

11
how many overflows

account to ~~prevent~~ overflow not supposed
to have any sanitary overflow

many communities (189 in 6 yr. period)
Pg 36-37 had overflows in sanitary

overflow reasons

- o 5 large storms

- o

penalties - allowed 6 a year

DNR did not take any action for any
sanitary sewer

DNR stipulated agreement to take add.

finished early 2002
doesn't address indiv. - \$ to prevent or reduce
human error & mechanical error

can cause the problems

largely put in treatment & storage
capacity

most recent overflow - DNR said they may

DNR - ask for presence

MMSD

1. July 2002

haven't done addl audit field work
current only through 7/02

2. Sen Darling requested the hearing

in findings

• Hear from MMSD about use of
what done
depends on wh

3rd audit in 10 years - ongoing audit
97, 91, 02 w/ diff focus

1st one - contracting

2nd one - mismanagement

3rd one - sewer overflow compliance

Milw sewer

2 diff kinds

combined - storm & sanitary

part of Milw showed

pg 13 (data in map combined)

overflow - largely rain water

mixture of both

overflow in combined

pg 24-25 # sewer overflow sanitary & combined

averages / 4.9 sanitary

of " " 3.00 combined

1. overflow

2. fiscal aspects - capital funding inside vs outside the dist.

96 base on her value rather than use

Scope - overflows + reason for them

recommend's - none

underest. costs

3. governance

structure of MMSD

① Jan - cover report - common groundwork updating what issues out there since the

② Kevin Schaffer ^{for} District - Exec Dir.

③ DNR

← Jan come back up to clarify?

11 members W/L Miller

7 Miller may be apted

3 spec in other

1 elected officials from

bring Kevin back up

Meigron German town - outside

contract w/ dist to sewerage

- reason for overflow
- count the "
- don't look at ways to incr. capacity
- Kevin done better job to work w/ outlying communities

Env. groups may show up - lawsuit dismissed

- questions
- article - highest

You're in

— Good Company

Across the country, cities have mandated that residents disconnect their downspouts from the sewer system. In Portland, Oregon, tens of thousands of homes disconnected, removing more than a million gallons of water from the sewerage system. That's valuable extra capacity and a very important step in reducing residential flooding. Disconnecting also helps keep our waterways clean by reducing the risk of a sewer overflow. For more information on similar programs and their successes, visit these Web sites:

Vancouver, Canada
www.cityfarmer.org/downspout.html

Toronto, Canada
www.city.toronto.on.ca/watereff/downspout.htm

Portland, Oregon
www.ci.portland.or.us/only/downspoutdisconnection.html

Chicago, Illinois
www.ci.chi.il.us/sewers/rain.html

Milwaukee, Wisconsin
www.mmsd.com

WHY

Should I Disconnect?

YOU can make a difference...

During a heavy storm, each downspout on your home can deliver 12 gallons a minute to the sewer system, which can contribute to basement backups and sewer overflows. By simply disconnecting a downspout, you can make a difference in keeping excess water out of the sewer system.



GET Disconnected

actions

For more information, visit www.mmsd.com

WHO Should Disconnect? Nearly Everyone!

Downspouts that are connected to the combined sewer system and any downspouts illegally connected to the sanitary sewer.

It's important to check with your municipality to make sure you can legally disconnect and that you disconnect correctly.

STEP 1 Contact Your Municipality

Bayside.....	414-247-7711
Brookfield.....	262-382-9650
Brown Deer.....	414-357-0120
Butler.....	262-783-2530
Caddy Vista.....	414-762-7878
Cudahy.....	414-769-2213
Elm Grove.....	262-782-6700
Fox Point.....	414-351-8900
Franklin.....	414-425-2592
German town.....	262-250-4720
Glendale.....	414-228-1710
Greendale.....	414-223-2133
Greenfield.....	414-761-5376
Hales Corner.....	414-529-6161
Menomonee Falls.....	262-532-4700
Mequon.....	262-242-3100
Muskego.....	262-679-4128
New Berlin.....	262-786-7086
Oak Creek.....	414-768-6547
River Hills.....	414-352-0080
St. Francis.....	414-481-2300
Shorewood.....	414-847-2650
Thienville.....	262-242-3720
Wauwatosa.....	414-479-8932
West Allis.....	414-302-8379
West Milwaukee.....	414-645-6238
Whitefish Bay.....	414-962-6690

In the City of Milwaukee

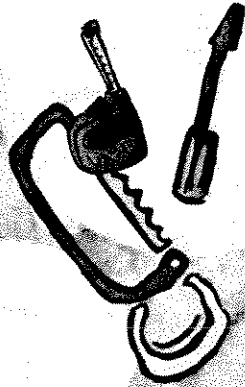
To find out if your home is connected to the combined sewer call: 286-2480

To find out if you can legally disconnect call: 286-3361

GETTING Started

Supplies you will need:

- 1) hacksaw
- 2) tape measure
- 3) hammer
- 4) screwdriver
- 5) pliers
- 6) sheet metal screws
- 7) downspout elbow
- 8) downspout extension
- 9) splash block (optional)
- 10) rubber cap



Total cost per downspout should be less than \$15.

STEP 2

Measure 9 inches from where the downspout enters the sewer connection.



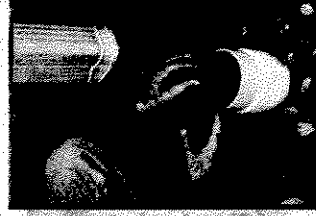
STEP 3

Cut the downspout with a hacksaw.



STEP 4

Cap the sewer standpipe. This prevents water from going in. In most cases, you should be able to use a simple rubber cap secured by hose clamps. You can also use a plug-out test plug if available cap sizes don't fit.



STEP 6

Attach a downspout pipe extension that is at least 6-foot long to carry water away from the house and foundation. You can use a hacksaw to cut the extension to the desired length. Insert the elbow into the extension to prevent leaks. Secure the elbow and extension with sheet metal screws. To prevent erosion where the water drains, you can place a splash block at the end of the downspout extension.



STEP 5

Insert the downspout INTO the elbow (if you put the elbow into the downspout, it will leak). You may need to crimp the end of the downspout with a pair of pliers to get a good fit.



Preserving The Environment • Improving Water Quality
www.mmsso.com

Dennis - not very exp @
up till 94

- struck - any time rain
sewer overflowed
- over last 8-9 years are
3 combined
- fact not any -
15 mos (\$10a)
- 30 day time to zero
- not designed to get to
zero
- 1.4 on ave.
expectation tighter
- 29 bodies tighter
local systems
- 29 entities
1790 more rainwater
- 30% more rainwater in
stuff getting + planned
for
- work w/ communities to
stop rainwater from

- at times contentious
at times cordial
- changed over time

DNR sewage

- level to due diligence
knowledge of project
- teaching word - pledge did
recommend.

amounts are large

amount sign - important
water quality has an issue
except an issue
bottom line not improve

no good way of comparing

CA PFA has a report

overflows -
94 50

3 now allowed to
64 goal

Pets replaced

pl. work w/ us to do better
very little till last few yrs.
off of our municipal land
transformed surface
in the watershed

limited water + more in the watershed
tries were -
draw to a conclusion
water quality
no longer come out of muni SD
pipes
every kind of pollutant
- largest is over land
- last 15 mos. other than
contractor overflow,
only drops got in pipes
that didn't

~~SD CR~~ - EPA relationship
ability to take enforcement
delegated state - DNR has
job admin clean water act

Slider one of 4 elected by
in ... than

- flow restrictions +
green roofs

- keep this resource
people kill + die for
this

SD -> a little under 3
- dramatic water quality
improvement

- no one swim there in 50
years
- nothing but carp could
live there
- slugs that live in
since 95 DNR went back
20-30 species of fish
33 species of fish

* when say turned w/ nets
river side part w/ nets
mayfair larvae -
mayfair water -

not a pristine water
look at what I see w/ eyes
look at what I see out of town
slugs, slugs

Alberta listed 4
disturbing facts

④

howie on MMSD not b/c find
fault - mills dollars
spent from taxpayers

① - can't have basement
- beach closed b/c no rain

② price tag except expensive
are we getting best bang
for our buck.

