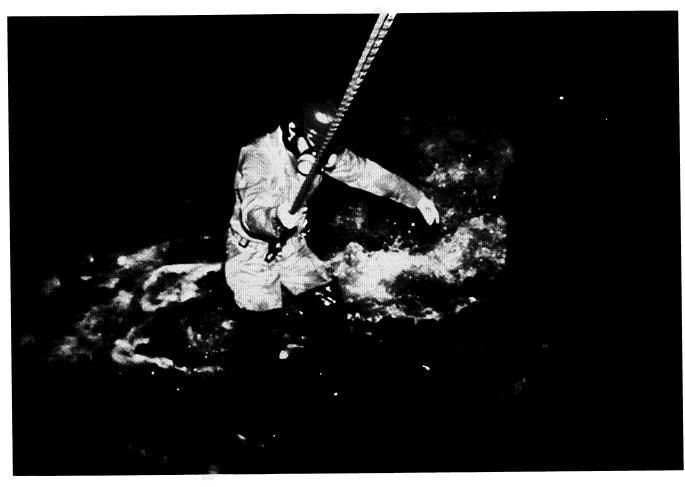
An aid to municipal sewage control highlights a sampling of spinoffs in the fields of environmental management and public safety

Space-Derived Sewer Monitor

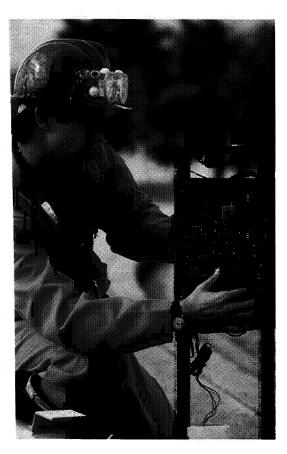


In many U.S. cities, sewage treatment plants are dumping raw sewage into lakes, rivers and streams because the facilities were not designed to handle as much sewer flow as they are getting. Conversely, many cities have multimillion dollar sewage plants capable of handling far more flow than the municipality generates, an unnecessary outlay of civic funds. These system-sizing errors are illustrative of wastewater management problems that plague city officials, problems that stem from a basic informational deficiency: accurate, reliable data on how much water flows through a sewer system over a long period of time is very difficult to obtain.

A major factor is the flow of "groundwater," rain absorbed by the ground which seeps into the sewer system through leaks and cracks in pipes and sewer walls. The amount of groundwater entering the sewer fluctuates considerably, not only with the amount of rainfall but also with the degree of pipe deterioration in the sewer. Thus, instantaneous "one-time" measurements of water depth at selected spots in a sewer system, a method often used as a basis for estimating flow quantity,

The project manager inspects a sewer prior to installation of a QuadraScan monitor, a spinoff system for long term measurement of sewer flow.

can produce substantial errors in calculating long term sewer flows. So city officials are increasingly turning to "permanent," or long term sewer monitoring systems—which are more accurate but subject to other problems. One, called "sensor drift," is an error-causing change over time in an instrument's calibration. Another is the possibility of frequent malfunction due to the



A technician checks out the electronic circuitry of the QuadraScan sewer monitor. An individual monitor continually measures water depth at a particular location in a sewer; a number of monitors, each reporting its findings to a central computer, provides information important to city managers on overall sewer flow, flow in any section of the city, location and severity of leaks and warning of potential overload.

harsh sewer environment in which monitors operate.

An aerospace-spinoff sewer monitor offers solutions to some of the wastewater manager's most pressing problems. Called the QuadraScan® Longterm Flow Monitoring System, it was developed by American Digital Systems, Inc. (ADS), Huntsville, Alabama. Highly accurate, QuadraScan can provide precise system-wide flow information for properly sizing sewage treatment facilities. Its accuracy allows improved customer billing, based on actual flow rather than "guesstimates." It can identify trouble spots, such as leaks, and target these areas for corrective action. Most importantly, QuadraScan answers the problems of sensor drift and potential

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malfunction by employing the aerospace technique of "system redundancy"—using multiple systems for the same job to guard against failure in any one sensor.

QuadraScan is a second generation sewer monitor, a major advancement over an earlier, temporary system—called IsoScan—invented by ADS founder Peter Petroff. An aerospace engineer of 15 years experience, Petroff worked for NASA at Marshall Space Flight Center as a spacecraft instrumentation designer and for other aerospace organizations as an electronics specialist. In designing his initial sewer flow measurement system, he applied electronic circuitry and data collection principles based on expertise acquired in Apollo and other NASA programs. QuadraScan borrows even more heavily from space technology. Its data acquisition and memory system derives from NASA satellites; the instrumentation is similar to that of NASA's Orbiting Astronomical Observatory: the ultrasonic flow sensors are close relatives of ultrasonic devices used to orient space thrusters; and the sensors are protected by closed-cell foam customarily employed as protective encapsulation for satellite equipment.

QuadraScan is a compression of Quadredundant Scanning and Analysis Network, the "quad" meaning that each sewer monitor has four separate ultrasonic sensors, thus insuring accuracy and reliability since the readings of an individual sensor are confirmed by the others; if one is obviously in error, the computer ignores it and takes a consensus of the other three.

Typically, a number of monitors-each composed of the four sensors and a minicomputer housed in a sealed aluminum cylinder—are distributed throughout a city sewer system. The monitors, called "bats" because they operate on sonar, are fixed to the ceilings of sewer pipes. The bat emits a sonar pulse which is reflected back to the monitor when it strikes the water in the sewer. Since the sonar signal travels at the speed of sound, the computer can determine the distance from monitor to water by measuring—in microseconds—the signal's round trip travel time and compensating for the in-pipe temperature, which affects the speed of sound. Next, the computer subtracts the sonar reading from the known diameter of the pipe—and the result is the depth of the water flowing through the pipe. Hundreds

of measurements can be taken and averaged within a few seconds; readings are consistently accurate to within a twentieth of an inch.

Connected by its own telephone line, the monitor's memory bank reports its findings to a central computer, which regularly and automatically collects data from all the monitors in the system and processes it into the end product—the overall flow rate for the city's entire sewer network. Flow readings from one section of the city can be compared with readings upstream and downstream; flow data can be correlated to weather conditions or to locations of key industries and other large contributors to the sewer system. In addition to providing input for informed decisions as to sewage plant sizing and maintenance of the sewer system, QuadraScan offers another major advantage: it can alert city engineers of approaching overload conditions which new businesses or housing developments might place on existing sewers. This early warning capability enables effective planning for city growth and helps a city avoid the crippling economic impact of "moratoriums", bans on new sewer connections in effect in many cities today.

American Digital Systems is a spinoff success story. The company began as a garage operation in 1975, then doubled its sales in each of the next six years. Today it has offices in 10 U.S. and Canadian cities and has installed QuadraScan systems in almost 100 municipalities, including such major cities as Washington, Baltimore, St. Louis and Oakland.



An American Digital Systems crew prepares to install a QuadraScan monitor (shown in foreground) in the Washington, D.C. sewer system. Almost 100 cities have QuadraScan systems, which are providing both economic and management efficiency benefits.