CLEAN STREAMS FOR PHILADELPHIA

The City's Billion Dollar River Clean-up

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FOREWORD

Sewers have carried urban wastes to streams since the Sumerian cities were at their height 5,000 years ago. Stream pollution in modern times, however, is heavier than in past ages, for population and industry have grown exceedingly.

Modern technology could prevent much of this pollution, but many communities lack the facilities to intercept and treat the increasing wastes. To correct this situation would cost our nation $3 billion a year for new capital projects up to 1985—and even more thereafter.

Fortunately, Philadelphia and other communities have already done much to improve the streams of the Delaware River Basin. The once heavily polluted Delaware and Schuylkill Rivers are in better condition today than in several decades.

Yet even in our basin, not all is completely well. Increasing population and industry around estuary centers must remove a higher percentage of wastes or the river will steadily decline.

The Water Department has developed a massive plan to protect more effectively its water source. Under this plan, the department will spend up to $843 million for new wastewater capital facilities in the period 1975-1983, with the Federal Government paying 75% and the City the remainder.

The plan includes the construction of three new wastewater treatment plants to reduce pollution entering the Delaware River. Treating flows from Philadelphia and enlarged suburban areas, these plants will replace three older plants dating from the 1950's.

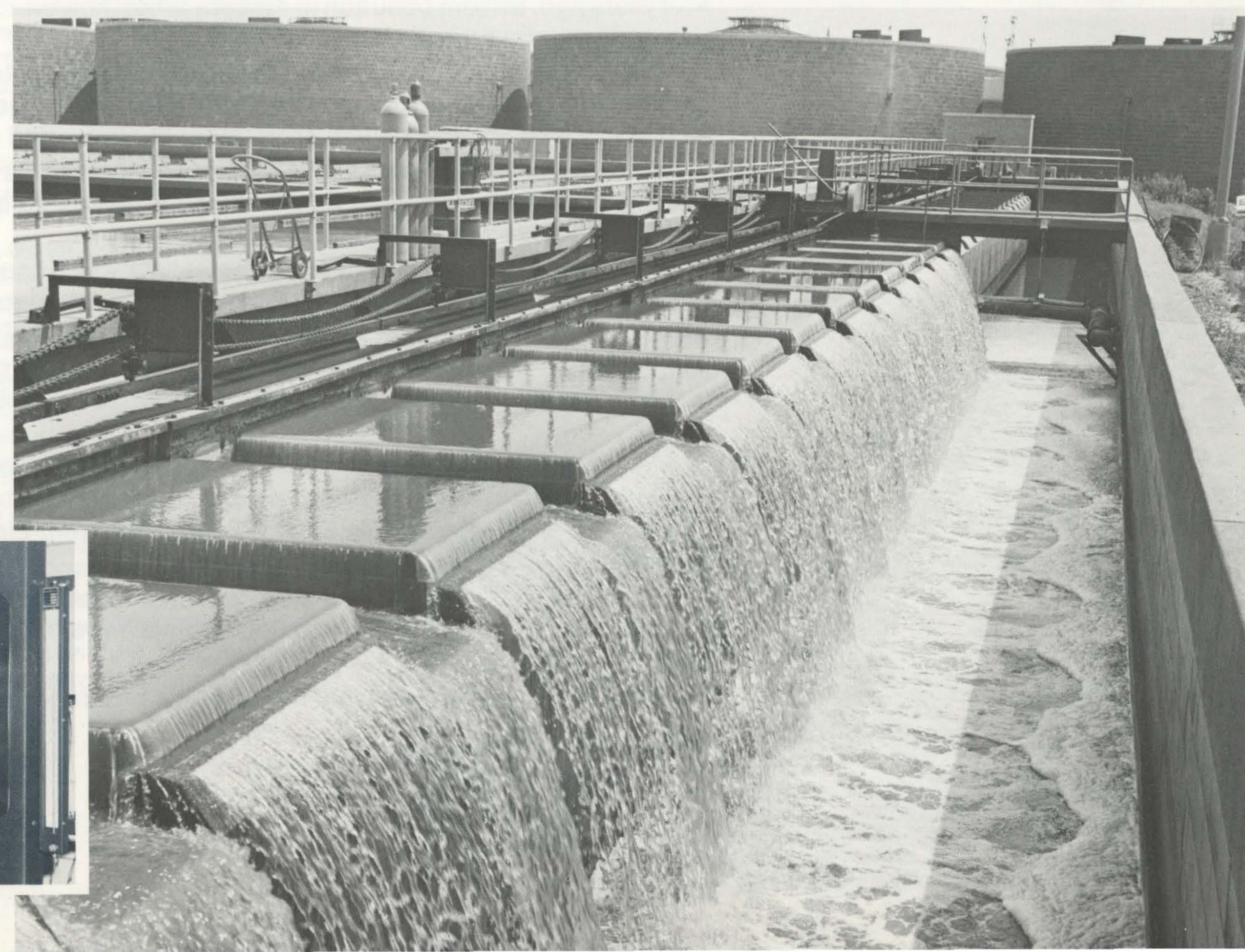
Delivering a cleaner effluent to the River, the new plants, scheduled to be completed by 1980-1984, will remove up to 90% of pollutants (as measured by biochemical oxygen demand) from wastewater. This will be five percentage points more than federal law requires for new secondary plants.

This booklet describes what Philadelphia has done, and hopes to do, for its rivers.

WATER POLLUTION CONTROL

A MODERN IDEA TO CURE AN

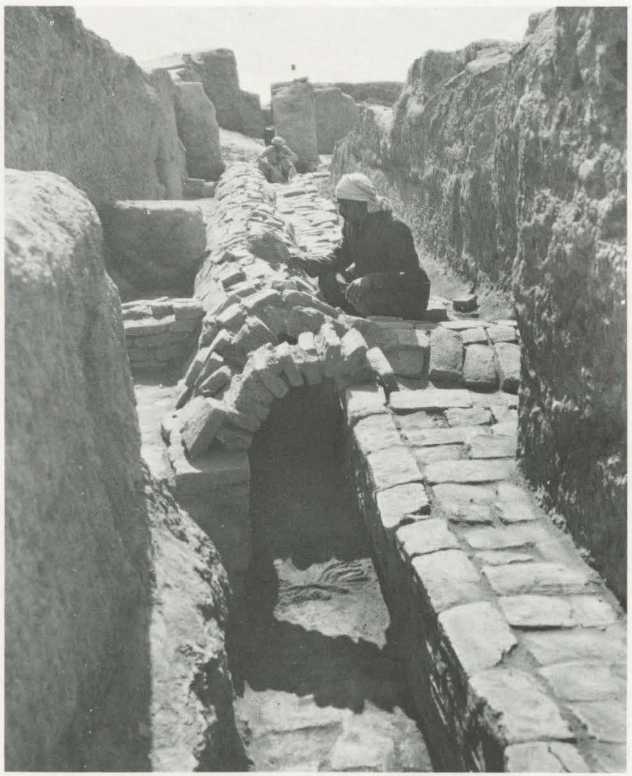
■ **For 6,000 years sewers have improved the sanitation of cities, but the idea of treating the wastewater borne by them is comparatively new. Only in the last century have treatment plants been built in Europe and America to protect the streams as well as the cities. In plants like that at right, Philadelphia today treats all its wastewater.**



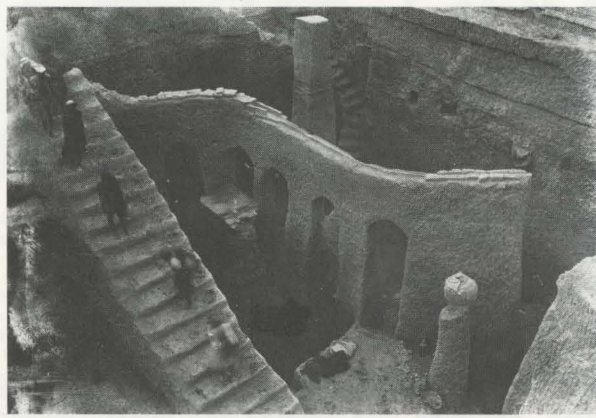
SEWERS HAVE A LONG HISTORY

Bath tubs, indoor toilets, and stone sewers were part of the great palace of Knossos built in Crete in 1700 B.C. (right), while in ancient Rome huge brick sewers called "cloacae" collected wastes and storm flow. Sewer-borne flows sometimes polluted ancient streams, and history repeated itself when modern cities like Philadelphia resumed sewer construction in the late 19th century. Philadelphia photo shows Mill Creek Sewer in 1883.

OLD PROBLEM



ESHNUNNA — 2425-2125 B.C.: One of the earliest examples of the vaulted brick sewer appears above. It was dug from the ruins of Eshnunna (Tell Asmar), a city of Sumerian-Akkadian culture in Iraq. Dating from 2400 B.C., the sewer is about 200 years older than the baked-clay house drain from the same site (right).



NIPPUR — 2300 B.C.: Photo shows arch-supported watercourse and vertical drain, composed of drain tiles and jars. Mesopotamian sewers reach back to 4000 B.C.

KNOSSOS — 1700 B.C.

ROME — 200 A.D.

PHILADELPHIA — 1883 A.D.

A BILLION DOLLAR PLAN IS SAVING THE STREAMS IN PHILADELPHIA

■ "You can stand at Broad and Chestnut Streets and smell the river," wrote a despairing editor in 1944.

In the 1940's, pollution was ruining the lower Delaware and Schuylkill Rivers. Raw wastewater flowed into the streams from many communities, and Philadelphia was contributing over 300 million gallons daily. Numerous factories were dumping industrial wastes; acid and coal from upstate mines were swept down the Schuylkill River, despoiling its beauty, filling its channel, and reducing usable water supplies.

Along the Delaware River estuary, hydrogen sulphide gases (the product of decaying sewage) were discoloring homes and ships, depriving crews of sleep, and sickening dock workers. Waste materials, it was reported, clogged the engines of freighters. The city's water was filled with offensive tastes and odors.

These conditions had been steadily growing. In the last quarter of the 19th century, Philadelphia had built 800 miles of sewers to pour its wastes into the streams. By 1944, this mileage totaled 1,800, and the city had only one small plant to treat its sewer-borne flow. About 15% of flow was treated, and the degree of treatment was minimal.

Happily, there have been many changes since the 1940's. Today the Delaware and Schuylkill Rivers are much better protected.

Federal, state and interstate agencies have cooperated to improve the streams. Riverside communities have built plants to treat wastewater, and many industries have learned to intercept industrial wastes. Coal deposits have been dredged from the lower Schuylkill River; the flow of mine wastes into that stream has been largely curbed.

By 1966 — according to the Federal Water Pollution Control Administration — Delaware estuary communities and industries were removing as a group at least half of their waste loads, as measured by carbonaceous oxygen demand. Though the rivers were still receiving some pollution, they were much cleaner than they had been in generations. The river-bank odors of yesteryear had nearly vanished.

Thanks in part to these changes, Philadelphia has been able to improve its drinking water, assure water abundance, increase the business of its port, stimulate recreation, and begin the redevelopment of its shoreline (see page 23).

NEW CITY FACILITIES

To stream clean-up, the city itself has contributed heavily. Since 1946, it has spent nearly $700 million to expand and modernize its wastewater system. About $500 million of this has gone into facilities that directly protect the rivers, while the remainder has improved public sanitation and sewer services.

In three short decades, Philadelphia has built—

- three modern water pollution control plants to treat wastewater,
- 1100 miles of sanitary and small storm sewers to collect flow from streets, homes and industries,
- 134 miles of big intercepting sewers to keep untreated wastes from entering the rivers,
- 14 new pumping stations to move wastes to plants for treatment.

Today, the city's wastewater system has a replacement value conservatively estimated at $1.234 billion, while its sewer network intertwines for 2,900 miles. Many new tunnel sewers and related pumping stations have been built to control storm flooding.

Treating only a small portion of its wastes in the 1940's, Philadelphia today treats practically all its wastewater—about 200 billion gallons a year. Included in this huge flow (under intercommunity agreements) are 20 billion gallons from neighboring boroughs and townships. In Philadelphia, only a tiny percentage of wastes, borne into streams during storms, escapes treatment.

To help preserve the cleaner streams, Philadelphia is upgrading its treatment of wastes. Thus it is expanding its water pollution control plants and replacing many of its older tributary sewers. The cost for this work may exceed $874 million—raising the city's outlays since 1946 to over one billion dollars.

GLOSSARY

Many sanitary engineers and engineering magazines have substituted the term "wastewater" for "sewage" and made related changes in terminology. In line with this current practice, the City of Philadelphia has officially adopted the following terms:

WASTEWATER — The words "wastewater" and "sewage" are used interchangeably in this booklet, with the former being preferred. Wastewater is a more accurate term, because 99.90% of the flow through city sewers is water, while the remaining one-tenth of one per cent is a mixture of domestic and industrial wastes.

WASTEWATER SYSTEM—A network of sewers, pumping stations, and plants for handling wastewater. Formerly, sewage system.

WATER POLLUTION CONTROL PLANT — A plant where wastewater is treated. Formerly, sewage treatment plant.

MODERN PLANTS TREAT THE CITY'S WASTEWATER

■ Treating the city's wastes, three modern plants protect the rivers. Opened in the 1950's, these "water pollution control" plants have been repeatedly improved. Their actual cost exceeds $207 million, and their replacement cost would be more than triple that amount.

Spread over many acres of ground, the plants are large complexes of intricate facilities. They include giant tanks and powerful pumps, broad lagoons and busy laboratories, mechanical rakes and huge air blowers, miles of pipelines and scores of valves. Interlacing them are numerous "push-button" controls.

Drawing their flow from three natural drainage districts (see map on page 10), the plants have different missions.

The Northeast Plant, located near the mouth of Frankford Creek, protects the upper portion of the Delaware River estuary. Put into service in 1951, it replaced a smaller plant built at the same site in 1923. Its daily treatment capacity of 125 million gallons was raised to 175 million in 1964 and in the future will be expanded to 250 MGD.

The Southeast Plant at the Walt Whitman Bridge, and the Southwest Plant, near Philadelphia International Airport, guard the estuary to the south. Located just above the confluence of the Delaware and Schuylkill Rivers, the Southeast Plant has a design capacity of 136 million gallons daily. The Southwest Plant, located just above the International Airport, has a design flow of 210 MGD.

Into these plants has come a rising flow of wastewater, as new sewers have linked them to outlying neighborhoods, and today the flow averages over 500 million gallons daily. The plants screen, settle, skim, aerate, or bacterially decompose this flow, in varying combinations of these and other treatment steps (see pages 21-24).