③ water quality

④ permit violations

had a neg. - if public feels
honest + open info
+ what say is on target

DG -

- ac customers
- price tag costly over next half
dozen yrs 78-900 mil
of variety of proj's
12.5 mil capacity

- Boston, Waco, St Louis, Knoxville
- look at other areas, not perfect
a lot of challenges

city just purchased
- prior to acquisition → zero
treatment

6 pipes - dump leachate
- 1946 MMSD began process
inorganic

- sewer was dead

- coop. basis across co + municipals
lines
rates extremely competitive

referenced articles

more great studies

& let a work ahead of us
continue to be a pioneer
tremendous diff since 1985
water bodies

- 33 species of fish water bodies

- 30 → 3 → 1.3

- fine tuning to be

5
- sewage rates credit + debit based on prev. yr. water credit
City of Mergu, U Elm Grove, water print in press not accurate

what doing to tell citizens the rest of the story
bring message to other elected officials
ongoing jobs to build in partnerships w/ organics.

Sue -
Mnemonee Falls - televised

Kevin
- Dir Tech serv Oct-98
- Exec Dir March 02
- engineer will back + masters

MMSD treats 40% WWT
420 sq. miles
123 mi. combined
J.S. 20 tot. area ..

polluted runoff of changing modest amounts of forested borders - along creeks in new ag land pay for more than how many solids

whole area 94-95
address from the perspective of yr. budget

overall water quality - open + honest accountability for.

Kevin Shafer much more open + direct + communicative
fully understands water quality improvement - went in a cost-effective manner

Seider - rep. municipalities as manage my munic gov
Same message - series of commun. when came - series of commun. w/comm + customer commun.

be allowed

separate overflows

Alberta - why beach closing

WOP Pt Poll. causing
beaches to close

Pocan - what major
sources?

KS WOP Pt. worked on a study
found at S. Shore beach

closed b/c of bird
droppings on

algae with
up on beach

Febra mussels

need scientists help

how much construction -
low hanging fruit

try to minimize

Sue - Great Lakes Lake + do
coop. effort

Dr. Whitman

cl - what's next
marine - manage beach better
to kill

2 pipes
sanitary - home / bus
↓
treatment plant

combined - surface water
& human waste

every

95-96% treating

hot system 10-15 miles of
rainfall

deep tunnel 405 gallons
as flow rises - collect flow
to

collect combined

200 mill gallons
reserve

bottom - combined

top - separate sewer
10-11 bus later

close gates from combined

Amused CSO comes sewer
then flows

Darling - leaves Miss article (7)
KS - 63 mill in effort in Chicago
talked to a combined
Shorewood installing
C. of Mill - concern w/ floods
Cont. to push

D-1 engineer says not going to do it
everyone talks about separating
+ more water quality
put inlet restrictor in

encourage Mill.

330 mill gallons a day

not full treatment - 2ndary
treatment

not partially treated - not
dumped wet water

CAHS told us to max. use
humpless power switchover
switch between

Don't Co-impact from
beach closing
improve testing methods

Mill in
quarter of in overflow or not

Darling -
whose accountable for water

quality
whose responsible
we get the calls of great
beach days

KS Miller Co parts system - if

- oversee overflow - if
- everyone's responsible
dig built on beach
kids swim + do...

Darling
assessment backlogs

Darling what do about
human error

KS - very difficult to go
to track
0 built ble cassette
+ 2

(8) Triad report developed for LT planning submitted on # not vol.

06 overflows
an est. w/ set of criteria
00-01 - decide on estimates
good - we did on our own to improve
marked for final -
needed to review + finalize
apologize to commission

hired a prof. from CO state to

Identify
don't have a water monitor
elev. of lake - calcul.
how much

not a gauge a computer Calc.

gauge - shd use that gauge + installed depth gauges in the stream

Harker siphon project
- 90% design complete
- Con

more inflow to Jones Isl.
Lobbying
200,000/yr for lobbying
I will over 5 yrs.
excuse - returning
1/9 # 10 mil in
awards + grants
awards + grants

Lincoln Creek
- pushing
- 8 a mos ahead of
- schedule award
- Design build award

beach closing
May 15 - Sept 30

2000 facility plan
announcing ahead

work together as a region
incentives for 2005
ask for lots of support
in cos + municipalities

will mail copy of report
determine where want water

comparable let
lowest sewer water
rates
— 3rd lowest in Midwest
— 7th lowest of all
in lowest
rates

2003 all in
\$170/1000 of equalized
volume
118 credit
all 28 communities

2003-04 -
since 1996 want to bill for cap
improvement

violations of contract

1. penalties
consider other contract
open bidding
possibility of other vendors

cover ltr. audit on water
services

Don (Seattle wants to beat DW)

no penalties or incentives

1/7 this yr.

1998 - March 2008 contract

66.4 million saved

in 5 years
Nat org that not
use

2 platinum awards
highest awards

do need to improve contracts -
maximum elements -
fine or penalty

< 400 colonies
contract 100 colonies
effluent quality

article excerpts
Dorling - toilet to zero level
what wd that cost -
cost is prohibitive
every drop of water

Prod. report in Oct.

- floatables -
- vor screens front end
 - never seen these floatables
 - till the last complex
 - vsko - way get
 - can't find treatment
 - through plant
 - in plant
 - now it 2006 - in plant
 - inverter + tail end
 - front end capture
 - could be coming from other sources

Plale - both plants in dist. (10)

Ogat Creek - odor Bradford S. Shore beach - # of closing esp S. Shore beach

when get closer if you in my PO's what tell them the better facilitate neighbors + mmsd

- spring + summer
- mean of understanding
- huge parking lots needed for sea gulls
- grooming beaches

take up on oppert. help w/ public -

- 2nd following to hearing
- shows priority placed
- comment you learned
- comment you on what done

1.11.

Darling - overflow

- cost of Proj's
- Triad report accuracy
- open + honest gov.
- much cleaner governance
- assurance accurate info
- consist excited
- stronger ~~PR~~ media + PR
- want a accountability done in more simple + direct way
- partner on water

US - #1 priority improve relationships

- have citizen adv. comm. once a mo - future + current
- tech. adv. events - wks.
- ... to come back every year

(11)

adv. comm. working on 880 mile hearing

- plog.

Plate - S. Wilms only city in Minn. rep. Co not part of MMSD have own sewer plants

Since seen a city Jim indicated yes

discharge statements - dis. 18,000 lbs of mercury don't hear occur - being Judg. 18 miles

record keeping issue

of operators 5 miles + MMSD

referred to DOS for enforcement

ten mile double - S. Wilms Plant vs. MMSD double standards

Pauline
DNR bigger watch dog
11.17 MMSD DOS

~~_____~~

DNR - do not ^{have} authority

- WI all too often has stricter compliance
- take into health & safety
- 3 ~~to~~ are - 6 for con

Referral plog. to refer a

discharge to DOS

counterpart contractor + MMSD

fact gathering

100,000

280,000 int. est.

90,000 current est.

- water quality - ongoing planning

- birds

- 50,000 Sturgeon fry

GL Inst. -

- Opport. to watch sturgeon to watch internet radio
- hope Popul. - rest. collar
- Kevin a chick covered ground
- part of res. group
- 2 issues being discussed

1. beach closing
 - reflect. of small part of water - out in lake

~~2. water stream water~~
 that contain wet there
 bacteria near shoreline
 - shoreline center
 - Journal water resources
 - study
 - water sample

DNR never been CSO vid.

W there a regional coop coalition to address beach concerns

trying to get fed \$ from beach fact 2002

water quality monitoring
 gd enough - getting elsewhere

Jan - TU for 2nd hearing held - get that scheduled
 Pledge to you continue to follow + monitor time

funding TU team
 - one. Bows

Request in a day
why urban storm
water so high

CSO part of discuss.
several (10 proj's in lab)
w/ not in source kiddin'
ourselves only
sanit. sewage
combined

have systems w/ small
pinholes

sample off a part
> 100,000/100 miles

part water shed -
not

spend \$ bench mark
these things

CSO in seg manner -
beach closing tied
more closely
to

science out there - chlorinate
most management approach
i.e. n.a. management

birds carry ~~sewage~~
studies not at this level
if MARSD fund
if vidag Scientific
Studies

~~test~~
urban storm water
has a huge effect

water quality has not signtly
improved - troubling
to say CSO's not the
problem

bact. counts
> 12,000 miles
reported 235/100 miles
Jose when →

1500 - 20,000/100 miles

when no overflow less
bacteria in downtown

accessib. of long term monitors
set

- how much gas in when rain
- closed garbage cans
- less paved services
- divert to storm heat system

monitor how well works

**AN EVALUATION OF
MILWAUKEE METROPOLITAN
SEWERAGE DISTRICT**

JULY 1991

91-18

1991-92 Joint Legislative Audit Committee Members

Senate Members:

**Brian B. Burke, Co-chairperson
Gary George
Marvin Roshell
Alan Lasee
Margaret Farrow**

Assembly Members:

**Shirley Krug, Co-chairperson
Peter Barca
Barbara Linton
Susan Vergeront
Dale Schultz**

The Legislative Audit Bureau is a nonpartisan legislative service agency responsible for conducting financial and program evaluation audits of state agencies. The Bureau's purpose is to provide assurance to the Legislature that financial transactions and management decisions are made effectively, efficiently and in compliance with state law, and that state agencies carry out the policies of the Legislature and the Governor. Audit Bureau reports typically contain reviews of financial transactions, analyses of agency performance or public policy issues, conclusions regarding the causes of problems found, and recommendations for improvement.

