pollution Abatement program, the District estimated the storage capacity requirement for the Deep Tunnel and related projects based on the largest storm previously recorded in the Milwaukee area, which occurred in June 1940. This storm of record generated approximately 6 inches of rain during a 48-hour period. On that basis, the District concluded that the Deep Tunnel's storage capacity of 405 million gallons would be sufficient to prevent virtually all sanitary sewer overflows and all but an average of 1.4 combined sewer overflows per year.

Since the Deep Tunnel's first year of operation in 1994, five storms have been larger than the June 1940 storm of record. In total, these five storms resulted in the discharge of 4.8 billion gallons of untreated wastewater from sanitary and combined sewers, or 36.4 percent of the District's overflow volume since completion of the Deep Tunnel. As shown in Table 12, the largest overflow occurred during a June 1997 storm that produced 8.1 inches of rain over a 36-hour period at some locations in the District's service area. This storm filled the Deep Tunnel and resulted in 203.0 million gallons of untreated sanitary sewage and 1.6 billion gallons of untreated combined wastewater being discharged into area waterways.

Table 12

Storms Larger than the June 1940 Storm of Record
(millions of gallons)

Date of Overflow	Maximum Rainfall (inches)	Duration (hours)	Sanitary Sewer Overflow Volume	Combined Sewer Overflow Volume	Total Overflow Volume
June 21-23, 1997	8.1	36	203.0	1,607.8	1,810.8
July 2-4, 1997	2.3	1	45.3	383.6	428.9
August 5-8, 1998	8.9	48	79.5	475.3	554.8
July 21-24, 1999	3.9	12	62.2	1,126.2	1,188.4
July 2-3, 2000	4.7	12	4.7	791.7	796.4
Total			394.7	4,384.6	4,779.3

The Deep Tunnel has not captured all wastewater generated by storms of a size it was designed to handle.

However, the District's sewer system and the Deep Tunnel have proven to be insufficient to capture wastewater generated by storms smaller than the 1940 storm. As shown in Table 13, precipitation from 16 storms smaller than the storm of record has resulted in the discharge of 8.4 billion gallons of untreated wastewater into area waterways. For example, wastewater generated by the second of two storms in April 1999, which produced a maximum of 3.3 inches of rain over a 36-hour period, filled the Deep Tunnel and resulted in an overflow of 784.1 million gallons of untreated wastewater. The District could not capture the wastewater generated by these smaller storms because of both limited storage capacity and two operational policies of the District and its contractor.

Table 13

Overflows Resulting from Storms Smaller than the 1940 Storm
(thousands of gallons)

Date of Overflow	Sanitary Sewer Overflow Volume	Combined Sewer Overflow Volume	Total
February 19, 1994	2,310*	171,200	173,510
August 27-31, 1995	62,324	773,280	835,604
June 17-20, 1996	67,640	674,825	742,465
November 10-11, 1998	32*	154,000	154,032
January 23-24, 1999	15*	214,800	214,815
April 9-10, 1999	48,680	644,900	693,580
April 23-24, 1999	74,501	709,600	784,101
June 13-14, 1999	83,885	911,200	995,085
September 28-29, 1999	72*	498,711	498,783
May 17-20, 2000	109,650	1,539,100	1,648,750
June 1-2, 2000	29*	194,200	194,229
August 5-6, 2000	1,990	127,200	129,190
September 11-14, 2000	21,130	837,500	858,630
February 9-10, 2001	55,840	261,900	317,740
June 12-13, 2001	0	99,400	99,400
August 25, 2001	0	103,300	103,300
Total	528,098	7,915,116	8,443,214

* These five sanitary sewer overflows were caused by equipment malfunction or insufficient conveyance capacity in the District's sewer system and were unrelated to the Deep Tunnel's capacity.

Sewer System Capacity

Inflow and infiltration, a siphon problem, and sediment deposits limit capacity.

The ability of the District's sewer system to convey wastewater and to store excess amounts in the Deep Tunnel until they can be treated is limited by surface water that flows directly into sanitary sewers through roof drains, sump pumps, leaky manhole covers in local sewers, and improper storm sewer connections, as well as by groundwater that infiltrates the system through defective sewers and manholes. A capacity problem also limits the District's ability to capture and store wastewater, and the amount of space available for wastewater in the Deep Tunnel has been reduced by groundwater infiltration and sediment deposits in the Deep Tunnel.