From the flow the plants as a group remove 78% of the suspended solids—thus keeping 167,000 tons of solid wastes out of the rivers each year. In addition, they remove over 67% of the "carbonaceous oxygen demand"—an important measure of pollution (see box). These removals are higher than those of most other communities along the Delaware estuary.

FUTURE EXPANSION

To satisfy growing needs, Philadelphia will treat its wastewater even more thoroughly in future years. To achieve this goal, it will expand its plants at a cost that will exceed $750 million.

This expansion will meet new requirements imposed by state and interstate regulatory agencies on the communities and industries of the Delaware estuary. Under these requirements, Philadelphia's wastewater effluent (as it enters the rivers) will be permitted only a limited carbonaceous oxygen demand. As a result, the city plants will have to remove 85% or 90% of such demand in the 1980's.

Most of the expansion is occurring at the Southeast and Southwest Plants. Their new settling and aeration tanks will be added to convert the plants from "primary", or limited, treatment of wastewater to "secondary", or more intensified, treatment. Some new tanks will also be built at the Northeast Plant.

As a result, the removal of carbonaceous oxygen demand will nearly double at the Southeast and Southwest Plants, and it will rise significantly at Northeast.

The removals of suspended solids and biochemical oxygen demand (B.O.D.) will also increase (see box).

PLANS FOR AUTOMATION

Future automation will also improve efficiency. Thus the Water Department is planning to operate its three expanded plants by computer.

The department's automation plan will:

- Place electronic instruments throughout the plants to analyze and report a variety of conditions** affecting wastewater treatment,
- Set up a digital computer at a central control point to receive, process and use the information transmitted to it by the monitoring instruments or fed into it by personnel,
- Establish a central control console, where flashing digits and signal lights will report to an operator the "status" of equipment*** and wastewater treatment in all parts of the plant.

Eventually the computer will regulate (as well as monitor) the treatment processes.

Automation will make possible the better control of wastewater treatment, larger removals of pollutants, and substantial savings in labor, chemicals, electric power and maintenance. Plant operating costs will be held down and streams will be better protected.

**Such conditions might include the dissolved oxygen, biochemical or chemical oxygen demand, turbidity, sludge volume, nutrients, suspended solids, carbon, etc., associated with the wastewater, as well as flow rates, elevations, pressures, gas and air volumes.

***This would include the operating performance of flow gates, bar screens, pumps, tanks, pipelines, air blowers, etc.

HOW PLANT EFFICIENCY IS MEASURED

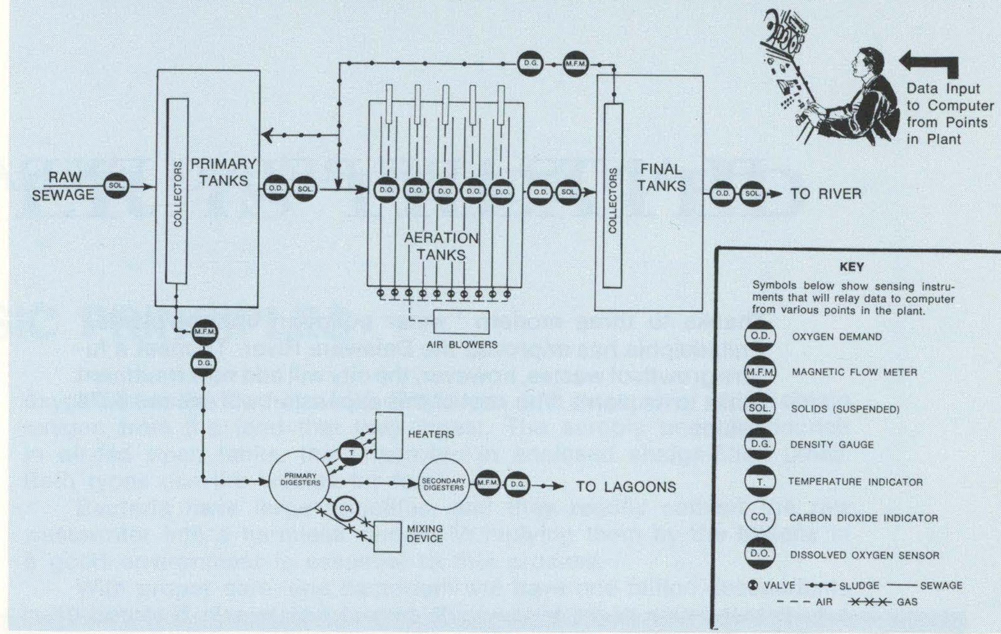
Aerobic bacteria living in streams take free oxygen from the water to help them decompose wastes. If the wastes are very potent, the stream oxygen may not be sufficient to enable the bacteria to do their work.

Thus one purpose of water pollution control plants is to limit the organic wastes discharged to streams. In Philadelphia, this is done by putting aerobic bacteria to work in the plant itself (as at the Northeast Plant) or by settling out solids (as at all the plants). This treatment is said to reduce the "carbonaceous" or "biochemical" oxygen demand of the plant effluent, or, more correctly, of the stream bacteria, since the latter will need less oxygen to break down the organic wastes which they do receive from the plant. This reduction of the demand is a measure of the plant's efficiency.

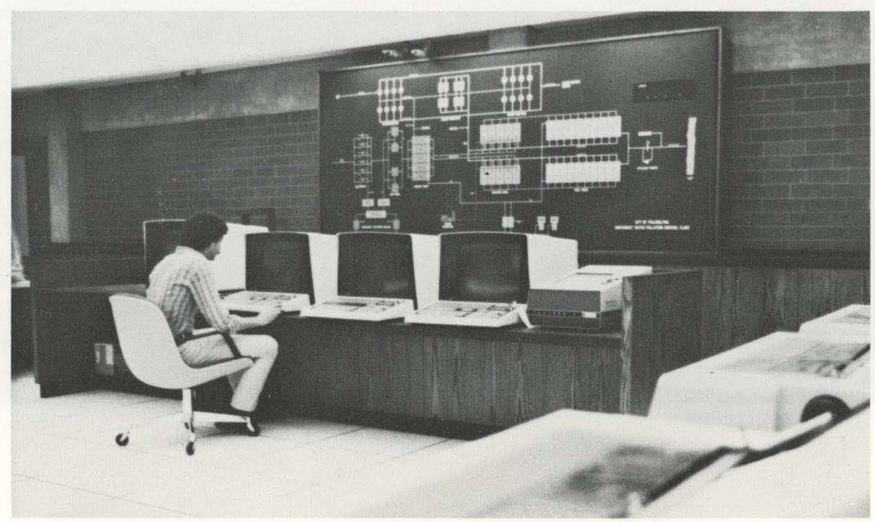
CARBONACEOUS OXYGEN DEMAND — **This is the quantity of oxygen used by aerobic bacteria to oxidize waste material containing carbon, and thereby convert this waste into carbon dioxide and water.**

BIOCHEMICAL OXYGEN DEMAND — **When the plant or stream aerobes have used up the carbon, they feed on the nitrogen in the wastes. The total quantity of oxygen used by the bacteria to convert *both* the carbon and the nitrogen into stable or harmless materials is called the biochemical oxygen demand.**

SIMPLIFIED INSTRUMENTATION PLAN FOR FUTURE AUTOMATION OF THE NORTHEAST PLANT

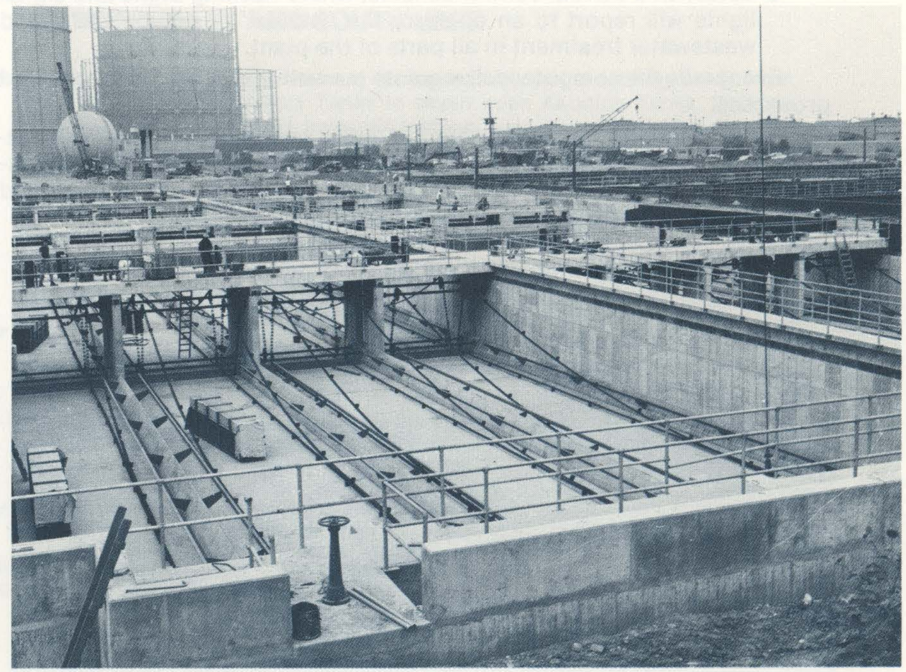


SOUTHWEST PLANT: Treatment will be highly automated under direct supervision of a digital computer system. The Process Control Center (below), located in the Administration Building, houses the computer and operator interface equipment. The PCC operator has unit process CRT graphic displays, including an overview on the entire plant operation, available at the Central Computer Console and can regulate all processes from the PCC.

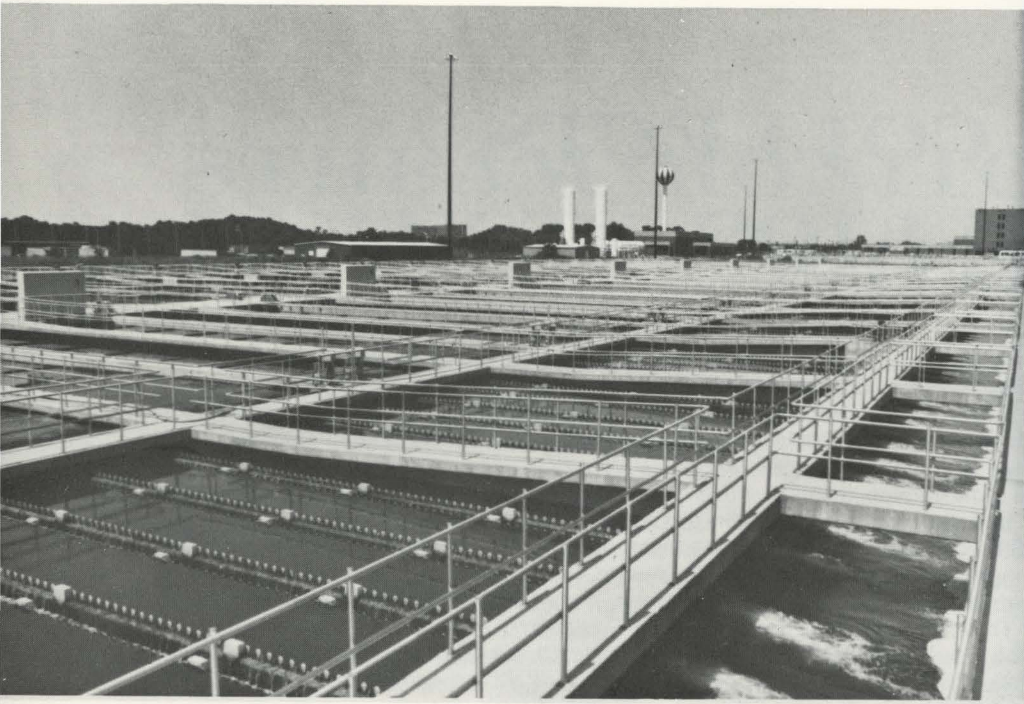


PLANTS ARE BEING EXPANDED

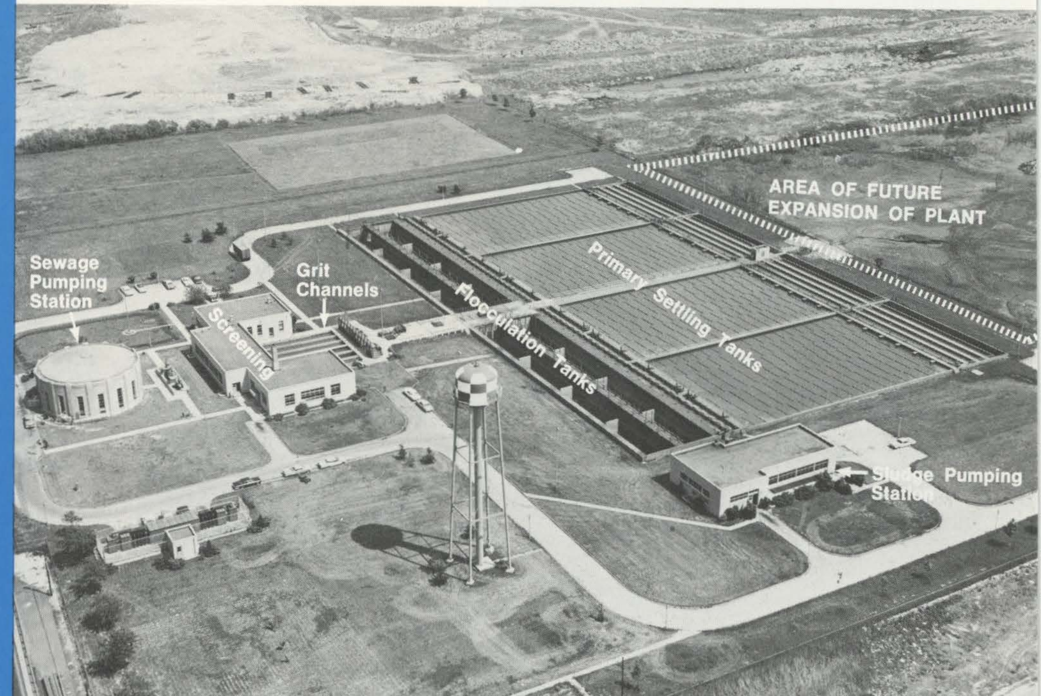
Thanks to three modern "water pollution control plants," Philadelphia has improved the Delaware River. To meet a future growth of wastes, however, the city will add new treatment tanks to its plants. The cost of this expansion will exceed $874 million.