Reports are submitted to the Joint Legislative Audit Committee and made available to other committees of the Legislature and the public. The Audit Committee may arrange public hearings on the issues identified in the report, and may introduce legislation in response to the audit recommendations. However, the findings, conclusions, and recommendations in the report are those of the Legislative Audit Bureau.

State Auditor - Dale Cattanach

Editor of Publications - Cassandra Jacobs

Audit Prepared by

Don Bezruki, Director - Contact Person
Timothy Saterfield
Timothy Coulthart
Emma Caspar
Sean Dingeldein
Morna Foy
Laura Sausen
A. John Voelker

TABLE OF CONTENTS

LETTER OF TRANSMITTAL	1
SUMMARY	2
INTRODUCTION	6
Water Pollution Abatement Program	9
Program Management Office	11
CONSTRUCTION COST INCREASES	14
Construction Contract Modifications	14
Types of Modifications	15
North Shore Tunnel	16
Geotechnical Review	18
Payment Provisions	19
Jones Island Treatment Plant	22
Project Design Change	23
Market Conditions	25
Contracting Decisions	26
PROGRAM MANAGEMENT	28
Program Management and Engineering Costs	28
Consultant Profit	30
Cost Control Mechanisms	31
Contracting Method	31
Monitoring	33
District Oversight	35
Contract Type	35
Engineering Design Review	37
Evaluations	38
Master Agreement	39
ADDITIONAL MANAGEMENT CONCERNS	42
Ineffective Use of Consultant Contracts	42
Failure to Document Noncompetitive Negotiations	43
Apparent Serial Purchasing	43
Questionable Purchasing Practices	44
Contracting Without Sufficient Funds	44
Failure to Follow Contract Terms	45
Unnecessary Use of Contracted Consultants	46
APPENDIX - RESPONSE FROM THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT	



State of Wisconsin \ LEGISLATIVE AUDIT BUREAU

DALE CATTANACH
STATE AUDITOR
SUITE 402
131 WEST WILSON STREET
MADISON, WISCONSIN 53703
(608) 266-2818
FAX (608) 267-0410

July 12, 1991

Senator Brian B. Burke and
Representative Shirley Krug, Co-chairpersons
Joint Legislative Audit Committee
State Capitol
Madison, Wisconsin 53702

Dear Senator Burke and Representative Krug:

We have completed an evaluation of the Milwaukee Metropolitan Sewerage District's implementation of the Water Pollution Abatement Program, as requested by the Joint Legislative Audit Committee. This program was initiated to improve sewage treatment and eliminate sewer overflows into Lake Michigan and is expected to cost \$2.29 billion when it is completed in 1996. The program is the largest public works project in the State's history.


The Pollution Abatement program has experienced significant, unanticipated construction cost increases since its inception. The largest increases have occurred as a result of two projects, construction of a portion of the North Shore tunnel and rehabilitation of a sewage dewatering and drying facility at the Jones Island treatment plant. Overall, construction contract increases of 15 percent, or \$205.9 million, have been approved as of December 1990.

The District contracted with an engineering consultant to manage the program and provide the majority of engineering services. While the District has retained final approval for program fiscal and policy decisions, we believe the District could have done more to monitor the consultant's performance to ensure funds were spent effectively.

We also found the District needs to improve its policies and procedures for procuring consultant services. We found several procurement practices that, while not in violation of current district policies, would not be allowed under state and federal regulations and, in general, do not appear to be good public policy. The District has taken steps to clarify and improve a number of these practices.

We appreciate the courtesy and cooperation extended to us by district staff and commissioners. A response from the Milwaukee Metropolitan Sewerage District is the appendix.

Respectfully submitted,


Dale Cattanach
State Auditor

DC/DB/ce

SUMMARY

As of December 1990, the Milwaukee Metropolitan Sewerage District has spent \$1.7 billion to implement a sewerage improvement program, called the Water Pollution Abatement Program. Initiated in 1977, the program seeks to reduce the amount of sewage discharged into Lake Michigan and ensure sewage treatment and disposal meets environmental safety provisions in federal and state law. Program projects include upgrading sewage treatment plants, improving or replacing sewer lines, and constructing several deep tunnels to store sewage during peak sewer flows. The District expects the projects to be completed, on schedule, in 1996 for an estimated total program cost of \$2.29 billion. In addition to program costs, it is estimated the District will incur \$500 million in financing costs. When completed, it will be the largest public works project in the State's history and one of the most complex.

At the beginning of the project, district officials believed the District lacked the necessary experience and resources to manage the program and provide engineering services. Therefore, the District contracted with an engineering consulting firm. This lead firm then formed a Program Management Office, which includes the lead engineering consultant and, over the course of the program, up to 100 subconsultants chosen by the lead engineering consultant and the District.

It is unusual for one engineering firm to provide a municipality with both management and engineering services, but district officials believed the benefits of project continuity and increased organization gained through contracting with a single firm would offset any disadvantages. The Department of Natural Resources, the Environmental Protection Agency, which has awarded \$486.3 million in grants in support of the program, and the 11-member commission which governs the District approved the relationship.

Significant cost increases in program construction and design activities have raised questions about the District's efforts to monitor program expenditures and ensure funds are effectively spent. As of December 1990, construction cost increases totaled \$205.9 million, and engineering costs also increased significantly. We, therefore, examined the extent and nature of the cost increases and the District's efforts to monitor program implementation. The relationship between the District and communities which contract for sewage services with the District was not included in the scope of this audit.

Even though it contracted for much of the management and engineering work, it remained the District's responsibility to monitor the Program Management Office, and it appears the District provided some level of oversight. For example, as a measure of control, the District retained final approval on

awarding contracts and contract changes. None of the \$1.7 billion spent as of December 1990 on the Pollution Abatement program has been spent without district review and approval.

However, we believe the District could have done more in fulfilling its responsibility to monitor the Program Management Office and analyze program expenditures. Increases in both construction and engineering costs, and questionable purchasing and contracting practices, highlight the need for fulfilling this responsibility.

We found the value of construction contracts has risen 15.4 percent as of December 1990, from a total of \$1.34 billion to \$1.5 billion. Sixty-six percent of the increase can be attributed to one large contract for the construction of one portion of the North Shore tunnel, a deep tunnel for storing sewage before treatment. The increases associated with remaining construction contracts average 5.3 percent, which is within industry standards.

The contract for the construction of one section of the North Shore tunnel was originally awarded for \$46 million. As of December 1990, its cost had risen to an estimated \$182.8 million, largely because unstable ground conditions were encountered during construction which required additional construction measures, such as increased tunnel support.

The District, the Program Management Office, and the U.S. Army Corps of Engineers, which determines the eligibility of program costs for federal grant funds, have all conducted evaluations of the costs associated with the construction of this section of the North Shore tunnel. Their subsequent reports do not question the need for the additional construction methods, which increased substantially the cost of construction. However, questions about the payment provisions for the additional construction methods remain unresolved. We, therefore, believe an additional, independent engineering review of the North Shore tunnel cost increases, currently planned by the Commission, is necessary to obtain a reliable and independent judgment on this issue.

In addition to cost increases which occurred during construction, we found one contract, for a new facility at the Jones Island sewage treatment plant, was awarded for more than five times the amount of the initial estimate, which contributed to higher than anticipated overall construction costs. Although initial estimates indicated this facility would cost \$36.4 million to construct, the final low bid to construct the facility was \$194.6 million. Subsequent reductions in the scope of the project have resulted in cost reductions of \$12.2 million.