Water Inflow and Infiltration - Sanitary sewers are designed to carry only household and industrial waste and to exclude stormwater; however, all sanitary sewer systems experience inflow and infiltration to some extent, particularly as sewers age. Excessive, unintended water entering the sewer system as inflow and by infiltration presents a problem for both the District and the municipalities it serves.

The most current information suggests that inflow and infiltration have increased by 17.4 percent over 1980 levels.

In planning the Deep Tunnel's capacity, engineers assumed inflow and infiltration would be reduced by 12.5 percent through projects undertaken as part of the Water Pollution Abatement Program. However, the most current information available suggests that inflow and infiltration have actually increased by 17.4 percent over 1980 levels. According to the District, the increase in inflow and infiltration suggests progressive deterioration of the sewer systems over time, because higher rates of infiltration are expected in aging sewer systems. The District also believes that faulty construction techniques and illegal connections of sump pumps by homeowners in some developments have contributed to the problem.

The amount of inflow and infiltration entering sanitary sewers varies among municipalities within the District's service area. The District has established a standard under which a peak wastewater flow equal to or less than six times dry-weather flow is acceptable, but a peak wastewater flow that exceeds six times dry-weather flow is excessive. As shown in Table 14, the increase in peak wastewater flow ranges from a low of 2.8 times the dry-weather flow for Germantown, which is 1 of 7 municipalities that meet the District's standard, to a high of 16.4 times the dry-weather flow for Elm Grove and Fox Point, which are 2 of 21 municipalities that do not. It should be noted that the District does not measure inflow and infiltration in its own sewer system; therefore, no data are available to measure whether the District meets its own standard. District officials indicate that they believe the amount of inflow and infiltration contributed by the District's sewer system is small.

Table 14

Dry-Weather and Peak Flow for Sanitary Sewers in 28 Municipalities
(thousands of gallons per day)

Municipality	Dry-Weather Flow	Peak Flow	Ratio of Peak Flow to Dry-Weather Flow
Meets District Standard			
Germantown	2,446	6,830	2.8
Oak Creek	5,575	29,143	5.2
Muskego	1,412	7,681	5.4
West Milwaukee	2,096	11,497	5.5
New Berlin	3,646	20,201	5.5
Thiensville	521	2,971	5.7
Brown Deer	2,769	15,763	5.7
Does Not Meet District Standard			
Cudahy	4,892	30,980	6.3
Caddy Vista	35	222	6.3
Mequon	2,269	15,834	7.0
Greendale	2,283	16,131	7.1
Wauwatosa	8,819	63,772	7.2
Menomonee Falls	2,630	19,976	7.6
Brookfield	2,901	22,785	7.9
Milwaukee*	44,531	385,875	8.7
Franklin	1,854	16,591	8.9
Hales Corners	964	8,955	9.3
Whitefish Bay	1,730	17,286	10.0
Glendale	2,152	21,836	10.1
West Allis	8,236	86,292	10.5
St. Francis	1,336	14,375	10.8
Greenfield	3,587	42,904	12.0
Butler	451	5,883	13.0
River Hills	511	6,963	13.6
Bayside	846	11,706	13.8
Shorewood*	327	4,883	14.9
Fox Point	920	15,042	16.4
Elm Grove	1,042	17,042	16.4

* Includes only the areas of Milwaukee and Shorewood served by their own sanitary sewers, not these municipalities' combined sewers.

The District's ability to capture and store wastewater is limited by a capacity problem with its siphons.

Sewer Capacity Limitations Caused by Siphons - The existing sewer system restricts the amount of wastewater that can pass from the District's interceptor sewers through siphons that carry it under the Milwaukee River to the Jones Island Wastewater Treatment Plant. The Jones Island treatment plant was designed to treat a peak flow of 330 million gallons of wastewater per day; however, a consulting firm hired by the District reported in August 2001 that the siphons can deliver no more than 260 million gallons per day, which is 21.2 percent less than the plant's peak capacity. As a result, during periods of heavy precipitation, a significant amount of wastewater is diverted into the Deep Tunnel rather than treated immediately by the Jones Island treatment plant.