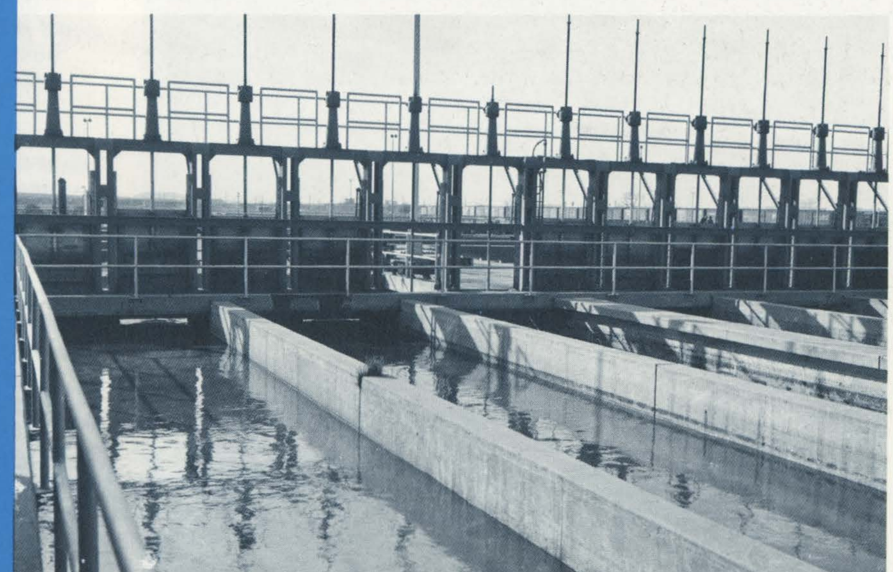
NORTHEAST PLANT: Providing "secondary" treatment, this plant (at left) has received increasing flows of wastewater. New basins (above) for final settling were added in 1964, thus raising treatment capacity from 125 to 175 million gallons daily. Further expansion has started to raise the capacity to 250 MGD and increase the level of treatment. The expansion work is scheduled for completion in the mid 1980's.



SOUTHWEST PLANT: Expansion to a 210 million gallon per day, oxygen activated sludge plant is virtually complete. Foreground above shows half of the twenty rectangular final sedimentation tanks. Seen below are the aeration tanks which are covered to confine the oxygen rich atmosphere above the water surface.

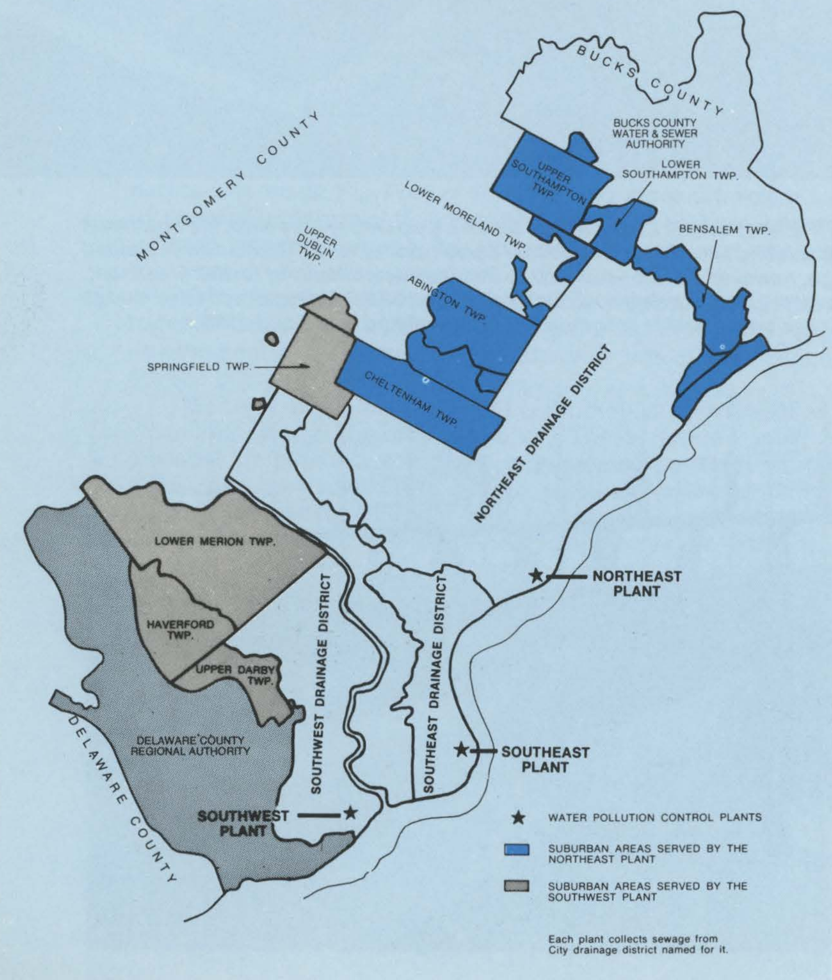


SOUTHEAST PLANT: Guarding the Delaware estuary to the south, the Southeast Plant screens and settles wastes that come from as far as Germantown. Settled sludge, however, must be pumped to the Southwest Plant for further treatment. Gates and grit channels below. Expansion to a 140 MGD oxygen activated sludge plant has begun and is scheduled to be completed in the mid-1980's.



PHILADELPHIA COLLECTS WASTES FROM MANY COMMUNITIES

OUTLYING COMMUNITIES WHOSE SEWAGE IS TREATED BY PHILADELPHIA



■ For better streams, Philadelphia follows the policy of the good neighbor; its water pollution control plants serve suburban areas as well as the city. Into these plants flow wastes from 230 square miles outside the city's boundaries and 130 square miles within.

This flow moves through three natural drainage districts that embrace both the city and the outlying communities.

In the Northeast District, great intercepting and collecting sewers carry the flow along the watershed of the Delaware River north of Lehigh Avenue, and the watersheds of the Frankford, Tacony, Pennypack, Poquessing and Byberry Creeks. This flow reaches the Northeast Water Pollution Control Plant.

In the Southwest District, the sewers stretch along the watersheds of Cobbs Creek, the Wissahickon Creek, and the Schuylkill River, until the flow enters the Southwest Plant.

In the Southeast District, the sewers follow the watershed of the Delaware River below Lehigh Avenue, and they also drain a minor portion of the Wissahickon Creek area. The Southeast Plant receives their wastewater.

Established by the city in 1915 as part of a comprehensive drainage plan, these three districts reflect the topography of Southeastern Pennsylvania. This topography favors the flow of suburban drainage towards the city and its bordering streams. As a result, the districts have given a regional mold to the growth of Philadelphia facilities. The city's water pollution control plants have been built with capacities sufficient to service nearby communities, and large collecting sewers have been run to the city's borders.

As the new facilities have grown, Philadelphia has made agreements with neighboring communities to receive and treat portions of their wastes. Thus wastewater is received at the city borders today from Lower Southampton, Lower Moreland, Bensalem, Abington, Cheltenham, Lower Merion, Upper Darby, and Springfield (Montgomery County) Townships. From these (through interlocking arrangements) comes flow from still other communities. The latter include part or all of Haverford, Radnor, Upper Southampton, Northampton, and Upper Dublin and Whitemarsh Townships and the Boroughs of Milbourne, Lansdowne, Yeadon, Narberth, Rockledge and Jenkintown.

Averaging 55 million gallons daily, the wastewater from outlying communities is metered at the city boundaries as it enters Philadelphia sewers. For the collection and treatment of this flow, the city charges a fee.

This regional cooperation benefits both the city and its neighbors. While keeping suburban wastes out of the rivers that supply Philadelphia with water, it also spares small communities the heavy expense of building and operating small water pollution control plants.

IMPROVED SEWERS REACH INTO EVERY NEIGHBORHOOD

■ To widen its collection of flow, the city has built 1,200 miles of sewers since 1946. The cost of this investment has reached $400 million.

The new sewers meet many needs. They serve new neighborhoods and industrial parks, relieve insanitary conditions, control storm flooding, replace old sewers, and reduce stream pollution.

Because of expansion, public sewers today collect nearly all the city's wastewater and channel this to the water pollution control plants for treatment. Only a few homes, served by cesspools, remain outside this system.

This rapid improvement will continue. Over 600 miles of sewers, which were built in the 19th century, will be replaced in the next few decades. Set at shallow depths and pounded by vibrations from overhead traffic, these old pipelines often break.

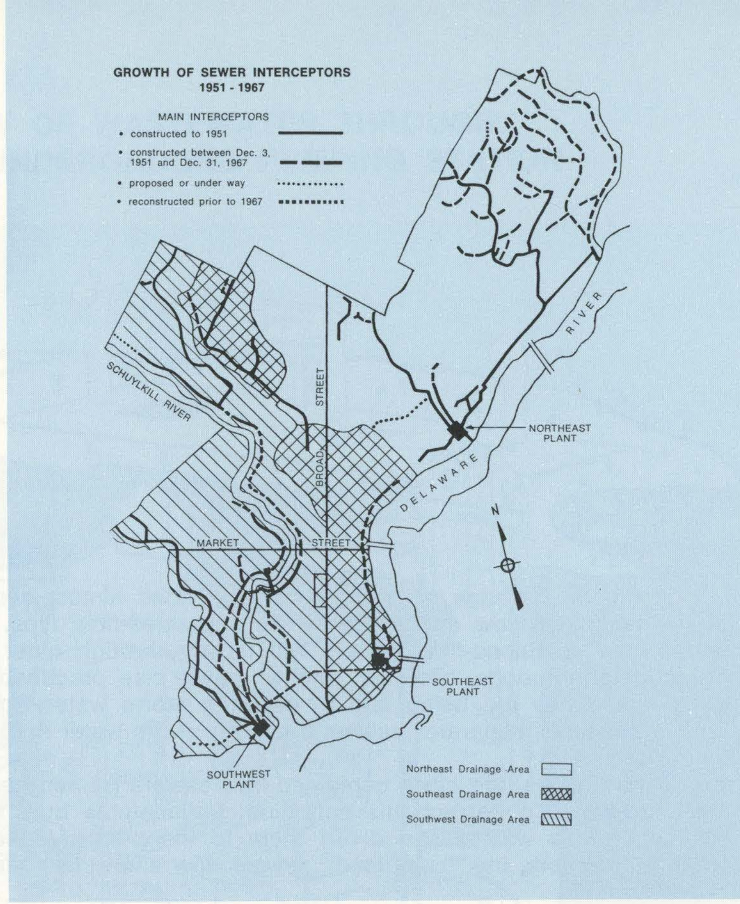
For replacement of old sewers, Philadelphia will spend from $8 million to $10 million a year for many years to come. Millions of dollars more will go into sewers for new neighborhoods and industrial parks.

NEW SEWERS TO PROTECT STREAMS

Today 2,900 miles of sewers reach into all parts of the city. Collecting wastes from homes and industries, the sewers carry an average of 500 million gallons of wastewater daily. In time of storm, millions of gallons of rainwater may be added.

As the wastewater flows from small house "laterals" into submains and then into main sewers, the pipelines become steadily larger and are set at ever lower depths. As a result, the wastewater moves by gravity most of the way to the water pollution control plants.

Intertwined in intricate grids, the city's sewers may carry different types of flow. Some sewers carry only wastes from homes, stores and factories; others carry only storm water, collected from streets, roofs and sidewalks; still others, called combined-flow sewers, bear both wastes and storm water in the same pipeline.



Of 150 miles of sewer interceptors, the city has added 80 miles in recent years. The big interceptors pick up mixed flows from branch sewers and carry them to plants for treatment. Map shows expansion; photo below, an interceptor on the west bank of the Schuylkill River.

Today the mileage of city sewers is divided almost evenly between those of the combined-flow and those of the separated-flow type. Built in an earlier period, the combined-flow sewers run mostly through older neighborhoods. In newer neighborhoods, however, and wherever else practicable, more and more double pipelines are being laid to separate storm water from sanitary wastes. This is because "separate" sewers bear only storm water to the rivers and wastes to the plants.

In past years, the city's combined-flow sewers poured heavy wastes into the local streams. To correct this condition, Philadelphia built special conduits to intercept these wastes and divert them to the plants. Linked to 150 miles of such interceptors, the "combined" sewers now empty into the rivers only during heavy storms.

This outflow to the rivers is regulated by intercepting "chambers". Some of these chambers are controlled by floats (see drawing on page 13). Others are of a simple well-and-tide gate type that works as follows.

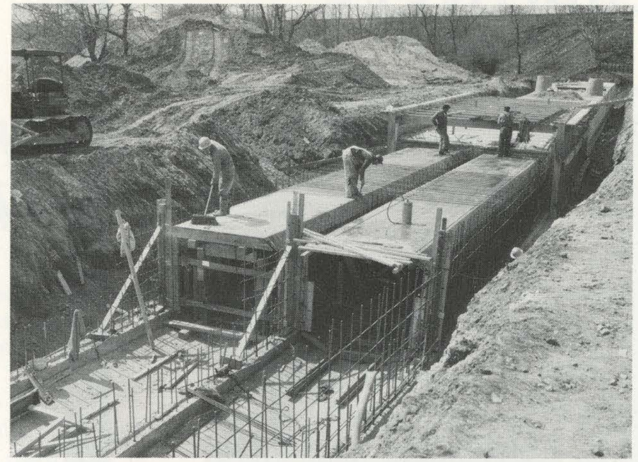
Plunging down a well, the flow passes from the "combined" sewer to the interceptor during dry weather. In time of severe storm, however, the rushing flow (swollen by rain water) leaps across the well and presses open a tide gate; the gate lets the excess storm water pour through a sewer outfall into the river. At such times, the swollen river easily dilutes and carries away the small percentage of wastes which it receives.

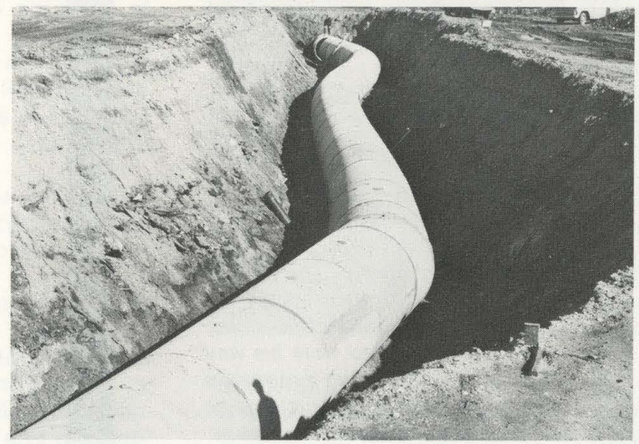
While the plants continue to receive heavy flow during storms, the "intercepting chambers" keep them from being flooded.