Several factors appear to have contributed to the higher than expected bid price, including a change in project design from original planning stages; the preliminary nature of the estimates, which were eventually refined and finalized; higher than expected construction material prices; and the competitive condition of the construction market. In addressing these factors, the District considered a number of alternatives and, in each case, chose an alternative which it believed would allow the District to meet program

completion deadlines and ensure a new facility would be built before the current facility deteriorated beyond use. However, each alternative it chose increased substantially the project's cost.

In addition to concerns over increases in construction costs, some have raised questions about the cost of the engineering and management services which the Program Management Office provides. To some extent, this is a question of how well the District negotiated its contract with, and monitored the performance of, the Program Management Office. As of December 1990, the District has paid the Program Management Office \$413 million for management and engineering services associated with the Pollution Abatement program. The Office's lead engineering consultant received about one-half of this amount, \$200.2 million.

Of the \$413 million the District paid the lead consultant and subconsultants, \$61.2 million was profit. However, because there are few projects of similar size to the Pollution Abatement program and none in which the scope of engineering consultant duties are similar, there are few standards against which to compare the reasonableness of the engineering costs or the profit earned by the District's engineering consultants.

Some have suggested that the level of profit was the result of the District negotiating an agreement with the lead engineering consultant that offers little incentive to control costs. There are two problems with this agreement: 1) the lead consultant is responsible for both engineering services and program management, thereby removing independent oversight of engineering services; and 2) the lead consultant earns a profit on all management and engineering contracts, even those which are subcontracted to other firms, creating a potential disincentive to control the costs of other firms.

However, district officials believe their efforts to monitor the Office have minimized the risks associated with this arrangement. The District has established several monitoring mechanisms over the years, including:

- instituting a management structure parallel to the structure of the Program Management Office; and
- amending the Master Agreement, which describes the relationship between the District and the Program Management Office.

While these efforts have provided some measure of oversight, we believe the District could have done more to oversee consultant performance and to ensure funds are spent effectively. For example, the District could have made greater use of a design review technique called value engineering, in which an independent engineering assessment of project design is conducted to identify cost savings without compromising the quality of the proposed construction.

In addition, the District could have performed formal evaluations of the lead engineering consultant's performance. District staff currently perform a limited review annually as part of the budget development process; however,

this exercise is focused largely on consultant staff composition and compensation for individuals, not overall performance compared to pre-established goals.

Similarly, the District could have conducted reviews of the performance of subconsultants. Currently, the District has relied on the lead engineering consultant to evaluate its subconsultants. A formal evaluation process could have enabled the District to negotiate incentive contracts that award profits based on meeting performance goals. Currently, the District awards fixed profits based on a percentage of costs, which provides only a minimum incentive to control costs.

It is not known conclusively to what extent these and other monitoring mechanisms would have mitigated program costs. However, we believe it is essential for the District to improve its level of monitoring in the future to ensure it meets its responsibility to the public for the effective implementation of the Pollution Abatement program and the expenditure of public funds.

During our review of district implementation of the Pollution Abatement program, a number of other issues concerning district purchasing and budgeting practices, as well as the District's use of management consultants, were brought to our attention. While these issues are, relative to the Pollution Abatement program, of less fiscal importance, they are not consistent with standard fiscal practices. We believe these issues need to be addressed through greater district oversight and adherence to standard purchasing practices.

The District has, for example, not always followed its own policies on budgeting and transferring funds. In addition, the District has not consistently evaluated its need for, and use of, consultants. For example, in one case, the District spent \$96,000 to hire three separate consultants to study a series of inappropriate financial transactions which cost the District \$68,600 and which had already been resolved. We include suggestions to improve purchasing and contracting practices to ensure district financial practices meet standard fiscal practices as well as state procurement provisions.

INTRODUCTION

The Milwaukee Metropolitan Sewerage District is a special purpose municipal corporation which, by statute, is responsible for providing sewer services to all communities within the District's boundaries, which encompass virtually every municipality in Milwaukee County. The District also provides sewer services to all or portions of ten communities in surrounding counties. Sewer services are funded by user fees. Additional fees are charged for capital improvements to the sewerage system.

The District has been governed since 1982 by a commission of 11 members, appointed pursuant to state statute. The Mayor of the City of Milwaukee appoints seven commissioners: four public members for three-year terms and three members, who must be elected officials, for one-year terms. The remaining four commissioners are appointed by a committee of the chief elected officials of municipalities within the District, other than the City of Milwaukee.

At \$2.29 billion, the program is the largest public works project in the state.

To satisfy federal and state water pollution regulations, the District initiated, in 1977, a major program to improve sewage management, called the Water Pollution Abatement Program. The program includes numerous construction projects which the District expects to complete, on schedule, in 1996. As shown in Table 1, the District estimates that the program's total cost, as of December 1990, will be \$2.287 billion, making it the largest public works project in the State's history.

As shown in Table 2, program cost estimates have fluctuated over the years, as changes in project scope, cost increases, and changing market conditions have been encountered. Although the program is nearing completion, additional cost increases or decreases may be possible.

Table 1

**Estimated Cost of the Water Pollution Abatement Program
As of December 1990**

<u>Construction</u>	<u>Total Estimated Cost</u>
Jones Island Treatment Plant	\$ 526,000,000
South Shore Treatment Plant	154,800,000
Tunnels	
North Shore	389,508,185
Crosstown	185,224,597
Kinnickinnic - Lake Michigan	103,433,125
Interceptor/Relief Sewers	184,628,619
Other	79,514,474
Total Construction	\$1,623,109,000
<u>Non-construction</u>	
Program Management	\$ 254,100,000
Engineering	356,600,000
Other	53,600,000
Total Non-construction	\$ 664,300,000
Total Estimated Program Costs	\$2,287,409,000

Table 2

**Estimated Cost of the Water Pollution Abatement Program*
(in millions)**

<u>Year</u>	<u>Estimated Cost</u>
March 1983	\$2,107.8
June 1984	2,047.8
April 1985	1,855.8
May 1986	1,747.8
February 1987	1,837.4
July 1987	1,898.0
April 1989	2,081.3
February 1990	2,219.8
December 1990	2,287.4

*Amounts are adjusted to reflect end of program value.

The program has been funded with a combination of federal and state grants and local funds, and, beginning in fiscal year 1990-91, with funds from the State's Clean Water Fund loan program. In addition, the District will incur \$500 million in interest costs, in addition to the estimated \$2.29 billion in program costs, for financing the Pollution Abatement program.

As shown in Table 3, through 1990, the District has received about 74 percent of the grant funds which it has been awarded and expects to receive the remaining 26 percent during the final five years of the program.

Table 3

**Water Pollution Abatement Program
Federal and State Grant Funds
As of December 1990
(in millions)**

<u>Fund Source</u>	<u>Awarded</u>	<u>Received</u>
Federal EPA Grants	\$486.3	\$395.5
State-Wisconsin Fund	411.2	279.8
State-Combined Sewer Overflow	<u>192.9</u>	<u>130.0</u>
Total	\$1,090.4	\$805.3

The share of total project costs, \$1.7 billion as of December 1990, paid with local funds is \$895 million. If the District receives all grant funds awarded and the project is completed within the current cost estimate of \$2.29 billion, additional local funds of approximately \$175.3 million will be required.

This program has been controversial for a number of reasons. District officials, legislators, and interest groups have expressed concerns about:

- construction cost increases, totaling \$205.9 million as of December 1990, and significant engineering cost increases;
- the construction methods used to complete some parts of the program; and
- the District's decision to contract the management of the program to the Program Management Office, a consortium of engineering firms.

Together, these circumstances have raised questions about the District's management practices regarding the Pollution Abatement program. At the request of the Joint Legislative Audit Committee, we examined the District's efforts to implement the necessary program improvements. Specifically, we undertook to:

- document the extent of cost increases;
- review the District's efforts to examine the causes of the cost increases and to prevent future increases; and
- review the findings of previous, relevant audits of the District.

As part of this review, we interviewed current and some former district commissioners and staff, representatives of local communities, and program contractors. In addition, we examined construction contract modifications and supporting documentation, grant files, district policy and procedures manuals, and previous audits and reviews as well as the method used to contract for construction management services. The scope of this review, which included management issues, is different than that typically employed in grant review audits. In addition, the relationship between the District and communities which contract for sewage services with the District was not included in the scope of this audit.