Although the siphons were updated in the mid-1980s as part of the Water Pollution Abatement Program, the problem was only recently identified. District officials have indicated they can partially compensate for this problem by pumping additional wastewater directly from the Deep Tunnel.

Inadequate siphon capacity contributes to overflows because wastewater is diverted to the Deep Tunnel rather than conveyed for treatment.

The siphon problem contributes to overflows because it results in the annual diversion of an estimated 1.0 to 2.0 billion gallons of wastewater to the Deep Tunnel. If the siphons operated as originally planned, this diverted wastewater would be conveyed to the Jones Island plant for treatment rather than to the Deep Tunnel, where it occupies available storage capacity and contributes to larger overflows. The extent to which overflow volume has increased because of inadequate siphon capacity cannot be calculated from available data.

Inflow, Infiltration, and Sediments in the Deep Tunnel - When the Deep Tunnel was constructed out of the natural bedrock, approximately 45 percent of its length was lined with concrete, and cracks in the walls of the remainder of the tunnel were grouted to control groundwater infiltration. Although the District's operating and maintenance manual recommends an inspection of the Deep Tunnel after the first year of operation and at five-year intervals thereafter, the District did not inspect the tunnel until early 2002. At that time, a consultant estimated that 2.8 million gallons of groundwater enter the tunnel each day. That amount is 1.9 million gallons per day less than original estimates. District officials speculate that minerals contained in groundwater have, over time, sealed or reduced the size of cracks in the Deep Tunnel's walls.

The consulting firm concluded that the Deep Tunnel was generally in good condition and operating as expected, and it recommended the Deep Tunnel be inspected at ten-year intervals. However, the 2002 inspection did show that at least 2.5 million gallons of wastewater and 521,000 gallons of groundwater were inadvertently reaching the Deep Tunnel daily from leaky sewers. For example, the consulting firm found that a City of Milwaukee sewer was plugged with sand and gravel,

causing a diversion of wastewater into the Deep Tunnel, and two of the District's sewers were plugged with debris that was causing wastewater to enter the Deep Tunnel. It is not known how long these diversions occurred, but the obstructions have been removed.

A buildup of sediments consisting of rocks, sand, and silt was found in portions of the Deep Tunnel, along with other materials, such as sports balls and plastic bottles. It is estimated that sediments and other materials have reduced the capacity of the Deep Tunnel by approximately 0.5 percent, or 2.1 million gallons. In April 2002, the consulting firm that performed the inspection recommended removal of the sediments and other material and estimated the costs for removal and disposal at between $2.2 million and $2.5 million. However, in a May 2002 letter to the District, the firm modified its recommendation to indicate that the removal of sediments did not require immediate action. At this time, it is not known whether the District will proceed with removal of sediments and other material from the Deep Tunnel. However, the District is unlikely to undertake additional grouting, because its consulting firm determined that additional grouting would eliminate less than half of the present infiltration and would be more than three times as costly as continuing to pump and treat the water entering through infiltration.

Operational Policies

The District and United Water Services have established procedures that are intended to meet the requirements of the District's wastewater discharge permit with DNR, including eliminating sanitary sewer overflows, minimizing combined sewer overflows, and avoiding overfilling the Deep Tunnel. While the District has generally met these requirements of its permit, we found that its procedures for eliminating sanitary sewer overflows have led to larger combined sewer overflows than would have otherwise been the case. In addition, we found that United Water Services has shut off Deep Tunnel pumps during periods of peak electricity rates in order to save money, despite larger overflows caused by this practice.

Deep Tunnel Sanitary Sewage Reserve Capacity - Combined sewer overflows generally contain lower levels of pollution than sanitary sewer overflows because combined sewage is diluted by rain and snowmelt. As a result, the District's wastewater discharge permit issued by DNR generally prohibits sanitary sewer overflows but allows up to six combined sewer overflows each year.

Combined sewer overflows may occur even when the Deep Tunnel is not full.