The entry of storm-borne wastes into streams may be reduced in the future; the Water Department is studying new techniques for retaining these wastes.

LEGACY OF THE PAST: Typical of old brick sewers built at the turn of the century was this 1909 sewer in Fairhill Street, intended to enclose Rock Run. Today the city is spending $8-$10 million a year to replace 600 miles of these brick veterans. One replacement (in Belfield Avenue) is shown below.

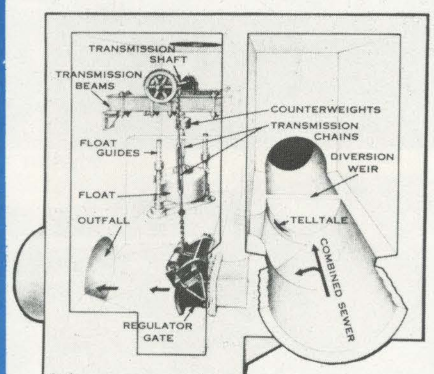
PRECAST CONCRETE PIPE: This type of pipe has replaced the use of old brick sewers to drain storm water from newly developed areas in Philadelphia.





FOR HOME SERVICE: Philadelphia has built many miles of sewers to serve newly developed neighborhoods. These range from huge box sewers to collect sanitary wastes to precast pipe to receive storm water. Concrete is used for large lines such as these.

MAIN RELIEF SEWER: This huge tunnel sewer has spread two additional miles to relieve flooding in North Philadelphia. An engineer (above) checks out a portion recently completed.



INTERCEPTING CHAMBER: Sewage in the "combined" sewer (above) normally passes through the "regulator gate" and then to a plant for treatment. During storms, however, the rain-swollen flow causes the float to rise, partly closing the gate. Excess flow leaps over the "diversion weir" or dam and enters the river.

SEWER MATERIALS AND SIZES

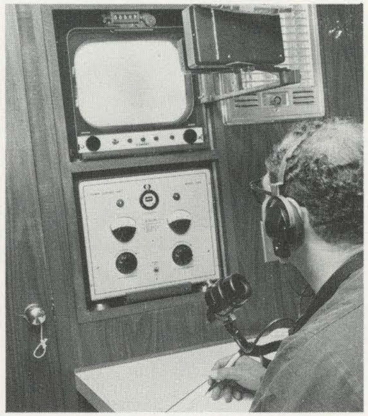
In Philadelphia, most sewers built in the 19th century were of brick, held together with lime mortar and (after 1895) with cement mortar. These old brick sewers still form one-third of the city's sewer mileage.

About 1890, vitrified clay was introduced, and today this material (since improved) is used for small and medium sanitary sewers. After 1890, vitrified brick was used in part or whole for some large sanitary and storm water sewers. In recent years, such large sewers have been built of reinforced concrete in the shape of tubes or boxes, while prefabricated concrete pipe has been used for small and medium storm sewers.

Smallest sewers are the "laterals",* which carry flow from homes to street sewers; such laterals are normally five or six inches in diameter. Sanitary sewers in streets begin at 10 inches in diameter and mount upward (15, 24, 36 inches, etc.) until they reach giant collector size of 14 ft. x 13 ft. Storm water sewers may begin at 18 inches and grow to great 20-ft. diameter tubes in tunnels.

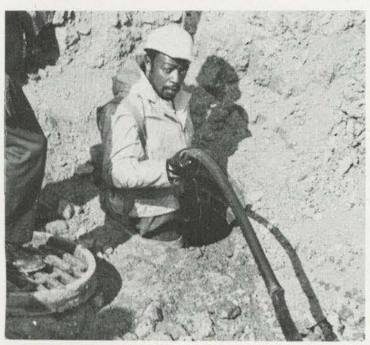
***Laterals not included in official City sewer mileage (2500) given on page 11**

SKILLED EMPLOYEES MAINTAIN SEWERS



TV INSPECTION: To inspect a small sewer, an operator lowers a television camera down a manhole. The camera will be pulled through the sewer by cable, while the operator observes a screen, which will reveal cracks inside the sewer.

SEWER MAINTENANCE INSPECTOR: A highly skilled employee who is trained in the repair and inspection of sewers to determine their condition for reconstruction and is often called upon to work his way through difficult and dangerous sewers to remove obstructions or repair breaks in the line.



SEWER CLEANING: The sewer inspector lowers a hose into a manhole. The hose is attached to a high-pressure machine, which will shoot powerful jets of water through the sewer . . . cutting through solid grease and sweeping away debris.

INLET CLEANING

UNENDING JOB: Often clogged by debris washed in by rain or tossed in by humans, the City's 75,000 inlets are a constant challenge to clean-up crews. Many are cleaned by hydraulic cranes while others are cleaned by hand or vacuum truck.

AUTOMATED STATIONS PUMP THE CITY'S FLOW

■ New, automated stations pump sanitary wastes and storm water. Though sewers carry most of the flow by gravity, there are a few points where it must be pumped to higher levels. To meet this need, the Water Department has invested $4.6 million in pumping station improvements.

Equipped with modern, electric pumps, the stations are of two types:

Sanitary Wastes — Ten stations move sanitary flow to the water pollution control plants. These include (1) three small facilities built in the northeast in 1969 to support new sewer services in several neighborhoods, (2) six west of the Schuylkill River, and (3) one in center city.

Most important of these is the big Central Schuylkill Station on the west bank of the Schuylkill River. Receiving flow from both shores, it is linked to the east bank by a siphon which plunges 60 feet below the stream. Its six pumps, with a combined capacity of 246 million gallons daily, speed the flow to the Southwest Plant.

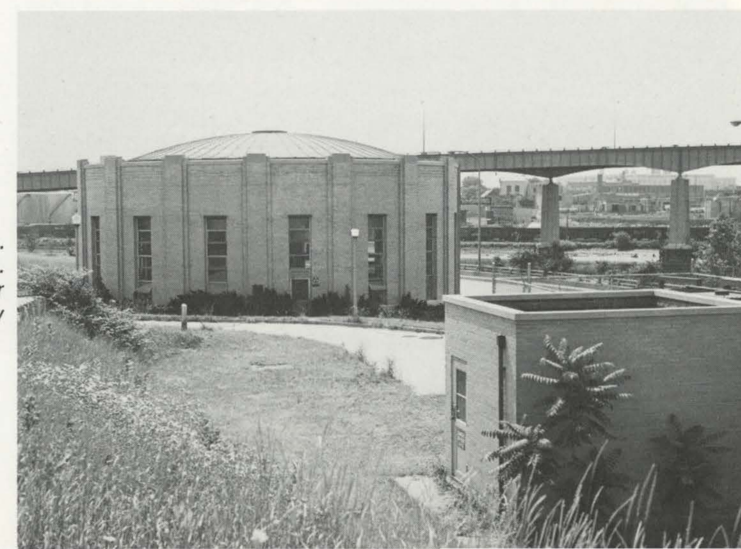
At each water pollution control plant, a station lifts part or all of the incoming flow, while another station pumps sludge between the Southeast and Southwest Plants. Some of these facilities are comparable in size to the Central Schuylkill Station.

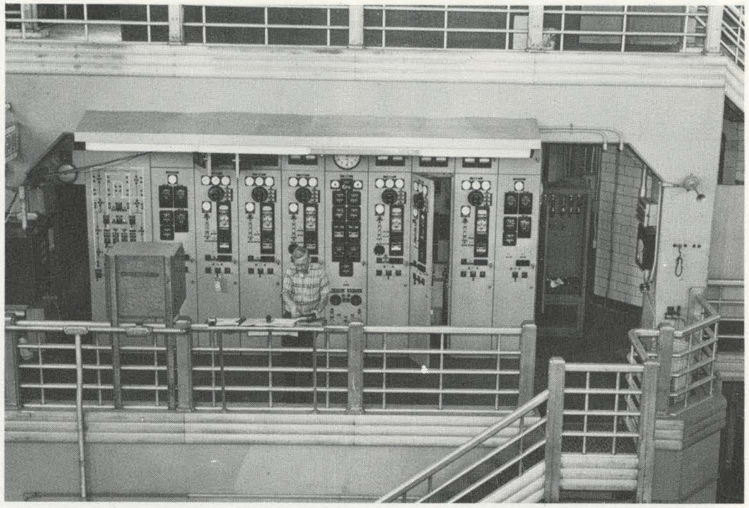
The 14 stations listed have a combined capacity of more than one billion gallons daily.

Storm Water — Several Stations receive storm water from collecting conduits and pump it into pipelines that empty into streams. Another station, opened in 1965, lifts storm water from Mingo Creek to the Schuylkill River; this $1 million unit receives run-off from Philadelphia's growing international Airport and redeveloping southwest. The four largest storm water stations have a combined capacity of 151,000 gallons per minute.

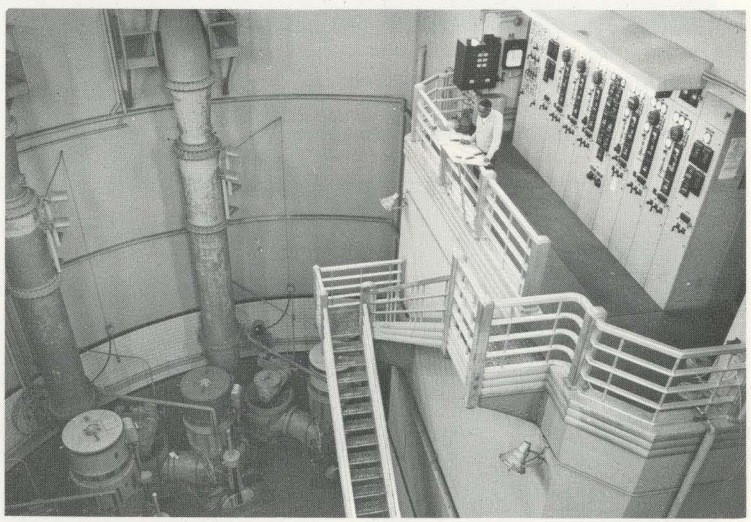
NORTHEAST PUMPING STATION: Equipped with new pumps, this spacious old station raises incoming wastewater to the primary settling tanks at the Northeast Plant. Pump motors project above the floor.

CENTRAL SCHUYLKILL STATION: Only the top of this 73-ft. tall station is visible on the west bank of the Schuylkill River. Set far below ground, the station screens incoming wastewater and lifts it 36 feet to a large gravity sewer that carries the flow to the Southwest Plant.





SOUTHEAST STATION: As in other stations, panelboard controls provide "push-button" operation of pumps in the raw wastewater station at the Southeast Plant. Set at the bottom of a deep circular well, the pumps force 120 million gallons of sewage daily up the tall pipes into the plant.



MOST STATIONS UNMANNED

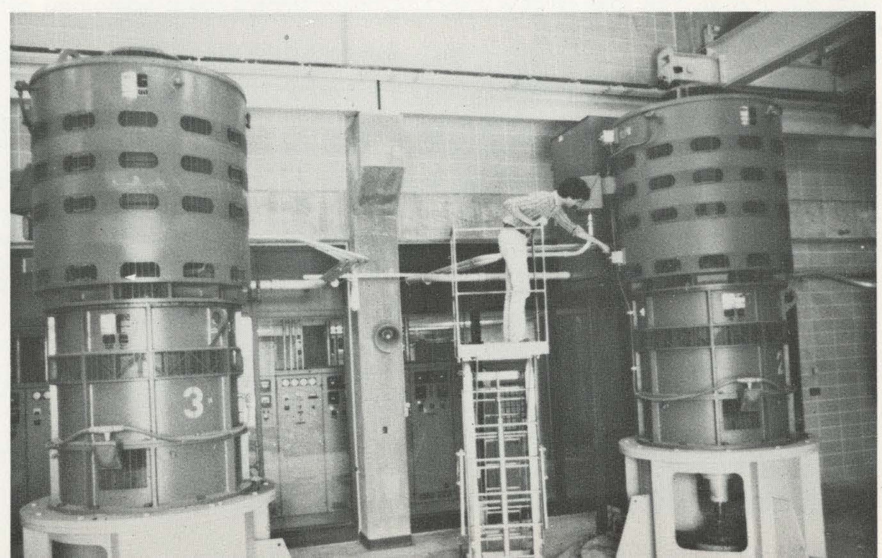
Projecting only a little way (or not at all) above ground, many of the stations are sunk 30 to 60 feet below the surface. Into them huge intercepting or collecting sewers bring their flow, and the pumps raise the flow to higher pipelines so that it can continue its course.

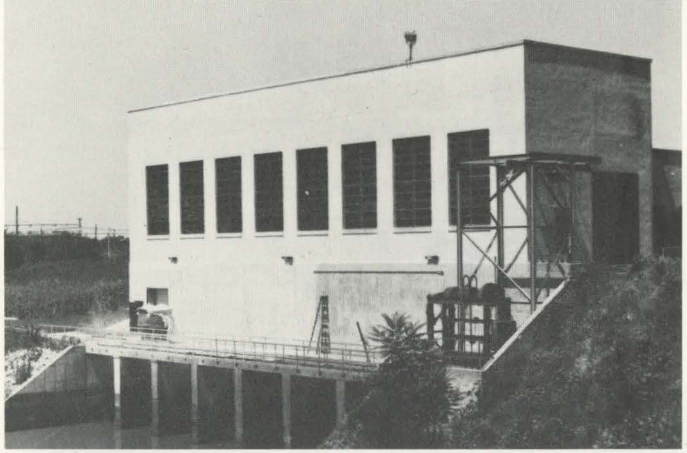
To save personnel, the small stations are completely automatic. When waste or storm water rises in the "wells" at such stations, a chain of events is begun. A float, rising on the water, or an electrical "probe" coming into contact with the water, may trigger an electrical current, which in turn actuates the pumps. A fall in the water level reverses this trend, shutting down the pumps.

At nearly all the large stations, however, operators watch over the pumping process because of the greater flow. Starting or stopping pumps, eyeing rates of flow in meter dials, or looking for malfunctions of equipment, the operators are on duty around the clock. In these stations, most of the equipment is operated by "push button", but, once the operator starts a pump, the rest of the sequence often follows automatically. Thus valves open, revolving trash rakes go into action, or warning lights flash on control panels.