Water Pollution Abatement Program

The need for major improvements in the District's sewage treatment system can be traced back to 1972, with the passage of amendments to the federal Clean Water Act. Among other provisions, the amendments required states to enforce stricter standards in sewage disposal. In Wisconsin, the Department of Natural Resources (DNR) is responsible for enforcing these federal standards, as well as state pollution limits, by promulgating administrative rules for municipal wastewater treatment systems and by issuing discharge permits which establish standards. DNR also reviews and approves facility plans for municipal sewerage systems, which describe how the municipalities intend to meet the discharge limits.

Also in 1972, the State of Illinois sued the City of Milwaukee and the District in order to stop sewer overflows into Lake Michigan. Under normal circumstances, combined sewers, which transport both storm water and sanitary waste, route sewage to treatment plants for processing. However, when large storms produce enough storm water to overwhelm the sewer system, this sewage, called "overflow," is discharged into Lake Michigan without being treated. In 1977, a federal judge ruled on the Illinois lawsuit, ordering even more stringent discharge limits than required by DNR, but this federal ruling was later overturned.

While this suit was being litigated, DNR, under the requirements of the 1972 amendments to the Clean Water Act, ordered the District to reduce the amount of sewage it discharged into the lake and meet the new, stricter discharge limits. The District sought court action in 1976 to prevent DNR from

DNR approved the master plan for pollution abatement.

enforcing the discharge limits. In 1977, the District and DNR agreed to a court order which required the District to remove 85 to 90 percent of the pollution in sewage, eliminate overflows from sanitary sewers, and greatly reduce overflows from combined sewers. The Pollution Abatement program was developed to meet these objectives.

In 1981, DNR approved the District's master facilities plan to implement the Pollution Abatement program. The plan, which delineates a massive construction project, provides for: 1) upgrading the Jones Island and the South Shore sewage treatment plants; 2) improving or replacing sewage lines; and 3) providing an alternative to discharging sewage overflows into Lake Michigan.

Choosing a method to accomplish the last provision proved particularly difficult and controversial. The District considered two approaches. First, the District considered separating storm sewers from sanitary sewers and treating the two waste streams separately. Much of central Milwaukee has combined sewers, while newer portions of the city and most other municipalities have separated sanitary and storm water systems. Many newer systems use separated sewers because storm water can legally be drained directly into rivers and lakes, greatly reducing the costs of treatment.

The alternative approach was to preserve the combined sewers and treat all wastewater. This plan called for the construction of 17 miles of tunneling at depths of up to 325 feet to store storm and sanitary sewage when rain or melting snow increased the flow into sewers beyond treatment plant capacity. Sewage would then be pumped up to treatment plants over several days, as capacity allowed.

There was considerable disagreement in Milwaukee over how to improve the sewers.

There was considerable debate within Milwaukee County over which of the two approaches to adopt. Supporters of combined sewers believed separating storm and sanitary sewers would be too disruptive, since many streets in Milwaukee's business district would have to be excavated. In addition, private property owners with single sewer lines would be required to make costly new connections to the separated sewers.

On the other hand, advocates of separated sewers noted that the aging combined sewers in the city would eventually have to be replaced, even with the deep-tunnel option, so street excavation could not be avoided indefinitely. Further, they believed separation would result in lower operating and maintenance costs since separated sewers would not incur the high energy demands of pumping sewage out of deep tunnels, and treatment plants would process less wastewater. Finally, supporters of separating the sewers maintained this option would allow local contractors to perform the work since it would use construction methods familiar to the Milwaukee construction industry; the deep-tunnel option would require the expertise of out-of-state firms familiar with this unique technology.

District officials, with the approval of DNR and the Environmental Protection Agency (EPA), eventually chose to address the overflow problem by constructing three deep-tunnel storage areas: the Crosstown tunnel, Kinnickinnic-Lake Michigan tunnel, and the North Shore tunnel. Public opposition to sewer separation, with its extensive street excavation and costs

Deep tunnels were estimated to be less expensive than separated sewers.

to private property owners, appears to have been an important factor in the decision. In addition, district cost estimates completed in 1980 showed the deep-tunnel option, at \$496 million, to be slightly less expensive than separating the sewers for \$514 million.

Revised district estimates completed in 1981 placed the cost for deep tunnels at \$342.4 million and separated sewers at \$700 million. Deep tunnel costs are now estimated to cost over \$678 million; whether these tunnels will be more or less costly than separated sewers would have been cannot be determined. District staff argue that deep tunnels would have been necessary under either alternative because deterioration of some existing separated sewers increased flow during storms beyond treatment plant capacity.

The court-ordered agreement between DNR and the District specifies that the Pollution Abatement program is to be funded with a combination of federal grants from EPA, which are administered by DNR; state grants from the Wisconsin Fund and the Combined Sewer Overflow program; and local matching funds. To assist DNR in administering the grants, the U.S. Army Corps of Engineers, under contract with EPA, reviews specific projects and contract changes for eligibility for both federal and state grant funding. A municipality can appeal Corps eligibility determinations to DNR and, in the case of federal funds, also to EPA. All funding available through EPA and DNR grants has been awarded, and funds from the State's Clean Water Fund loan program will be used to complete the Pollution Abatement program.

Program Management Office

The District contracted with consultants for construction management services.

Because of the size, complexity, and duration of the Pollution Abatement program, the Milwaukee Metropolitan Sewerage District decided to engage an engineering consulting firm to manage the entire program as well as provide all engineering services. The District continues to be responsible for the day-to-day sewage treatment operations and related administrative activities, such as billing for services and routine maintenance.

Management services provided by consultants include, for example, program scheduling, construction and engineering management and support, administration, accounting, and providing the District assistance in negotiating and monitoring engineering contracts. Engineering costs are incurred to:

- 1) develop a facility plan which demonstrates the need for the facility and a cost effective means of meeting water quality treatment requirements,
- 2) prepare construction drawings and specifications for the facility, and
- 3) supervise and inspect construction of the facility.

To assist in managing the program, the consultant formed a Program Management Office. This office is a consortium of subconsultant engineering firms chosen by the lead engineering consultant and the District. Except for the lead consultant, and an initial small core group of firms, the make-up of the Program Management Office has changed throughout the life of the program as project needs have changed; over 100 additional firms have been involved. The lead engineering consultant has coordinated the overall project

and provided approximately 50 percent of direct engineering services, while relying on associates in the Program Management Office to complete the remaining 50 percent of design and construction supervision.

Significant cost increases in the program have raised questions about the Program Management Office's management decisions as well as the District's relationship with the Office. Because the District contracted for the management of the program, we would have expected the District to oversee diligently contractor performance. While the District has established some monitoring mechanisms, we believe the District could have done more in fulfilling its oversight responsibility. However, district staff maintain that the circumstances leading to the largest increases could not have been anticipated; therefore, a change in the management of the program would have had little effect on the overall cost increases.

CONSTRUCTION COST INCREASES

The Pollution Abatement program has experienced significant cost increases since its inception. Over the years, estimates of total program costs have fluctuated, from a low of \$1.75 billion, to the December 1990 estimate of \$2.29 billion. To a certain extent, the fluctuations have been caused by the difficulty in accurately estimating construction costs as much as 15 years in the future. However, a substantial portion of the fluctuations has been caused by two factors: modifications to construction contracts, particularly for one portion of the North Shore deep tunnel, and inaccurate estimations of the cost to build a new facility at the Jones Island treatment plant.

Construction Contract Modifications

4,000 contract changes have increased costs by \$205.9 million, or 15.4 percent of total construction costs.

While Pollution Abatement program costs have increased for both construction and engineering services, the largest increases have been in construction costs. As of December 1990, there were 281 construction contracts associated with the program. Although originally awarded for a total of \$1.34 billion, over 4,000 changes to the contracts, called contract modifications, have resulted in additional costs of \$205.9 million, bringing the value of construction contracts, as of December 1990, to \$1.5 billion. This represents a 15.4 percent increase in the cost of the contracts. However, additional modifications are likely to occur on these and future construction contracts, contributing to further increases.

District and Program Management Office staff believe the method of contracting has contributed to the number of contract modifications for this program. EPA, which has awarded grants totaling \$486.3 million in support of the program, requires grant recipients to use a contracting method called risk-sharing. The general goal of this method is to reduce contingency amounts in construction contracts, thereby lowering bid amounts, by assigning financial responsibility for cost increases to the parties most able to control the risks which may lead to contract modifications and increased costs. For example, additional costs due to a differing site condition would be borne by the owner, not the contractor, reducing the need for the contractor to include a contingency for such possibilities in the bid.