Because of the location of the Deep Tunnel and the configuration of the sewer system, wastewater from combined sewers reaches the tunnel first during a storm. In an attempt to eliminate sanitary sewer overflows, as required by its permit, the District reserves a portion of the Deep Tunnel's capacity to capture the sanitary sewage. One consequence of this policy is that the District allows combined sewer overflows to occur even though the Deep Tunnel is not full.

The volume reserved in the Deep Tunnel for sanitary sewage has changed over the years. Following a July 1999 storm in which 62.2 million gallons of sanitary sewage were discharged into area waterways, the District increased the amount of the Deep Tunnel's capacity reserved for sanitary sewage from 40 million gallons to 200 million gallons. By reserving additional capacity for sanitary sewage, the District minimizes the likelihood of a sanitary sewer overflow. It should be noted that the 200 million gallon reserve capacity is intended as a general guideline, and the District expects United Water Services to modify the reserve capacity during a storm based on predicted wastewater flows and precipitation intensity in various areas of the District.

A policy change has reduced the volume of sanitary sewage overflows but increased the volume of combined overflows.

The new reserve policy has reduced the volume of sanitary sewage overflows, but it has also resulted in combined sewer overflows that could have been avoided or reduced if the Deep Tunnel had been filled to capacity. For example, in a July 2000 storm, an estimated 70 million gallons of additional sanitary sewage that would have been discharged into area waterways under the 40 million gallon reserve policy was captured under the new policy. However, during the same storm, 93.5 million gallons of storage capacity, or nearly a quarter of the Deep Tunnel's capacity, remained unused while 791.7 million gallons of untreated combined wastewater was discharged into area waterways.

Overall, during six of the nine combined sewer overflows that have occurred since the new reserve policy was adopted, a significant amount of the Deep Tunnel's capacity went unused. As shown in Table 15, over 100 million gallons of unused storage capacity remained in the Deep Tunnel during three different overflows since the new policy was enacted. If the Deep Tunnel's storage capacity would have been

completely utilized during these storms, combined sewer overflows would have been reduced by 656 million gallons, or 14.1 percent. Moreover, during the August 2001 overflow, enough storage capacity remained in the Deep Tunnel to capture all of the combined sewage that was released into Milwaukee-area waterways.

Table 15

Available Deep Tunnel Storage Capacity During Overflows Since September 1999
(thousands of gallons)

Overflow Dates	Combined Sewer Overflow Volume	Sanitary Sewer Overflow Volume	Unused Deep Tunnel Storage Capacity
September 28-29, 1999	498,711	72*	149,170
May 17-20, 2000	1,539,100	109,650	2,500
June 1-2, 2000	194,200	29*	109,640
July 2-3, 2000	791,700	4,736	93,520
August 5-6, 2000	127,200	1,990	46,670
September 11-14, 2000	837,500	21,130	2,680
February 9-10, 2001	261,900	55,840	4,940
June 12-13, 2001	99,400	0	67,770
August 25, 2001	103,300	0	179,080
Total	4,453,011	193,447	655,970

* These sanitary sewer overflows resulted from insufficient conveyance capacity and were unrelated to the Deep Tunnel's capacity.

District officials have indicated that reserving adequate storage capacity for sanitary sewage depends on accurately predicting weather patterns and storm intensity, which affect the volume of wastewater entering the District's sewer system from each municipality's sanitary sewers. However, limited data are currently available to allow the District to determine how much capacity must be reserved during a storm to capture sanitary sewage. As noted, unlike wastewater flows from the combined sewers, which can reach the Deep Tunnel in a matter of minutes after the start of a storm, it may take several hours for the flows from sanitary sewers to reach the Deep Tunnel. The automated system the District currently uses to monitor wastewater volume throughout its service area does not permit precise predictions of the volume of sanitary sewage that will enter the Deep Tunnel, and weather

predications are frequently inaccurate. Therefore, United Water Services must make decisions that affect the amount of wastewater that may be discharged into local waterways without complete information.