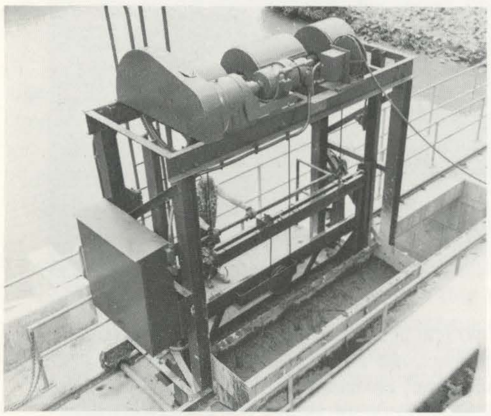
To protect pumps and plants, most stations have mechanisms that screen out or cut up coarse debris in the waste or storm water. Many of the unattended stations are also linked to alarms that sound at distant points when flow rises too high or other trouble develops. Sewer-borne gases are removed by ventilating systems.

SOUTHWEST PLANT: Effluent pumps will be used only when the tide level prohibits gravity discharge to the Delaware River. Five vertical, propeller type, low lift effluent pumps have a total capacity of 575 MGD.

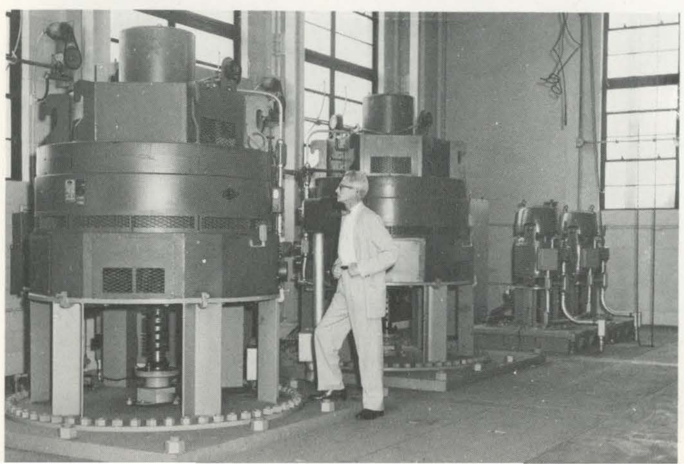




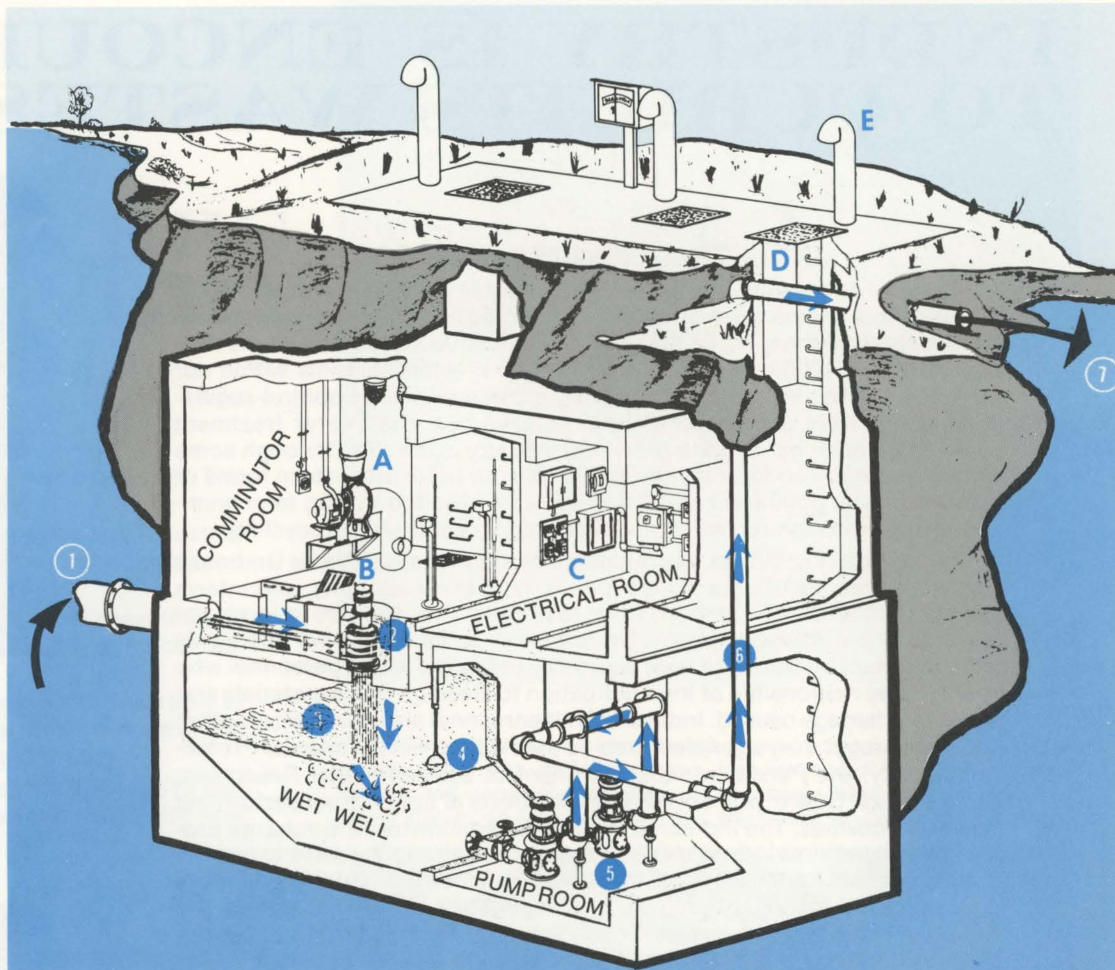
MINGO CREEK: Expanded in the last few years at a cost of almost $4 million, this station pumps storm water from Mingo Creek into the Schuylkill River. In 1980, the Mingo Creek Surge Basin was built to receive more run-off from Eastwick.



AUTOMATIC PUMPING: Replacement of these pumps (below) by 1983 will triple the pumping capability of the Mingo Creek Station. Trash rake and gantry (above) remove debris from flow.



FLOW OF WASTEWATER THROUGH AN UNDERGROUND PUMPING STATION



WASTEWATER

1. Enters pumping station
2. Flows through comminutor, a grinder which cuts up coarse material
3. Sinks into wet well
4. Causes float to rise as wet well fills
5. Moves through pumps, which have been started by rising float
6. Is forced up through pipe by pumps
7. Flows to treatment plant

Other Equipment

- **A** Exhaust blower removes gases from station
- **B** Bar screen filters flow when comminutor is taken out of service
- **C** Electrical controls . . . Station is automatic
- **D** Entrance hatch
- **E** Exhaust pipe for air and gases

INDUSTRY IS ENCOURAGED TO CURB ITS WASTES

INDUSTRIAL WASTES CONTROL

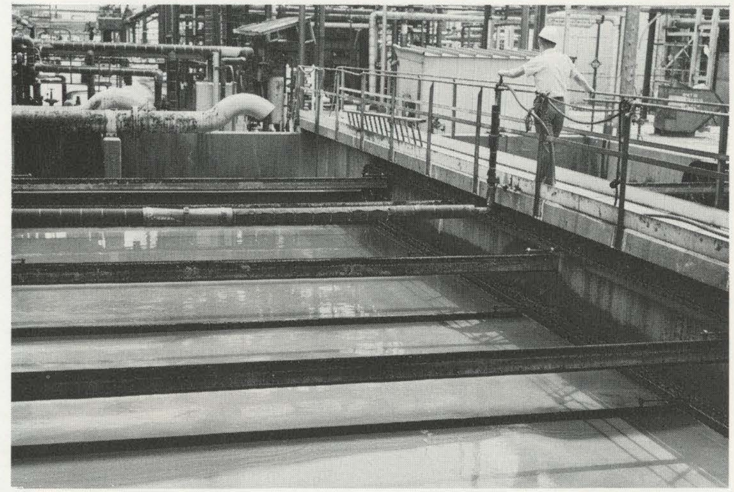
In order to operate our modern wastewater collection and treatment systems most effectively, they must be protected from the potentially harmful industrial discharges. To that end, the Industrial Waste Unit works with approximately 1200 industries and commercial establishments within our service area. The Water Department enforces wastewater control regulations which were developed to both achieve our wastewater treatment goals, while not inhibiting the growth of industry in the City. Through some innovative engineering practices applied by our industries, some forms of industrial water pollution control have actually resulted in long term financial savings through recovery of useful products and water recycling.

In their daily activities, the members of the Industrial Waste Unit must locate the sources of potentially harmful industrial pollutants, and inform plant personnel of their responsibility to pretreat these wastes to levels acceptable to our sewage system. On occasion, spills of harmful chemicals and fuels must be traced to their source by industrial waste personnel who inform those responsible of their obligation to clean up these materials and repair any damage caused. Industrial Unit personnel also must inform other applicable regulatory agencies such as the Federal Environmental Protection Agency, the Pennsylvania Department of Environmental Resources, and the Coast Guard; and coordinate the efforts of contractors performing clean-up activities. The Industrial Waste Unit administers a surcharge program which requires industries discharging high strength wastes to pay the additional costs for treatment of these wastes. When Industrial Waste problems become a matter of continual civil negligence or criminal activity, the Industrial Waste Unit must work closely with the City Solicitor's and District Attorney's offices to achieve compliance through legal recourse.

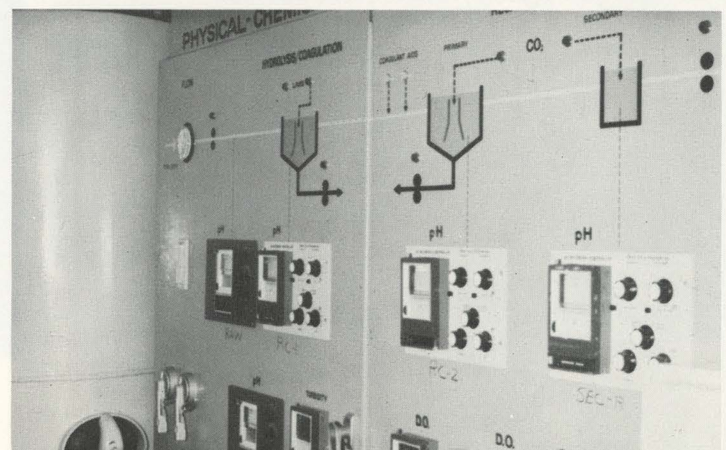
City engineers have visited nearly all manufacturing and processing plants. These account for the greater part of the wastes produced by local industry, and cover hundreds of manufacturing firms, restaurants, laundromats, gasoline service stations, and other waste-producing enterprises.

Plants visited represent such varied activities as plating, pigments, wire products, packing, chemicals, dyeing, roofing, paper products, marble polishing, storage batteries, textiles, containers, meats, engraving, distilling, printing, wool scouring, plastics, and dairy products.

City engineers also review plumbing plans for commercial wastes and approve the issuance of permits for waste interception devices.



OIL SEPARATION: Large chemical processing industries use water for processing. Before returning the used water to the sewer system, immiscible substances are separated, removed and recycled. PH CONTROL (below). Utilities and manufacturing plants handling corrosive materials employ sophisticated monitoring and control instrumentation to maintain neutral wastewater discharges.



STREAM MONITORING DETECTS POLLUTION

■ The Water Department constantly watches the rivers. It operates — jointly with the U. S. Geological Survey — a number of tiny stations, equipped with electronic devices for measuring conditions in the streams.

These stations warn of industrial "spills", temperature rises, salt water influx, sewage overflows or other forms of pollution. They also provide data for long-range prediction of river conditions.

Along the Delaware River estuary, six "multi-purpose" stations keep daily vigil. Analyzing the river water automatically and recording data continuously on charts, they measure the dissolved oxygen, temperature, turbidity, "pH", and specific conductivity of the river water. Each is capable of measuring up to eight "parameters", or stream conditions.

Lesser stations report on water levels and rates of flow in the estuary, while devices at distant water treatment plants record radioactivity in both streams.

On the shore of the Schuylkill River, another "multi-purpose" station checks on the fresh water pool above Fairmount Dam.

Begun in 1960, this electronic monitoring program — the first of its kind on any estuary in America — has been steadily expanded and improved. Early-model instruments were replaced in 1968-69 with later models.

The work of the shore-based stations is supplemented by mid-stream sampling. Roaming the estuary in a high-speed cabin cruiser, sanitary engineers collect water samples from Marcus Hook to Trenton. Portable electronic gear and an on-board laboratory permit immediate testing. Mid-stream samples have been collected by the Water Department and USGS since 1949.

COMPUTERS TO STUDY RIVERS

Thanks to monitoring, the city has collected a growing mass of stream data. This data will be studied on a computer in future years, so that the rivers may be understood more fully. Thus —

1. At present, tapes are prepared by digital recorders attached to the river instruments. These tapes are then translated into punched cards for use on a digital computer, operated by the Water Department.

2. A yet more ambitious plan is under way. The river stations will transmit data eventually by land wire or microwave to a central computer. The new-model instruments at the stations are readily adaptable to such transmission.

While awaiting these more ambitious projects, Philadelphia has made many special stream studies. In recent years it has studied dissolved oxygen distribution, size of waste loads, bottom sludge blankets, flow volumes, tidal influx, pesticides, the effects of sunlight on algae growth, storm water overflow, and many other factors affecting the quality of the river water.

Some studies too have been made jointly with federal, state and interstate agencies interested in the streams of the Delaware Valley.

STREAM STUDIES: To keep an eye on stream pollution, engineers of the Water Department and the U. S. Geological Survey make weekly boat runs on the Delaware River. This fast motor launch, owned by the Water Department, makes it possible to collect water samples from all parts of the river, at various depths.

FROM CLEANER STREAMS OUR CITY REAPS MANY BENEFITS

■ Thanks to stream improvement since the 1940's, Philadelphia has become a more desirable community in which to live. The improvement has brought these benefiits —

● *Better Drinking Water* — Clean-up has reduced wastes (with related tastes and odors) in the river water, and this has made it easier for the city's filter plants to purify and refine the water. Partly because of this, Philadelphians now drink one of the purest treated waters in America; tastes and odors at the tap have practically disappeared.

● *Water Abundance* — Because river wastes are fewer, the waters of the Delaware and Schuylkill Rivers are usable even in times of low flow or drought. This helps to assure water abundance the year around. Without adequate stream protection, Philadelphia might be seeking water far upriver at tremendous cost.