Contract modifications are reviewed by the U.S. Army Corps of Engineers for grant eligibility.

While the goal of risk-sharing is to reduce costs, an additional effect is an increase in the number of contract modifications, since a modification must be negotiated whenever a change in construction time, materials, or site conditions occurs. Once the modification has been executed, the U.S. Army Corps of Engineers, acting on behalf of DNR, makes advisory determinations on whether the modification costs are eligible for grant funds.

Types of Modifications

Contract modifications occur for a number of reasons. For example, design errors may lead to revisions in construction plans, or unforeseen conditions at a construction site may require alternative construction methods. Contract modifications may increase or reduce the cost of a project. As shown in Table 4, a variety of circumstances have led to construction contract modifications.

Table 4

Contract Modifications for the Water Pollution Abatement Program

<u>Reason</u>	<u>Number of Modifications</u>	<u>Cost Increase (decrease)</u>
Differing site condition	555	\$182,060,002
Improve/enhance original design	1,230	20,554,631
Designer or engineer-related change	673	4,656,904
Other*	787	4,055,896
Time extension	233	1,851,463
Regulatory agency code change	129	1,607,716
Excess/insufficient materials	118	(9,146,071)
Not yet categorized by Office	155	239,528
Change with no cost	<u>551</u>	<u>0</u>
Total	4,431	\$205,880,069

* Includes miscellaneous changes and changes on district-designed projects.

Most of the cost increase has been due to differing site conditions.

Differing site conditions have resulted in the most costly modifications, despite representing only 12.5 percent of all modifications. A differing site condition exists when the conditions of the actual construction site differ materially from those indicated in the design and contract. These conditions are not foreseen by the designer. Seventy-eight percent of the cost for the differing site conditions, through December 1990, is associated with the construction of one portion of the North Shore tunnel.

As shown in Table 5, modification costs were not evenly distributed over all contracts. Five percent of the contracts were responsible for 81 percent of modification dollars. These include contracts for the Crosstown tunnel and several Jones Island contracts, as well as a contract for the construction of one portion of the North Shore tunnel.

Table 5

Construction Contracts By Rate of Change

<u>Rate of Change</u>	<u>Number of Contracts</u>	<u>Percentage of Contracts</u>	<u>Modification Costs</u>	<u>Percentage of Modification Dollars</u>
Greater Than 25%	15	5.3%	\$167,285,455	81%
10% to 24.9%	36	12.8	20,056,810	10
5% to 9.9%	46	16.4	9,437,430	5
.01 to 4.9%	101	35.9	12,551,359	6
No Change	37	13.2	0	0
Negative Change	46	16.4	(3,450,985)	(2)
Total	281	100%	\$205,880,069	100%

North Shore Tunnel

Although construction costs for the program have increased 15.4 percent, 66 percent of the increase can be attributed to one large contract for the construction of one portion of the North Shore tunnel. The increases associated with the remaining 280 construction contracts average only 5.3 percent of the cost increase, which is within industry standards.

One North Shore tunnel contract increased from \$46 million to \$182.8 million.

This contract was originally awarded for \$46 million. As of December 1990, its cost had risen to an estimated \$182.8 million, a 297 percent increase over the original contract value. In addition to construction cost increases, engineering costs for this portion of the tunnel increased from approximately \$7 million to \$14 million, primarily because of higher construction supervision costs related to managing the additional construction work required by the differing site conditions.

The Program Management Office points to three reasons for the increase in construction costs for this portion of the North Shore tunnel:

- additional tunnel support was necessary due to unstable ground conditions;
- additional time and equipment were needed to pump a greater than expected amount of water which accumulated in the tunnel during construction and to grout the tunnel; and
- additional concrete was needed to line the tunnel.

The Program Management Office, which designed the tunnel, did not anticipate the need for these additional measures at the time the contract was bid. Therefore, the contract was modified to account for the differing site conditions, and the payment provisions were changed to accomplish the modifications.

As noted, in the 1970s, not all interested groups agreed that construction of deep tunnels was the best method of relieving sewer overflow into Lake Michigan. However, the construction of deep tunnels was estimated to be the most cost-effective way to address sewage overflow and the least disruptive to Milwaukee residents, since it required less street excavation.

As the District has encountered differing site conditions, mining methods and contract payment provisions have changed, once again raising questions about the cost of the project. These two changes resulted in costs quadrupling from the original bid price on the major segment of the North Shore tunnel (North Shore phase IA) and generated significant interest in identifying the causes of the problems and whether any could have been avoided.

Between 1988 and 1990, the District, the Program Management Office, and the U.S. Army Corps of Engineers each commissioned a study to examine issues related to the North Shore tunnel differing site conditions and corresponding cost increases. The ensuing reports addressed a variety of concerns. The District, as owner, was interested in determining whether the Program Management Office had performed appropriately on the District's behalf and, if not, whether there were any overpayments made to the contractors. The Program Management Office, as provider of geotechnical, design, and construction supervision services for the North Shore tunnel, wanted to support its assertion that it had performed appropriately and that the differing site conditions and their ensuing costs were unforeseeable. The U.S. Army Corps of Engineers, as the grant review agency acting on behalf of DNR and EPA, needed to determine whether costs incurred were grant eligible.

We reviewed these reports and a limited amount of related correspondence which was made available to us. The Audit Bureau is not staffed to conduct an independent engineering assessment of the North Shore tunnel project, nor did we engage engineering consultants as part of this review.

We would have expected a thorough analysis of cost increases associated with the North Shore tunnel's differing site conditions and payment provisions to have determined whether:

- the Program Management Office could have predicted actual rock behavior and water inflows prior to construction;
- appropriate design decisions were made subsequent to identification of the differing site conditions;
- the design and final cost of the North Shore tunnel would have changed, had rock behavior and water inflows been correctly predicted at the design stage;

- once the first differing site conditions were encountered, the Program Management Office could have predicted accurately all subsequent additional costs;
- it was appropriate to change payment provisions; and
- the payments were appropriate and documented.

However, our review found that none of the reports address definitively all of these points, and several of these points are not addressed at all. Others are addressed, but not fully or authoritatively analyzed.

Existing reports do not definitively answer important questions on North Shore tunnel costs.

The District's report, for example, which a consultant prepared for the District, describes the circumstances leading to the differing site conditions and contains copies of many documents, but does not present extensive analysis. Similarly, since the Program Management Office's report was prepared by engineers which the lead engineering consultant hired, it is not likely to be perceived as independent enough to be able to definitely resolve all outstanding issues. Finally, the reports do not address the questions of whether the Program Management Office should have been able to predict accurately the full extent of cost increases once the differing site conditions were encountered and whether this information would have changed the construction methods eventually chosen. Nevertheless, the reports provide some insight into the controversy surrounding the differing site conditions and the resulting change in payment provisions.

Geotechnical Review

Because the North Shore tunnel cost increases were caused by differing site conditions, many have questioned whether the Program Management Office performed adequate geotechnical review for the design of the tunnels. However, none of the reports suggest that the geotechnical exploration was inadequate or did not meet professional standards. The engineering firms which reviewed the geotechnical report seem to have agreed with its contents. However, the District's report suggests further geotechnical exploration would not have been unreasonable.

A central issue is whether more exploratory borings should have been made during the geotechnical exploration. A boring is a vertical sample of soil and rock taken to determine ground conditions. The District's report noted a subconsultant's initial geotechnical review recommended eight borings in addition to the 15 borings already taken. However, only three additional borings were completed. The District's report concluded that the five additional borings might have provided more useful knowledge to the designer regarding rock quality and potential water inflow into the tunnel.

In their reply to this report, the Project Management Office stated that, after further negotiation, the subconsultant agreed that the existing geotechnical information was sufficient and that existing borings could be substituted for five of the eight recommended borings. While the Office was not able to

provide us with specific documentation to substantiate this agreement, meeting notes taken subsequent to the agreement show there was no further discussion of the issue.

The U.S. Army Corps of Engineers' report noted that more borings would not have provided new information, but would only have substantiated the existing information, which the Corps found to be reasonably accurate. Instead, the Corps' report suggests the Program Management Office was optimistic in predicting the behavior of the rock when excavated. This determination suggests the cost increases associated with the differing site conditions may have occurred regardless of additional exploration.

None of the reports suggest that the Program Management Office made unreasonable engineering decisions about how to proceed with construction. However, a major unresolved issue is whether payment provisions for the contract were handled reasonably, once differing site conditions were encountered.