Turning Off Deep Tunnel Pumps - In an effort to reduce costs, United Water Services uses two different sources of electrical power for pumps that remove wastewater from the Deep Tunnel. United Water Services purchases electric power from the local electric utility from 10:00 p.m. to 9:59 a.m. weekdays and on weekends and holidays, when the rates are lower (off-peak). United Water Services generates its own electrical power with turbines at the Jones Island Wastewater Treatment Plant during other peak times, when purchasing electricity from the utility is more expensive.

A money-saving strategy resulted in the discharge of an additional 107.0 million gallons of wastewater.

When United Water Services changes the source of power supplied to the pumps, the pumps must be shut off for at least one hour to cool before they can be restarted. Turning the pumps off reduces the amount of wastewater that is pumped from the Deep Tunnel, thereby decreasing the available storage space and influencing decisions on when gates are closed or reopened to allow wastewater into the tunnel. Based on our review of detailed overflow data from June 1999 through December 2001, we estimate that an additional 107.0 million gallons of untreated wastewater was discharged into area waterways during six overflows as a result of turning pumps off to switch power sources. Available data did not permit us to estimate the volume of additional sewer overflow that resulted from this policy before June 1999. District officials indicated that this procedure has been a standard practice since early 1996, and therefore precedes the contract with United Water Services, which began in March 1998.

Although we estimate that United Water Services saved approximately $515,000 by switching power sources during these overflows, turning off the pumps in order to save money appears to violate the terms of its contract with the District. District officials indicated they have been working with United Water Services for the past three years to resolve the problem and that in September 1999, they issued a notice of contract noncompliance to United Water Services that was related to this issue. However, the notice did not specifically address the issue of turning off the pumps during overflows as a cost-saving measure. In addition, the District did not issue additional notices of noncompliance even though United Water Services turned pumps off during sewer overflows on four occasions subsequent to September 1999.

After we raised this issue with the District during the course of our audit, the District specifically directed United Water Services in March 2002 to continuously operate the Deep Tunnel pumps, regardless of energy costs, whenever the Deep Tunnel is being used to capture and store wastewater. District records indicate that during an April 2002 sewer overflow, the pumps were operated continuously as required. It

should be noted that the contract between the District and United Water Services does not give the District authority to impose any financial penalty against United Water Services for its apparent breach of the contract.

District officials indicated that they plan to upgrade electrical equipment in order to allow operators to switch power sources without having to turn off the pumps. A contract for preliminary engineering of this work was approved in January 2001, and construction is to be completed in spring 2003. The District estimates this upgrade will cost between $50,000 and $100,000.

Sewer Overflows in Wisconsin

Excluding the District, there were 988 reported sewer overflows in Wisconsin from 1996 through 2001.

The District is not the only operator in Wisconsin to experience sewer overflows. As shown in Table 16, there were 988 reported sewer overflows, excluding the District, from 1996 through 2001, which resulted in the discharge of 564.1 million gallons of untreated wastewater to Wisconsin waterways. These overflows, in 288 different sewer systems, were caused by rain, snowmelt, equipment failure, power outages, plugged sewers, and flooding.

Table 16

Statewide Sewer Overflows, Excluding the District

Year	Number	Estimated Volume (millions of gallons)
1996	173	115.3
1997	124	81.2
1998	177	113.2
1999	148	77.2
2000	194	77.6
2001	172	99.6
Total	988	564.1

Sewer overflows occur in the District's sewer system as well as in sewer systems owned and operated by the municipalities it serves. As shown in Table 17, 19 of the 28 municipalities served by the District reported a total of 189 sewer overflows from 1996 through 2001, resulting in the discharge of 146.1 million gallons of untreated wastewater to Milwaukee-area waterways. Approximately 86.0 percent of these overflows were caused by rain, snowmelt, or flooding.