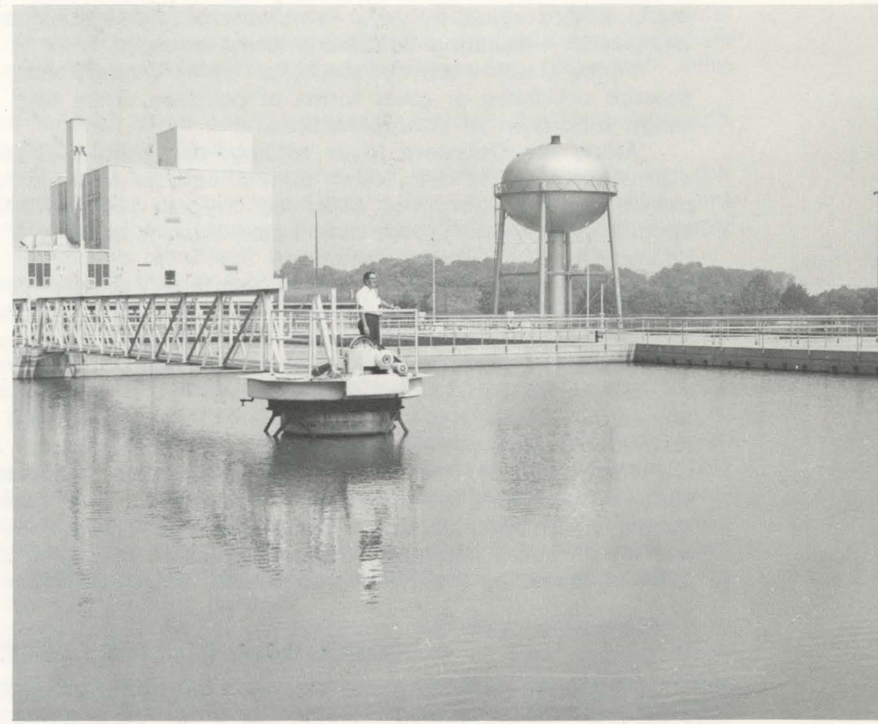
● *More Port Business* — Banishment of river fumes and floating sewage debris has made the Port of Philadelphia more attractive to shipping. This is one of several factors which (since the late 1940's) have helped to double the cargo tonnage passing through the Port. This tonnage has exceeded 100,000,000 yearly for most of the past decade.

● *Industrial Advantages* — Cleaner river water for cooling and processing — together with the city's improved water system — has made Philadelphia more advantageous for industry. Philadelphia has plenty of good water to hold or attract industrial firms.

● *River Bank Development* — Stream improvement is encouraging new investments along the city's shores. These include millions of dollars, already invested or planned, for piers, marinas, parks, and apartment houses. City and state agencies, as well as private developers, are working on large-scale plans. Eventually, investments will total hundreds of millions of dollars.

● *More Tax Revenues* — As investments in areas bordering the rivers increase, the municipality will reap increased tax revenues.

● *Recreation* — Pleasure boating has increased on the Delaware and Schuylkill Rivers. Fish have returned in large numbers, providing sport for amateur fishermen. The beauty of the Schuylkill shores lures thousands of visitors, no longer repelled by river odors.



FINE DRINKING WATER: Costing $200 million, the modernization of the city's water system has been closely linked to stream clean-up. New "push-button" plants, like the Belmont Water Treatment Plant above, produce one of the purest treated waters in America.

APPENDIX

HOW WASTEWATER IS TREATED

I. SOME BASIC PRINCIPLES

■ In Philadelphia's water pollution control plants, the lore of science is used daily to remove or destroy wastes. Science-trained employees and costly equipment (much of it automatic or semi-automatic) aid the process.

The employees may include sanitary engineers, chemists, microbiologists, electronics specialists, and skilled operators. To meet exacting requirements, many employees are prepared by colleges or specialized schools. Under a new law, many will also be licensed by the State to operate water pollution control plants after January 1, 1971.

Operating complex equipment, the employees use many skills. They watch over pumps that lift millions of gallons daily, huge open tanks with moving "arms", enclosed tanks with covers that float on bacteria-produced gas, giant machines blowing thousands of cubic feet of air per minute, complicated electronic panels, and revolving screens and rakes. Through well equipped laboratories, they sample and test the wastewater flow at every stage of treatment.

For the sciences — biology, chemistry, physics, and a variety of engineering specialties — there is constant need. This is because the city plants reproduce Nature on a grand scale. Here simple physical and biological principles are applied to treatment.

One of these principles is physical sedimentation: Solid wastes are allowed to settle out by slowing the wastewater flow as it passes through channels and tanks.

In some instances, air is used to *flocculate* the flow, causing oil particles to rise to the surface where they are skimmed off, and other particles to coagulate into heavy masses that settle.

Another idea is the *use of bacteria* to break down or destroy wastes. This is a process that occurs in Nature, and Philadelphia's plants speed it up by providing the right environment for the temporary flourishing of helpful bacteria. Depending on the plant, one or two types of bacteria may be used in treatment: *aerobic,* which take oxygen from the fluid in which they swim, and *anaerobic,* which obtain oxygen from the food that they ingest. The aerobic bacteria flourish in air-fed open tanks, the anaerobic in enclosed sludge-filled tanks. Both types use the wastes for food.

Bacteria have large appetites, and they readily convert the raw wastewater into a harmless sludge. Multiplying them by the billions in a good environment is essential to this process.

With proper care, one bacterium will have one billion descendants in 10 hours. If placed end to end, they would reach seven-tenths of a mile, but bunched together they would scarcely cover the face of a dime.

To provide such care, the plant chemist makes sure that the bacteria are well fed, and that they have a regular "physical" check-up. Nutrients may be added to some of the tanks, while a variety of laboratory equipment determines whether the bacteria are well fed or starved, active or lazy, sick or well.

Thus protected, the anaerobes perform another useful service. They produce methane gas, which is used to heat the buildings and fuel the sludge heaters of the plants.

The principles noted are only part of the sophisticated notions that underly the operation of water pollution control plants. The application of these principles is complex and varied, and it is not completely the same for all of Philadelphia's plants.

Treatment at the plants is affected at present by their location, as well as by the nature of the flow they receive. Thus treatment is more intensive (with more steps) at the Northeast Plant, because the plant (1) protects the intake of the city's Torresdale Water Treatment Plant farther upstream, and (2) receives two flows, one largely domestic, and the other mainly industrial in origin. The other two plants are located well downstream, and their flow is mainly domestic. Treatment will be similar at all the plants when they are expanded (see page 6).

II. STEPS IN TREATMENT

1. INITIAL TREATMENT AT ALL PLANTS

PUMPING

To move flow by gravity, collecting sewers slope gradually downward on their way to the water pollution control plants. Thus, on reaching the plants, some or all of the flow must be lifted into the plants by pumps. At present, all incoming flow is lifted into the Southeast Plant, while at the Northeast Plant the wastewater enters at plant level but is subsequently raised by pumps from the Grit Channels to the Primary Settling Basins. Most flow enters the Southwest Plant at plant level, and only 10% must be raised. All the stations are equipped with modern, electric pumps, and pumping capacity is well in excess of current inflows. (For a description of pumping, see pages 15, 16).

SCREENING

Treatment begins as the wastewater enters the plant Grit Chamber.* In this chamber it flows through bar screens that trap sticks, rags, leaves, and other floating materials. This debris is lifted from the screens by revolving rakes and dumped on a belt conveyor, which in turn takes the material to an ejector. Then it is blown to open lagoons at the Northeast Plant, or shredded and returned to the wastewater flow at the other two plants.

GRIT REMOVAL

After passing through the bar screens, the wastewater flows slowly for 60 to 80 feet through open channels, where sand, coal dust, pebbles, and other inorganic materials settle out. A screw conveyor carries the grit to a bucket elevator, and the latter lifts it to the belt conveyor for ejection to disposal areas or hauling to an incinerator.

FLOCCULATION

From the Grit Channels, the flow moves to long, narrow Flocculation Tanks at the Southeast and Southwest Plants. There a small amount of air is bubbled through the wastewater. The purpose is to float grease and to help coagulate the suspended particles by bringing them into contact with one another. Flocculation is omitted at this stage in the Northeast Plant.

PRIMARY SETTLING

Most of the suspended solids are still present as the wastewater enters 250-ft. long "Primary Settling" Tanks. Slowed as it moves through the open tanks, the flow takes one and one-half to two hours to pass through. In the process, about half of the suspended solids settle to the bottom of the tanks, and then this deposited "sludge" is swept away by chain-collected, motor-operated wooden arms called collectors. These collectors also skim floating grease from the surface of the flow.

The "effluent", or liquid from the Primary Settling Tanks at the Southeast Plant is emptied into the river; at the Northeast and Southwest Plants it passes to other tanks.

*Part of the flow to the Northeast Plant is also screened at the Frankford Grit Chamber ("O" and Lycoming Sts.) several miles before it reaches the plant.

2. SECONDARY TREATMENT ... AT NORTHEAST AND SOUTHWEST

AERATION

The wastewater at Northeast, after initial settling moves from the Primary Tanks to seven open Aeration Tanks. In these great tanks (over 400 feet long and almost a quarter as wide), huge quantities of air are injected into the flow by motor-operated blowers. Nourished by this air, tiny aerobic bacteria multiply by the billions. Most of the bacteria are within the flow. Some of the bacteria reside on special rotating disks located along the tank's entire length. The wastewater stays in the aeration tanks for 2½ hours. At Southwest the settled wastewater flows to ten covered reactors. Here the wastewater and aerobic bacteria are mixed together with pure oxygen for 2 hours. As at Northeast the bacteria consume organic matter, become fat and pass along to settlers.

FINAL SETTLING

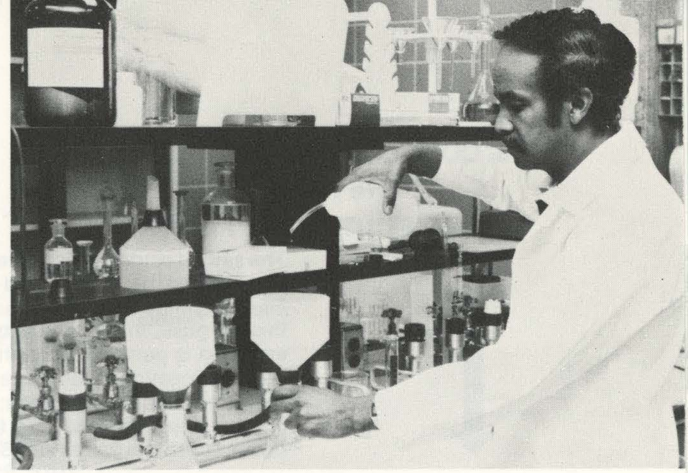
The flow from the Aeration Tanks passes to the Final Settling Tanks. In the latter, the bacteria flocculate and carry waste solids to the bottom, where the sludge is removed by collectors. The effluent from these huge tanks is chlorinated and emptied into the river. The flow through the final Tanks requires about two hours.

RETURN SLUDGE

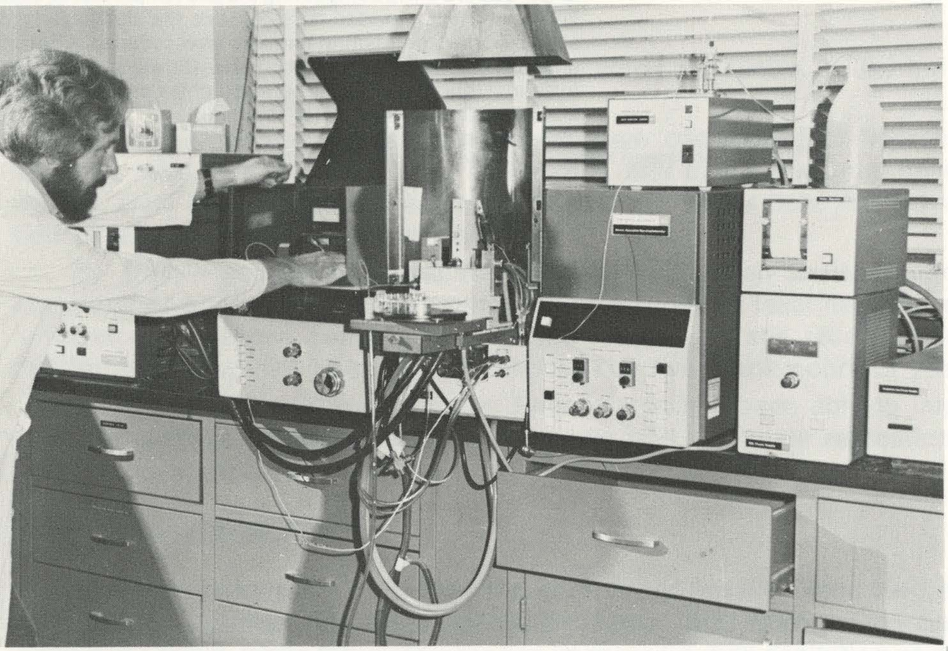
An important technique at both plants is the reuse of sludge to improve treatment. Thus the bacteria-laden sludge from the Final Tanks is returned in part to the Aeration Tanks; there the fresh bacteria and returned nutrients spur the biological process. The rest of the Final-Tank sludge is pumped to the Primary Tanks, where it is mixed with incoming wastewater and then is settled out as part of a thicker sludge. Future plans call for this sludge to be sent to special thickening tanks.

(Continued on page 24)

LABORATORIES MAKE 200,000 TESTS YEARLY



SLUDGE TEST: *The laboratory personnel continually monitor the wastewater treatment processes by analyzing several control parameters such as the solids content in wastewater as shown above.*



MODERN EQUIPMENT: *Using an atomic absorption spectrophotimeter, chemists check various types of samples for heavy metal content. These results are used for industrial waste control and to assure effluent standards are met.*

SPECIAL ANALYSIS: *Monitoring for trace organic compounds is accomplished by using one of the department's gas chromatograph mass spectrometers. Results from these instruments help us with industrial waste control problems and provide valuable information on wastewater plant effluent quality.*

BACTERIA: *A department aquatic biologist studies the biological make-up of thousands of samples a year. The type and quantity of bacteria are important health signs for wastewater treatment processes.*

3. CONCLUDING TREATMENT
... AT THE NORTHEAST
AND SOUTHWEST PLANTS

The settled sludge which is removed from the open tanks in all plants must be decompsed—or "digested", as the technicians say—by anaerobic bacteria to render it harmless. For this purpose, the sludge is collected into sumps or hoppers and then is pumped through a series of facilities to Digester Tanks. Digestion takes place at each plant except the Southeast, which has no facilities; the latter pumps its sludge five miles to the Southwest Plant for digestion. The following steps occur at the Northeast and Southwest Plants:

SLUDGE THICKENING

After leaving the Primary Settling Tanks, the sludge is thickened.