Payment Provisions

The original contract for the construction of this portion of the North Shore tunnel was awarded in June 1986 for \$46 million, and mining began in August 1987. The contract called for a unit-priced basis of payment. This payment basis specifies the number of units of each item, for example linear feet of concrete lining, and a price per unit that will be necessary to complete a project.

Part of the contract was completed under the original payment terms. However, the differing site conditions encountered during construction resulted in a change in payment terms. Table 6 outlines the major events influencing this change.

Based on the geotechnical exploration, the Program Management Office designed the tunnel believing the rock would be relatively stable. Consequently, the specifications of the contract indicate that the basic tunnel support is to be provided by rock dowels. As a contingency for some unforeseen need for additional support, the contract also provides for the supply of 50 sets of steel ring beams, enough to provide support for about 1 percent of the total tunnel length. The specifications explicitly state that if more than 50 sets are required, the use of additional sets will constitute a differing site condition.

As mining progressed, it became clear that the actual ground and water conditions encountered in tunneling were different than expected. By the end of construction, instead of the 50 sets of steel rings called for in the contract, nearly 2,000 sets were used.

Table 6

North Shore Tunnel Timeline
(Phase IA)

June 1986	Contract awarded for \$46.1 million.
February 1988	Mining halted because of unstable rock; differing site condition declared and support method changed; payment changed from unit-price basis to time-and-materials-plus-fixed-fee basis; costs increased by \$7.3 million.
April 1988	Mining temporarily halted because of water inflow problems; Program Management Office and the District began evaluating alternatives and, to avoid litigation, kept time-and-materials payment terms for tunnel construction, while additional construction measures were developed and undertaken to address differing site conditions; costs increased by \$6.5 million.
August/ September 1988	Mining resumed when surface grouting was used to resolve water inflow problem; costs increased by \$18.0 million.
July 1989	Costs increased by \$11.7 million.
September/ October 1989	Additional concrete lining required due to water inflow and unstable rock; differing site condition declared; payment provision renegotiated to address changes; costs increased by \$21.4 million.
May 1990	Costs increased by \$71.8 million to address remaining work.
September 1990	Mining of the North Shore tunnel completed.
December 1990	Final cost estimate for the contract was \$182.8 million.
January 1, 1992	Expected completion date of entire tunnel.

The contract also specifies the expected amount of water inflow, in terms of peak flows, average flows, and total volume of water pumped out of the tunnel. By each of these measures, the actual water inflow was many times

greater than expected. For example, the contract specifies that in a particular area of rock, the inflow could be on the order of 700 gallons per minute. In fact, flows reached as high as 7,000 gallons per minute over the entire length of the tunnel.

The severity of the rock and water problems was apparent by February 1988, when mining was temporarily halted. The Program Management Office acknowledged a differing site condition, and the District approved a modification for tunnel support.

In addition, the contract payment terms were changed, for both the tunnel construction and the construction measures necessary to address the differing site conditions, from a unit-priced basis (low bid) to a time-and-materials-plus-fixed-fee basis. This payment basis required the District to pay the contractor for actual time and materials used, with an additional fee for overhead and profit. The District intended this change to be a short-term solution to enable work to continue.

Work continued until April 1988, when water inflow exceeded the capacity of pumping equipment. Mining was suspended for about four months while the Program Management Office evaluated alternatives and implemented a plan of surface grouting to reduce water inflow so mining could resume. While mining was halted, payment negotiations with the contractor broke down over a price dispute over the cost of concrete and, to avoid litigation, the remaining work to construct the tunnel and address the differing site conditions continued on a time-and-materials basis.

However, even after mining resumed, the contractor continued to encounter differing site conditions. For example, poor rock quality and increased water inflow increased the amount of concrete lining required to complete the tunnel. Costs increased not only due to using more concrete liner but also because the unit cost of concrete was higher than expected.

The mining work called for under this contract was completed in September 1990 and, as noted, the estimated value of the contract, as of December 1990, was \$182.8 million. The Program Management Office believes that the contract will be completed at or under that estimate. The expected completion date for the entire North Shore tunnel is January 1, 1992.

Studies conducted to date differ sharply in their judgment of the appropriateness of the changes to the payment terms. The Program Management Office's report concludes that under existing conditions, a time-and-materials payment basis was the best option; all parties were interested in completing the tunneling expeditiously, and renegotiating the contract would have been time-consuming. In addition, this solution avoided litigation, since the contractor advised he would refuse to continue work without a bilateral agreement clarifying payment and other provisions. Legal evaluation at the time suggested that the contractor would be able to strongly support such a claim because the actual construction conditions were so different from the contract terms.

On the other hand, the U.S. Army Corps of Engineers, the grant review agency for the program, asserts that time-and-materials payments should be used as infrequently as possible and that anything that can be quantified as a discrete change to the contract (unit-price basis) should be paid that way. The Corps recognizes that time-and-materials payments could be justified for the differing site conditions, to ensure work continued; however, it contends the District should have maintained the original contract for the actual tunnel construction, reserving time-and-materials payment provisions for construction measures necessary to address the differing site conditions.

The Corps has been conducting an ongoing review to determine grant eligibility of the cost increases associated with the North Shore tunnel. This review focuses on the changes in payment provisions and the way in which costs were negotiated and has raised questions about the appropriateness of these payment provisions.

The Corps is concerned that the decision to change the payment terms of the original agreement when the differing site conditions were encountered resulted in unnecessarily high costs to complete the tunnel. The Corps has determined that some of the North Shore tunnel modifications are at least partly ineligible for grant funding because the District has been unable to document to the Corps' satisfaction that costs were reasonable and were negotiated appropriately. DNR will make the final determination.

The Program Management Office's accountability in regard to whether costs were reasonable and negotiated appropriately remains unresolved. Questions continue to surface concerning the appropriateness of the total cost increases. The District, however, has recognized the need for further review and has taken steps to establish the reasonableness of the costs. First, the District has engaged an accounting firm to audit costs to ensure that they are appropriate and to determine whether there were any overpayments. This review has, to date, identified as much as \$9.7 million in overpayments.

In addition, the Commission has approved a request for proposals for an engineering consulting firm review of all decisions made on the North Shore tunnel to identify potential funds which could be recovered. This will be the first study to consider the full consequences of the differing site conditions and all of the contract modifications. The District expects this report to be completed by the end of 1991.

Jones Island Treatment Plant

In addition to cost increases which occurred during construction, we found one contract, for a new sewage dewatering and drying facility at the Jones Island treatment plant, which was awarded for significantly more than initially estimated, contributing substantially to the total estimated cost to rehabilitate the entire plant (\$526 million, as of December 1990). Although the Program Management Office's initial estimates in 1983 indicated this facility would cost \$36.4 million to construct, as shown in Table 7, the final low bid to construct the facility was \$194.6 million, or 435 percent more than planning stage estimates.

Full, independent engineering review of the North Shore tunnel project is planned by the District.

Costs for a Jones Island facility increased from an estimate of \$36.4 million to a bid of \$194.6 million.

Table 7

**Jones Island Dewatering and Drying Facility
Cost Estimations
(in millions)**

<u>Year</u>	<u>Estimation</u>
1983	\$ 36.4
1985	51.7
1987	112.8
1988	138.9
1989 (pre-bid)	163.4
1989 (actual bid)	194.6

A combination of factors contributed to this increase. These include: 1) a change in project design from original planning stages, 2) conditions in the construction market, and 3) district contracting decisions.

Project Design Change

In addition to treating wastewater for release into Lake Michigan, the Jones Island treatment plant has, since the 1920s, processed solid waste into an organic fertilizer called Milorganite. This processing involves treating sludge (a sewage treatment byproduct) in a dewatering and drying facility.

This facility was slated for major renovations as part of the Pollution Abatement program. Among other problems, the wooden pilings which supported the building were disintegrating. These structural problems, brought on by the age of the building, led to a decision to replace the dewatering and drying facility rather than renovate it and, in 1983, preliminary plans for its construction were developed.

The preliminary plans for the dewatering and drying facility required the use of new technology which would require fewer sludge dryers, lower maintenance and operating costs, and less total floor space and, according to the Program Management Office, would enable the District to produce Milorganite at a lower cost. This 1983 plan estimated costs to be \$36.4 million. A cost estimation team within the Program Management Office prepared this estimate and all subsequent cost estimates. While the District did not assist in preparing the estimates, it was involved, somewhat, in this process, since a district employee oversees the Cost Estimation Office.