Table 17

Sewer Overflows in Municipalities Served by the District*
1996 through 2001

Municipality	Number	Estimated Volume (millions of gallons)
West Allis	22	3.4
Brookfield	20	40.9
Wauwatosa	20	11.6
Milwaukee	14	33.8
Whitefish Bay	13	11.3
Bayside	12	2.1
Menomonee Falls	12	6.5
Elm Grove	11	3.6
Cudahy	10	0.7
Mequon	10	17.2
River Hills	8	1.3
Brown Deer	7	1.0
Hales Corners	7	0.4
New Berlin	7	4.4
Fox Point	5	1.4
Germantown	5	2.3
Shorewood	3	<0.1
Muskego	2	1.2
Thiensville	1	3.0
Total	189	146.1

* The cities of Franklin, Glendale, Greenfield, Oak Creek, and St. Francis; the villages of Butler, Greendale, and West Milwaukee; and the Caddy Vista Sewer District reported no sanitary sewer overflows from 1996 through 2001.

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Through 2010, the District plans to spend $786.4 million on capital projects to increase capacity and reduce the amount of stormwater entering sanitary sewers. These projects include building additional wastewater storage, making improvements to the sewer system, implementing a new wastewater flow control system, and increasing treatment plant capacity. In addition, the District is undertaking watercourse improvement projects in an effort to reduce flooding and improve water quality. The District is also preparing to begin work on its comprehensive 2020 Facility Plan, which will review a broad array of alternatives for reducing future overflows, preventing flooding, protecting the environment, and improving water quality. That plan is expected to be completed in 2007.

Efforts to Increase Capacity

To increase the capacity of its system, the District plans to:

- add additional wastewater storage capacity;
- improve and rehabilitate the Jones Island siphons, the collector sewers, and other aspects of its sewer system;
- update its control system to evaluate changes in storage capacity over time; and
- increase the wastewater processing capacity of its treatment plants.

Additional Storage Capacity

Three new sewers are expected to provide 116.0 million gallons of additional storage capacity.

By December 2009, the District plans to construct three wastewater storage sewers that are expected to provide 116.0 million gallons of additional storage capacity for sanitary sewage. As shown in Table 18, the District plans to spend $175.5 million to construct this additional storage capacity.

Table 18

Planned Wastewater Storage Sewers

Project	Estimated Cost (millions)	Additional Storage Capacity (millions of gallons)	Scheduled Completion
Northwest side relief sewer	$131.7	89.0	December 2006
Wisconsin Avenue sewer	25.3	24.8	December 2009
Port Washington Road sewer	18.5	2.2	December 2009
Total	$175.5	116.0	

The Northwest side relief sewer project will consist of a 7.4 mile, 20-foot diameter tunnel that will hold approximately 89.0 million gallons of sanitary sewage. A construction contract was awarded in December 2001, and the project is expected to be completed in December 2006. The Wisconsin Avenue sewer project, scheduled for completion in December 2009, will consist of a 2-mile, 20-foot diameter tunnel that will provide an additional 24.8 million gallons of storage for sanitary sewage. Finally, the Port Washington Road sewer project, scheduled for completion in December 2009, currently is expected to consist of a 2-mile, 6-foot diameter sewer that will provide approximately 2.2 million gallons of storage for sanitary sewage. District officials indicate that this project is still being reviewed and may be increased to provide additional storage capacity.

Additional storage capacity is expected to reduce sanitary sewer overflows.

The three wastewater storage sewer projects are expected to reduce sanitary sewer overflows caused by a lack of storage and conveyance capacity. The addition of more storage capacity may also allow the District to reduce its Deep Tunnel sanitary sewage reserve. Therefore, the District will need to closely review its sanitary sewage reserve capacity to ensure that future combined sewer overflows are reduced as much as possible.

Improvements in the District's Sewer System

To correct the problem that prevents siphons from delivering sufficient wastewater to the Jones Island Wastewater Treatment Plant, the District has budgeted $96.2 million for their redesign and reconstruction. This project is expected to be completed by 2007. District officials expect the redesigned siphons to deliver wastewater at a rate of 390 million gallons per day to the Jones Island plant.

The District has also budgeted $77.7 million through 2010 to maintain and increase the wastewater transportation capacity of its sewer system. Planned projects include construction of additional sewers that will provide additional capacity during times of high wastewater flow, rehabilitation of existing sections of interceptor sewers, and increased capacity at four sewage pump stations.