SLUDGE HEATING

The sludge is then heated (usually to 100 degrees F.) to assure a favorable environment for the anaerobic bacteria when the sludge reaches the Digester Tanks.

SLUDGE DIGESTION

Leaving the heaters, the sludge moves to the Digesters. One of Nature's more useful processes occurs in these big, enclosed tanks. There the sludge is attacked by anaerobic bacteria. When no free oxygen is present, these bacteria are able to break apart organic matter to obtain oxygen as well as food. They multiply by the billions in the Digesters and in the process of decomposing the sludge they create a number of products. One type of anaerobe converts complex compounds such as fats, carbohydrates, and proteins into simpler substances like acetic acid; another type (bacterium methano) converts the acetic acid into methane gas. All the bacteria respire carbon dioxide. As a result, the three main products are methane, carbon dioxide, and an undecomposable residue, which is mostly nitrogenous. The residue is called digested sludge.

Measuring 110 feet in diameter, the Digester Tanks have large covers that float on a cushion of gas produced inside. This gas is forced to the bottom of the tanks by compressors, and it bubbles up through the sludge, keeping the latter turbulent and breaking up the scum on the surface.

DEWATERING OF DIGESTED SLUDGE

The digested sludge is the final, innocuous product of wastewater treatment. Before composting this sludge, the plant removes some of the water from it. This is accomplished by using centrifuges or belt filters. Separation of the water from the sludge is aided by the addition of polymers.

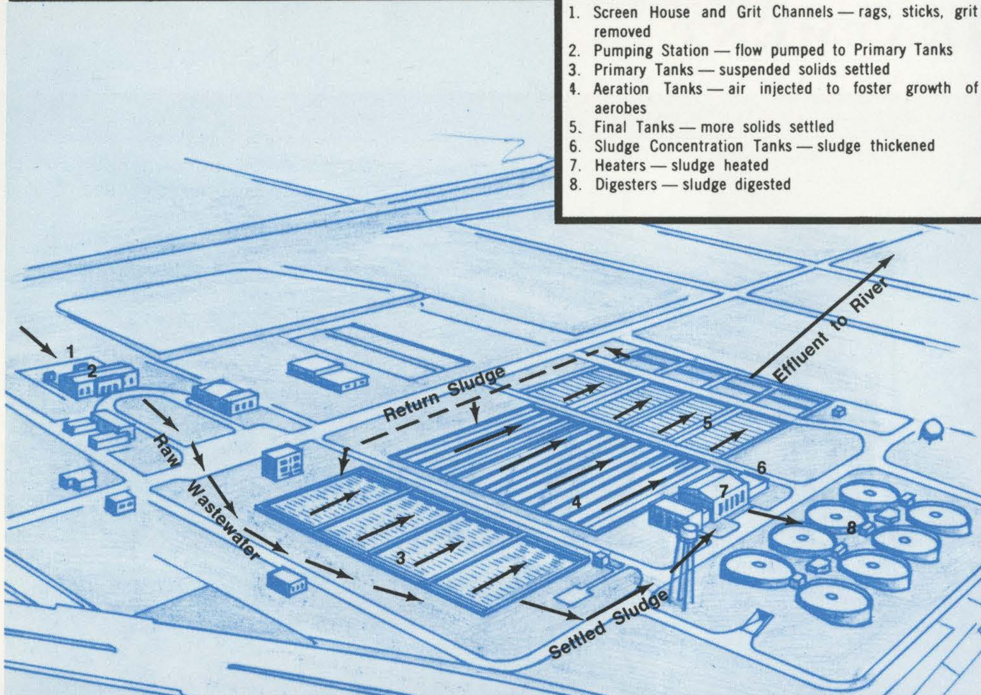
COMPOSTING AND RECYCLING

Once the sludge is dewatered it is trucked* to the composting area for further processing. Here the sludge is mixed with wood chips and aerobically composted for 20 days. The operation is very similar to a backyard compost pile but on a much larger scale. During composting the pile temperatures exceed 140°F. At these elevated temperatures the sludge is further stabilized and the harmful bacteria level reduced. After composting the sludge is stored or cured for 30 days to bring about further stabilization. Then the wood chips are separated out and the compost is ready for recycling.

*All dewatered sludge at Northeast and Southwest is composted at Southwest.

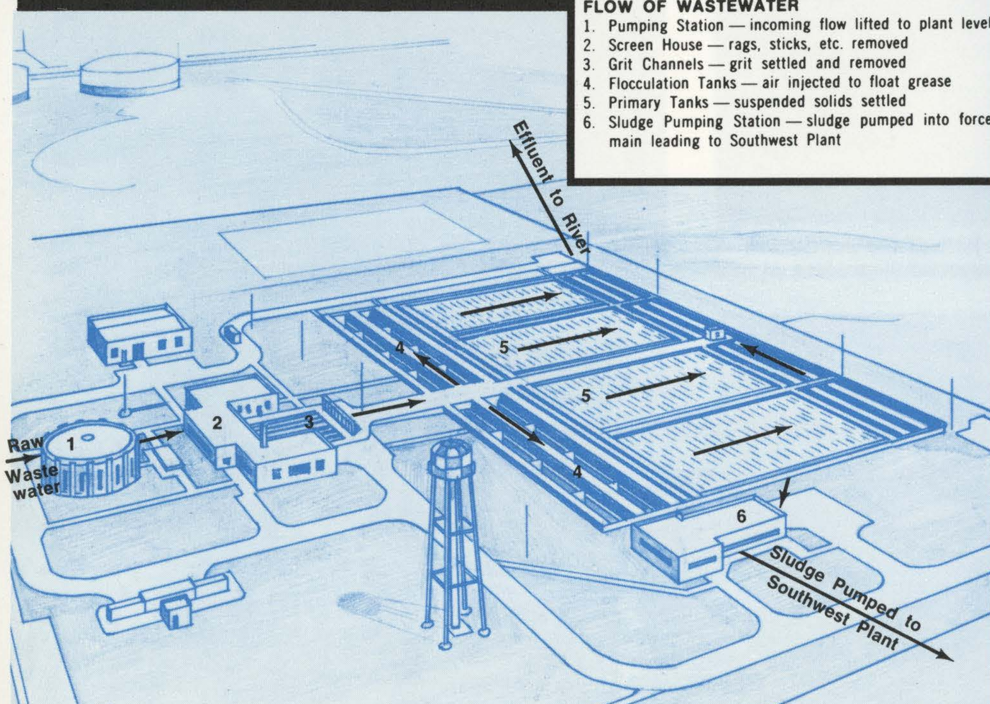
NORTHEAST WATER POLLUTION CONTROL PLANT

FLOW OF WASTEWATER
1. Screen House and Grit Channels — rags, sticks, grit removed
2. Pumping Station — flow pumped to Primary Tanks
3. Primary Tanks — suspended solids settled
4. Aeration Tanks — air injected to foster growth of aerobes
5. Final Tanks — more solids settled
6. Sludge Concentration Tanks — sludge thickened
7. Heaters — sludge heated
8. Digesters — sludge digested

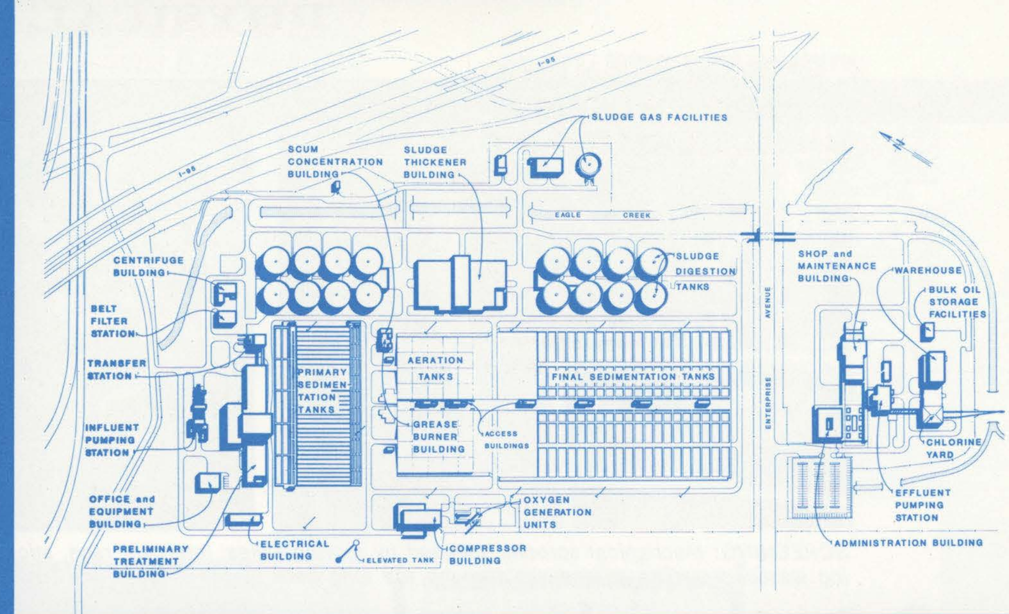


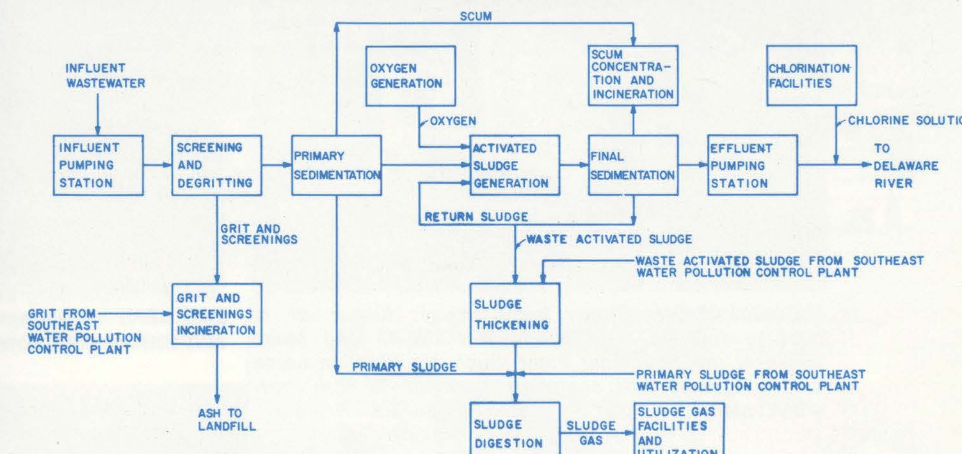
SOUTHEAST WATER POLLUTION CONTROL PLANT

FLOW OF WASTEWATER
1. Pumping Station — incoming flow lifted to plant level
2. Screen House — rags, sticks, etc. removed
3. Grit Channels — grit settled and removed
4. Flocculation Tanks — air injected to float grease
5. Primary Tanks — suspended solids settled
6. Sludge Pumping Station — sludge pumped into force main leading to Southwest Plant



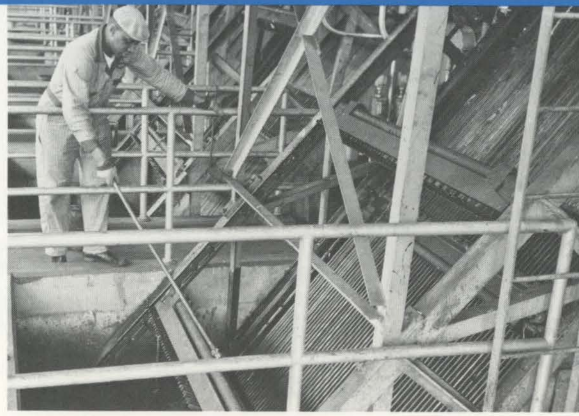
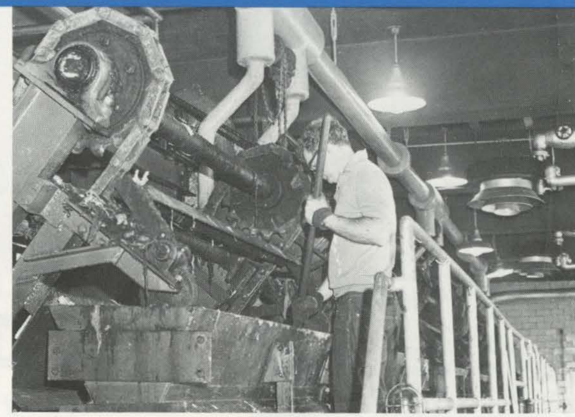
SOUTHWEST WATER POLLUTION CONTROL PLANT



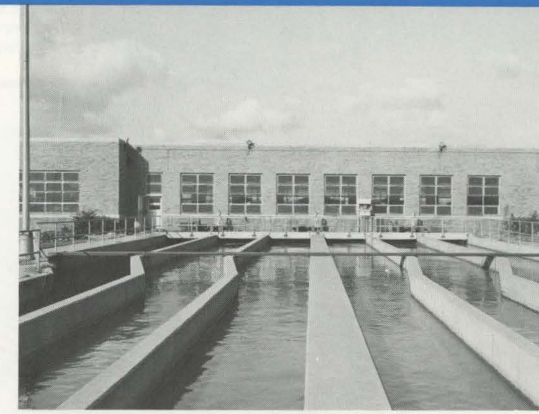
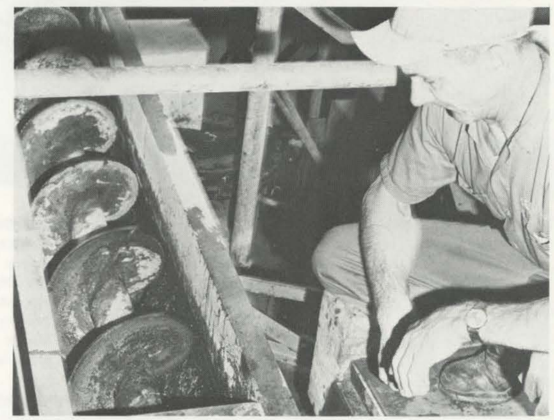


PROCESS FLOW DIAGRAM
PHILADELPHIA SOUTHWEST WATER POLLUTION CONTROL PLANT

PHYSICAL TREATMENT

SCREENING: Mechanical screens, cleaned by moving rakes, intercept rags, sticks, and other debris in incoming wastewater. The latter flows through the long bars at the rate of two feet per second. Southeast Plant.