Based on these plans, the District issued a contract for the design of the dewatering and drying facility in 1985, with the design scope referencing the 1983 plans. This design featured the new technology and correspondingly smaller floor space and had a construction cost estimate of \$51.7 million.

In 1986, the Milwaukee Metropolitan Sewerage District Commission approved a four-month pilot program to study the new technology. By the end of the pilot study, district staff were not yet confident that the new machines would work consistently. At the same time, the EPA grants program, which the District depended on to provide 75 percent of the project's costs, was ending, and final designs needed to be submitted in order to receive grant funding. District and Program Management Office staff believed it to be in the local taxpayers' interest to maximize grant participation by meeting this deadline. Therefore, at this time, the District chose the existing, more expensive, but reliable technology, rather than the new, more cost-effective, but unproven technology.

**Design changes added
\$61.1 million to the
Jones Island facility
contract.**

In 1987, the lead consultant revised the designs to reflect a return to the existing technology, which required additional dryers and increased space to house the dryers. This revision resulted in additional costs of \$61.1 million above the previous \$51.7 million estimate, for a new construction estimate of \$112.8 million. Fifty-one million of this increase is directly attributable to the more expensive dryers and the increased building size. The project design was refined and adjusted over the next ten months. When the final design was completed in April 1988, the cost estimate had increased to \$138.9 million, which was submitted to DNR for grant purposes.

Although the District's decision to return to the old technology ensured the continued, consistent production of Milorganite, this decision added substantially to the cost to construct the facility. Given the significantly higher cost, we would have expected the District's decision to have been supported by detailed analysis showing that the benefits of returning to the old technology outweighed the higher costs.

In support of its decision, the District points to: 1) the findings of the four-month pilot study, which did not determine conclusively whether the new technology would or would not produce adequate Milorganite; 2) the deteriorating condition of the existing Milorganite facility; and 3) the pending grant funds deadline. However, some question whether four months' review of the new technology was adequate and, given the expense of changing the project design, whether the District could have extended the review to determine, conclusively, whether the new technology could be used. District officials argue the existing facility was deteriorating rapidly, and they did not have time to extend the study. However, the existing facility continues to produce Milorganite today, as construction is completed on the new facility. It appears, therefore, that while district officials made a decision which addressed their primary concern, that Milorganite production would continue, uninterrupted, it is not clear that other alternatives to reach that goal were fully analyzed.

In addition to the increases due to design changes, further increases occurred between grant application in April 1988 and bid receipt in March 1989; the Program Management Office's estimate rose from \$138.9 million to

\$163.4 million immediately prior to bid opening, and the low bid was \$194.6 million. The Office attributes most of these increases to changing market conditions.

Market Conditions

The condition of the construction market at the time bids opened appears to have contributed somewhat to price increases. Material prices, particularly for stainless steel, rose steeply immediately prior to bid opening. The Program Management Office's estimate rose to \$163.4 million to reflect the higher material prices.

After this sharp increase, it was unclear whether prices would continue to rise at a steep rate, or level off. Construction suppliers will generally only guarantee prices for a period of 45 to 100 days. However, the long-term nature of the Jones Island project made it necessary to estimate prices years into the future. Because of the price instability, for many items suppliers would only guarantee prices for a few weeks, or not at all. In addition, the construction market at the time was such that contractors had many project options and were, therefore, reluctant to accept the level of risk and commit a large number of workers for four or five years when many shorter-term projects were available.

Only two contractors submitted bids; the low bid was \$31.2 million above prebid estimates.

Although the Program Management Office apparently made substantial efforts to solicit bidders, only two contractors submitted bids, and the contract was let for a low bid of \$194.6 million, or \$31.2 million more than the Program Management Office prebid estimates. The Office contends that, because of the low number of bidders, each contractor made much higher projections of material price increases than would have been likely in a situation with more competition. In fact, since material prices stabilized after that initial increase, the contractor's high projections may have resulted in higher than expected profits.

In reviewing the bids, the Program Management Office estimating team noted major differences in, for example, inflation factors and equipment prices between the contractors' bids and the Office's estimations. Subsequently, the team developed a new estimate of \$181.4 million to reflect factors taken into account in the contractors' bids but not the Office's estimate.

To mitigate costs, once the bid of \$194.6 million had been accepted, designers attempted to reduce the scope of the project, without affecting functionality. Actions taken have included eliminating backup machines, eliminating skylights, and changing stainless steel specifications. These scope reductions have resulted in cost reductions of \$12.2 million for the project.

Contracting Decisions

The District had three alternatives to accepting the low bid of \$194.6 million. The District could have:

- divided the project into smaller contracts and bid them over time;
- rejected the bid and reopened bidding at a later date; or
- eliminated Milorganite production altogether and pursued alternative disposal methods.

Although alternatives were available, the District chose not to rebid the Jones Island contract.

Although the District considered these options, the District rejected them, citing several reasons, including: 1) the need to continue Milorganite production, which provides operating revenues; 2) the perceived need to avoid delays because the existing facility was rapidly deteriorating; and 3) the need to avoid liability problems inherent in multiple contractor arrangements.

The first option, dividing the project, would have increased the likelihood of more contractors bidding, since contractors appeared wary of the four to five year commitment involved in the contract. Smaller contracts may also have resulted in a lower total project bid price, since the increased competition might have reduced inflation factors used by contractors. In addition, since the smaller contracts would be bid over time, there would be less uncertainty about future material prices built into the bids. Finally, since contractors' resources would not be tied up for such a long period, the risk factors would be reduced.

The District considered the option of dividing the contract, but rejected it. District officials believed multiple, smaller contracts would have extended the completion date, since each piece would have to have been completely finished before the next contractor could begin work. When a single contractor conducts the entire project, different activities can be coordinated.

Although this objection may be valid, it is not clear whether the end date would have been delayed. District officials believed that a building delay of any length would increase the risk of interrupting Milorganite production, since the existing facility was rapidly deteriorating. The District depends on Milorganite revenue of approximately \$6 million per year to help fund its operations and limit user charges. However, it does not appear the District prepared estimates to determine when the existing plant could no longer produce Milorganite.

In addition, the production of Milorganite includes many steps, and the District was concerned that if the facility had not, in fact, produced acceptable Milorganite and several contractors had been involved, identifying the problem and assigning liability would have been extremely complicated. Further, the District decided not to divide the contract because multiple projects and contractors are likely to increase the risk of contractor disputes and resulting contractor claims for contract changes. However, the District did not analyze whether increased claims costs would have outweighed the

savings from dividing the work into smaller contracts. Since the Pollution Abatement program already had hundreds of contracts, it is not clear how substantial the increased risk associated with a few more contractors would have been.

As a second alternative to accepting the low bid of \$194.6 million, the District could have rejected the bid and reopened bidding at a later date. With hindsight, the advantages of this option are apparent; since prices for materials stabilized and the construction market became less saturated, a later bid date would likely have resulted in a lower bid price.

District officials considered this option, but believed that two major risks outweighed the potential cost savings. First, at the time, it was not clear that market conditions would improve. Material prices could have risen even more. In addition, there was no guarantee that there would be any bidders in a second round of bidding. Contractors spend a considerable amount preparing a bid (more than \$300,000 in this case) and will only do so if the expected return is worth the risk. Therefore, the District rejected this option.

The final alternative the District considered was to eliminate Milorganite production altogether and pursue alternative sludge disposal methods, such as landfilling the sludge or agricultural application. A cost-effectiveness study completed by the Program Management Office after bid submission compared Milorganite production to these two alternatives. The study found that with the expense of a new facility, Milorganite production was estimated to be approximately 5 percent more expensive than disposing of sludge through landfilling or agricultural spreading. The District considers a 15 percent range on facility estimates to be acceptable and, therefore, believed Milorganite production was justified.

Cost increases raise questions about district monitoring of consultants.

The events and major cost increases surrounding the North Shore tunnel and the Jones Island treatment plant unfolded over several years and were reported in the press and generally perceived by the public as a series of costly mistakes. However, because of the wide scope of management responsibilities contracted to the Program Management Office and the very close relationship between the District and the Office, it has been difficult to determine what has caused the cost increases. While the District, for both the North Shore tunnel and Jones Island projects, eventually engaged consultants to review the Office's performance, neither report provided definitive answers. Questions regarding the manner in which these two projects have been handled raise concerns about the District's overall success in evaluating and monitoring the Pollution Abatement program as well as the Program Management Office's performance in managing the program.