Improvements in the Control System

In order to reserve the appropriate storage capacity for sanitary sewage in the Deep Tunnel, the District must be able to accurately predict wastewater flows from each municipality. As noted, this task is complicated by the lag between the onset of precipitation and the time required for flows from the outlying municipalities to reach the Deep Tunnel. The current control system, which was installed in 1986 as part of the Water Pollution Abatement Program improvements, does not provide adequate information to predict wastewater flow.

A new $16.5 million control system is scheduled to be operational by December 2004.

The District has included $16.5 million in its capital budget for planning and construction of a new "real-time" control system, which is scheduled to be operational by December 2004. The proposed system incorporates technological improvements that have occurred since 1986, and it is expected to allow the District to better predict storage capacity needs by, for example, updating precipitation data every 15 minutes rather than every 24 hours, as the current system does. In addition, the new system is expected to integrate data collection systems that are now separate, including rain gauges and flow monitors, and to automatically adjust the sanitary sewage reserve capacity every 10 minutes based on these data. While the new system will improve the District's operations, officials indicate that it will not completely eliminate the need to establish tunnel reserve capacity, because its ability to accurately predict the amount, time, and location of precipitation that will fall in the District's service area will still have limits.

Increasing Treatment Plant Capacity

The District's two treatment plants cannot reach their designed capacities.

Maximizing the available capacity of sewage treatment plants can reduce the size and frequency of overflows. Although District documents state that the Jones Island Wastewater Treatment Plant has a peak capacity of 330 million gallons per day, and the South Shore plant has a peak capacity of 300 million gallons per day, a consultant hired by the District determined that actual maximum capacities are 295 million gallons per day at the Jones Island plant, and 260 million gallons per day at the South Shore plant.

The consultant recommended improvements that would increase the Jones Island plant's capacity by 80 million gallons per day, or 27.1 percent over current actual capacity, and the South Shore plant's capacity by 60 million gallons per day, or 23.1 percent over current actual capacity. The District has budgeted $5.8 million for these capacity improvements, which it has estimated may be completed by September 2004 at Jones Island, and by March 2003 at South Shore.

Efforts to Reduce Stormwater Entering Sanitary Sewers

Because the amount of stormwater that is captured and treated can have a substantial effect on the number and volume of sewer overflows, the District has undertaken several initiatives to reduce the amount of stormwater entering its own sewer system, the Deep Tunnel, and the treatment plants, including:

- inflow and infiltration reduction projects;
- watercourse improvement projects; and
- stormwater rule changes.

Inflow and Infiltration Reduction Projects

The District hopes to reduce inflow and infiltration by 5 percent district-wide.

As noted, inflow and infiltration reduce the system's available capacity for conveying wastewater and contribute to overflows. Eliminating sources of inflow and infiltration is complicated by the fact that many sources—including illegal non-sanitary connections and leaky sewers that convey wastewater from households and businesses to the municipal sewers—occur on private property. The District's 2010 Facility Plan established a goal of reducing inflow and infiltration by 5 percent district-wide through 2010. To reach this goal, the District is undertaking several projects in the municipalities it serves.

In September 1998, the District adopted new rules directing municipalities served by the District to minimize infiltration and inflow to the "maximum extent economically achievable." To assist the municipalities in implementing the rules, the District budgeted $8.6 million to provide funding for municipalities to evaluate their sewer systems. The amounts budgeted for this purpose, which are listed in Appendix 3, range from $2.5 million for the City of Milwaukee to $10,013 for the Caddy Vista Sanitary District.

Through 2001, the District has provided $5.7 million to municipalities for sewer system evaluations. District officials indicate that available funds were allocated based on the size of the communities' sewer systems, using factors such as total system length and number of manholes, which are one of the primary pathways for inflow.

The District will spend $2.1 million for demonstration projects in eight communities.

The District has also entered into agreements totaling $2.1 million for demonstration projects awarded on a competitive basis to eight communities. The projects are intended to identify economically feasible approaches for addressing inflow and infiltration problems. For example, Caddy Vista is investigating whether it is more cost-effective to eliminate sources of inflow and infiltration in the public right-of-way or on private property. Brown Deer is inspecting and repairing sewers on private property using a new technology that lines the sewer from the public street. As shown in Table 19, project funding ranges from $521,000 in Wauwatosa to $100,000 in the City of Milwaukee.