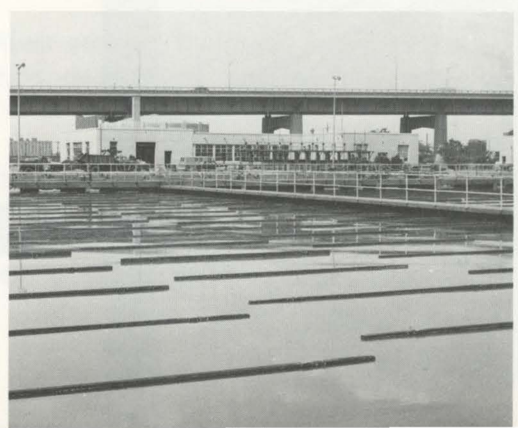
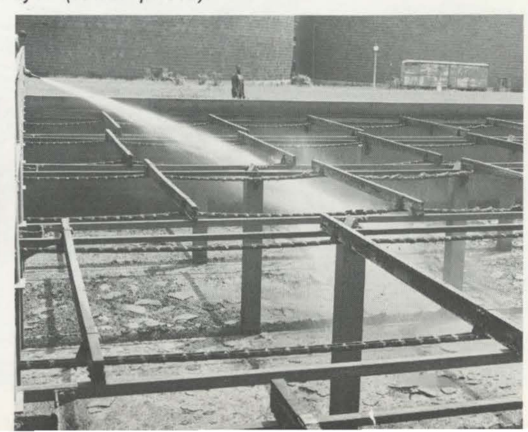



GRIT REMOVAL: After screening, the wastewater flows through the 50-ft. channels (top photo), and there the grit settles out and is removed by chain operated "collectors" to the screw conveyor (lower photo).

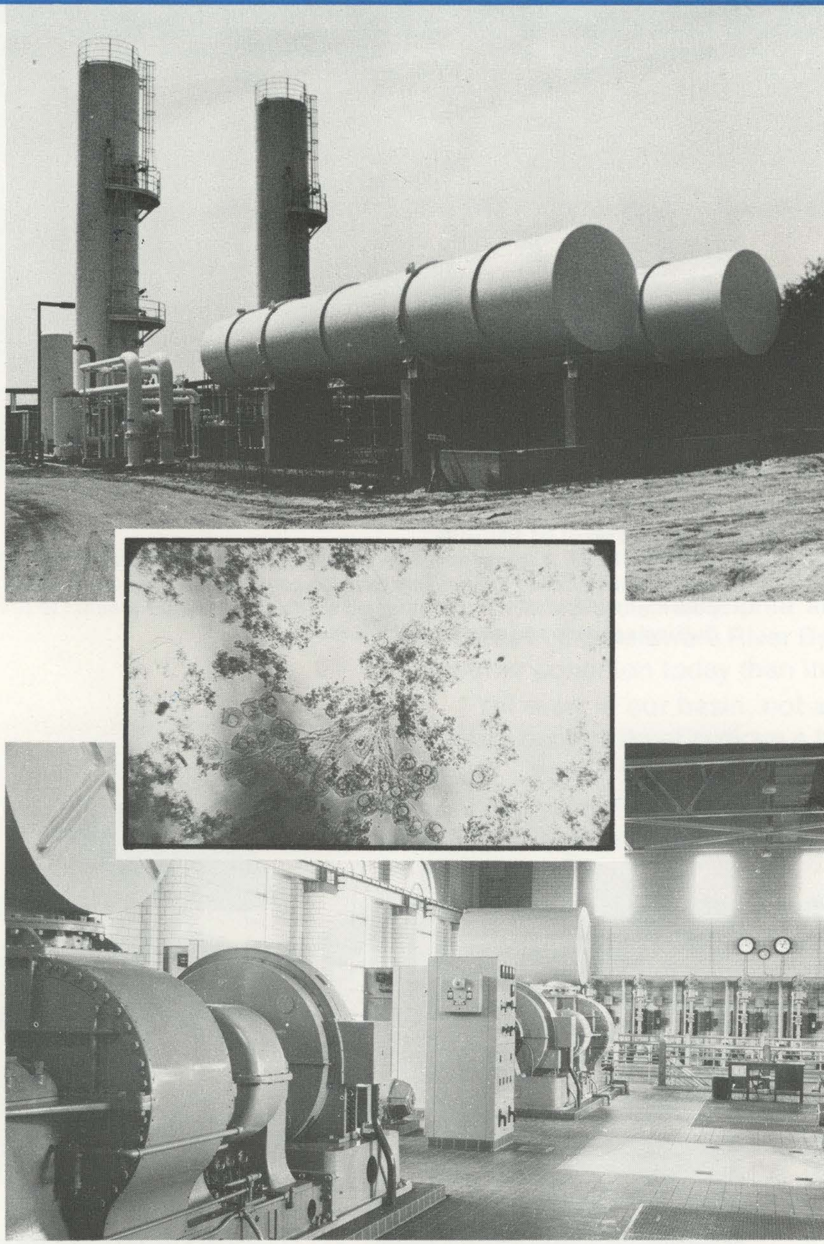
FLOCCULATION: Blown from diffuser tubes, air is bubbled through the flow in the 250-ft. long tanks above at the Southeast Plant. Such air injection helps to float grease and coagulate particles in both "primary" plants.

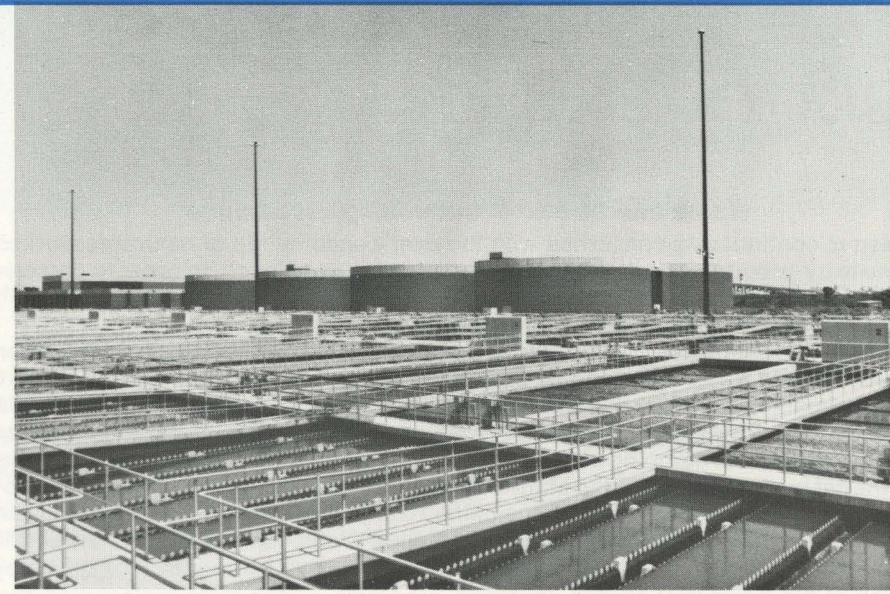
EFFLUENT: After removal of part of the solids, the effluent, or liquid, flows to the secondary process.

SETTLING TANKS: About 50% of suspended solids settle out in the Primary Tanks, as long wooden arms move across the surface (right), skimming off grease. This chain-connected arm mechanism (shown fully in the drained tank at far right) also sweeps sludge from the tank bottom.

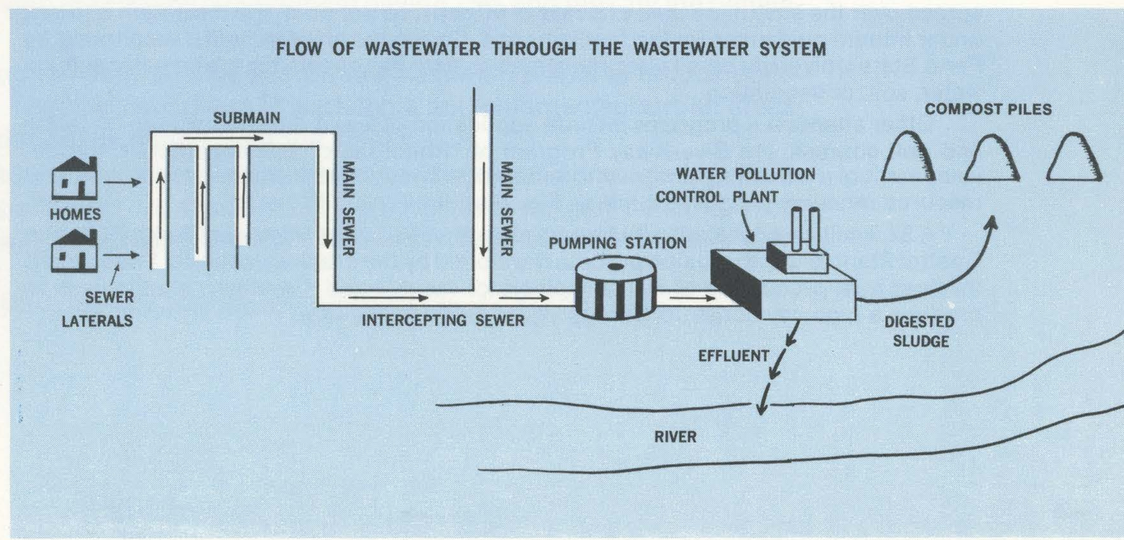
BIOLOGICAL TREATMENT





DIGESTER TANKS: Anaerobes–a second type of bacteria–decompose sludge that has been removed from the Settling Tanks (foreground). Taking oxygen as well as food from the sludge; the anaerobes do their work in enclosed Digester Tanks (background) like these at the Southwest Plant.

AERATION: To help aerobic bacteria (inset) multiply, giant air blowers (lower photo) at Northeast Plant inject 16,000 feet of air per minute into aeration tanks. Southwest Plant generates oxygen at these two cryogenic units (top photo).



SLUDGE MANAGEMENT

Waste and its role in our ecological balance

Man is continuously concerned with the over-consumption of natural resources, and waste by-products that result from our expanding population. In order to preserve the complex nutrient cycle that sustains our ecological system, we must constantly explore alternate means for waste management.

In the past several years, the Water Department has committed a geat deal of effort and funds to end its sludge disposal practice of ocean barging which began in 1961. The department has developed sludge utilization programs which return the nutrients, found in sludge, to the soil. These environmentally acceptable programs have enabled the City to end ocean dumping of sludge well ahead of the December 31, 1981 national deadline set by the passage of the Marine Protection, Research and Sanctuaries Act by Congress in 1972, and one month ahead of the 1980 year-end deadline, which was part of the Consent Decree signed by the Environmental Protection Agency and the City in May of 1979.

One of the alternative sludge utilization programs is strip mine reclamation that now handles 60% to 70% of the 60,000 to 70,000 dry tons of sludge produced annually at Philadelphia's three water pollution control plants.

The program involves the loading of coal trucks with a sludge mixture after they have made their coal deliveries in and around the Philadelphia area. The trucks then make the return trip to sites in Southwest Pennsylvania—Clarion and Somerset Counties—where the sludge is spread over spoiled strip mine land to foster revegetation.

The sludge mixture of one part composted sludge and one part sludge cake is spread over the strip mine land at a rate of 60 dry tons per acre, the maximum allowed under interim guidelines for land reclamation. Continued environmental monitoring by Penn State University on all sites reclaimed to date has shown no adverse impacts on water, soil, or vegetation.

Other alternative programs include application of liquid digested sludge on farms and golf courses, the Give-Away Program of "Philorganic" soil conditioner, the development of a marketing program to sell sludge through retail chain-store outlets, and resource recovery programs such as the "Residue Fusion Process."

A $2.3 million pilot plant willl be completed in 1982 at the Northeast Water Pollution Control Plant to test the fusion process developed by the Franklin Institute. The process involves heat processing of refuse incinerator residue and dewatered sludge cake to produce a highway construction aggregate called "EcoRock."

COMPOSTING: A front end loader (above) mixes wood chips with the dewatered sludge cake prior to the delivery to large compost piles. A forced aeration compost method is used. The composted sludge is screened (below) to remove the bulking agent (wood chips) which is reused.

EARLY CHRONOLOGY

18th-19th CENTURIES The earliest sewers in Philadelphia, dating from the colonial period, were drains, designed to carry off rain water and lower the level of ground water. Later, house fixtures were connected to these drains, and tributary sewers were built, with the drains receiving both sanitary wastes and storm water.

Philadelphia had only 67 miles of sewers in 1867, when it began an era of feverish sewer building. By 1900, it had 848 miles . . . most of them brick.

20th CENTURY

1905 Because of growing pollution, the Pennsylvania Legislature passed an act empowering the State Department of Health to control the discharge of wastes into the waters of the state.

1907 The State Department of Health asked Philadelphia to prepare a plan for the collection and treatment of all its wastewater. The city sent engineers to Europe to study treatment processes.

1909 Philadelphia began operating a small experimental plant to obtain data for building larger plants for treating wastes. This (Spring Garden) plant was closed after one year.

1912 The small Pennypack Treatment Works went into operation. It remained in service until 1930.

1914 Philadelphia completed the writing of its comprehensive report and plan for the collection and treatment of all its wastes.

1915 The city's plan was approved by the State Department of Health.

1917 Construction of the Northeast Sewage Treatment Works began, shortly after purchase of land. The land for two other plants was bought in 1910 and 1925.

1923 The Northeast Plant went into service on October 29. Equipped with Imhoff tanks, this plant screened, settled, and bacterially decomposed its wastes. Treating an average of 30 million gallons of wastewater a day in the 1920's, it had a capacity of 60 million.

1917-29 In this period, Philadelphia spent $17 million to build new wastewater facilities, including pumping stations, intercepting sewers, and one plant. Two plants were not built, and the Northeast Plant was not enlarged as hoped.

1937 Stream pollution continued to grow. As a result, the Pennsylvania Legislature passed a new anti-pollution law. It also authorized the collection of annual rentals to finance wastewater systems and water pollution control plants.

1944 The Philadelphia City Council imposed a sewer rent, effective January 1, 1946; this was amended December 14, 1948.

1946 Philadelphia began an $80 million stream clean-up program, which has since been expanded.

1975 Construction began on the $874 million program to expand and upgrade all three water pollution control plants.

SPRING GARDEN STATION: At this humble facility, Philadelphia made its first experiments with sewage treatment from April 1, 1909 to April 30, 1910. A half-dozen different methods were tried.

BRICK GIANT: Many large brick sewers were built by Philadelphia in the late 19th century and the early 20th. This large sewer, constructed in 1917, was one of the last big brick lines created.

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