Table 19

Inflow and Infiltration Reduction Demonstration Projects
As of July 2002

Municipality	Amount Approved	Payments through 2001
Bayside	$ 230,000	$ 45,968
Brown Deer	200,000	0
Caddy Vista	146,525	42,450
Elm Grove	312,000	66,815
Milwaukee	100,000	0
Oak Creek	291,800	0
Wauwatosa	521,000	38,698
Whitefish Bay	249,500	0
Total	$2,050,825	$193,931

Information gained from the demonstration projects will be shared with other municipalities the District serves. These projects are expected to be completed by December 2002, although monitoring of inflow and infiltration will continue into the future in order to assess the success of the reduction efforts. Furthermore, a recent agreement between the District and DNR requires the District to spend $2.9 million over the next six years on inflow and infiltration reduction on private property and to adopt rules on private property inflow and infiltration by December 2007. Finally, to address inflow and infiltration problems within its own sewer system, the District budgeted $945,000 in 2002 for projects that include identifying sources of inflow and infiltration, sealing manhole covers, and installing liners inside manhole shafts.

Watercourse Improvement Projects

Watercourse improvement projects may include:

- construction of levees and flood walls;
- construction of underground stormwater storage basins and above-ground detention ponds;
- rehabilitation of streambeds to improve flow and reduce erosion and sedimentation;
- rehabilitation and restoration of natural floodplains;
- land acquisition for conservation purposes;
- stormwater management to improve water quality; and
- purchase and demolition of homes and commercial buildings that cannot be protected from flooding through other means.

While the primary benefits of these projects are reducing the damage to structures caused by flooding and improving water quality, the projects also serve to reduce inflow into the sewer systems, which contributes to sewer overflows.

Through 2010, the District plans to spend $410.0 million for watercourse improvement projects.

As shown in Table 20, through 2010, the District plans to spend $410.0 million from its capital budget for watercourse improvement projects, including $133.8 million that was spent through 2001. Watershed projects for the Milwaukee and Menomonee rivers and their tributaries account for 78.9 percent of all current and planned expenditures. It should be noted that a September 1996 ruling by the Public Service Commission restricts the District to allocating capital costs associated with watercourse improvements to those communities that "are clearly tributary to the watercourse being improved." Therefore, the District reduces capital charges for communities outside of its service area in order to offset costs associated with watercourse improvement work that does not directly benefit them. From 1997 through 2001, ten communities received reductions in their capital charges totaling $36.1 million.

Table 20

Anticipated Costs for Watercourse Improvements
(in millions)

Watershed	Expenditures through 2001	Anticipated Costs 2002-2010	Total
Milwaukee River	$97.1	$ 34.2	$131.3
Menomonee River	24.3	167.7	192.0
Miscellaneous projects*	6.6	40.0	46.6
Root River	4.1	12.4	16.5
Kinnickinnic River	0.6	15.8	16.4
Oak Creek	1.1	4.4	5.5
Lake Michigan drainage	0.0	1.7	1.7
Total	$133.8	$276.2	$410.0

* Includes studies on sedimentation, water quality, and stormwater best management practices, a long-term watercourse maintenance plan, conservation and greenway plans, and allowances for cost overruns and project close-out issues.

We reviewed financial data for the watercourse projects undertaken to date and found that costs for the Lincoln Creek project (which is part of the Milwaukee River watershed) have been significantly higher than originally projected. In addition, increases in projected costs during planning for the Menomonee River watershed watercourse improvement project raise concerns about the potential for similar cost increases.

Lincoln Creek drains a 21-square-mile urban watershed that includes parts of the north side of the City of Milwaukee, the City of Glendale, and the Village of Brown Deer. The Lincoln Creek watershed has a history of flooding, which caused significant property damage in June 1997 and August 1998. The Lincoln Creek project was designed to protect approximately 2,000 homes and businesses in the 100-year floodplain by widening and deepening the creek's channel, constructing floodwater detention basins to hold 80 million gallons of floodwater, and flattening and widening the natural floodplain. Construction on the Lincoln Creek project was substantially completed in early 2002.