Management Adviser

Volume 8 | Number 2 Article 4

3-1971

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Recommended Citation
Sawin, Henry S. (1971) "CPA's Role in Restoring the Ecological Balance," *Management Adviser*: Vol. 8: No. 2, Article 4.
Available at: https://egrove.olemiss.edu/mgmtadviser/vol8/iss2/4

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This is the story of the first statewide program to restore a delicate ecological balance that has been distorted for centuries—and how the MAS department of one CPA firm is aiding in the program—

THE CPA'S ROLE IN RESTORING THE ECOLOGICAL BALANCE

by Henry S. Sawin
Price Waterhouse & Co.

THE "ENVIRONMENTAL CRISIS" is shaping up as the most important issue of the 1970s. The President of the United States keynoted his program for the coming decade with emphasis on a wide-ranging program to clean up the environment and with establishment of the President's Council on Environmental Quality. Governors of practically all of the 50 states have called for action to abate pollution; many have established new state departments to bring together responsibility for environmental control; and more and more states are looking across their borders toward regional cooperation on the problem. Citizen attention is directed to the environmental crisis by daily accounts in the mass media of new pollution crises, and they have made known their concern by giving overwhelming approval in the 1970 elections to bond issues that will finance environmental improvement. Student activists, always in the vanguard in advocating social change, have shifted their attention to problems of the environment.

The country's pollution scorecard reads like this: 7,000,000 automobiles scrapped each year; 30,000,000 tons of waste paper to be disposed of yearly; 48,000,000 cans and 28,000,000 bottles per year to be processed through waste disposal plants or picked up from the edges of our highways; 1,000,000 tons of garbage to dispose of every day; 200,000,000 tons (90,000,000 tons from cars) of pollutants released into our air every year; national yearly water use of 25 trillion gallons. Practically every use adds a new pollutant.

Traditional piecemeal approaches to pollution control and abatement tend to be a self-limiting solution to the problem. A municipal incinerator, for example, may temporarily solve the problem of disposing of a city's garbage and trash. But it will also quickly create air pollution problems because of its fly ash, smoke, and gaseous output —and even water pollution if residual slag and ashes are dumped into a river, a bay, or the ocean.

For a broad view of the pollution problem and possible solutions, attention is turning to the science of ecology. Since this science is basically a systems approach to the environment, every businessman can grasp its essential ideas. The

This article is being published simultaneously in the *Price Waterhouse Review*.

concept of an ecosystem is that there is a closed-loop system of living and nonliving parts that support life cycles within a selected area. The critical subsystems include:

Nonliving Matter—The sunlight, water, oxygen, carbon dioxide, organic compounds, and other nutrients used by plants for their growth.

Plants—From microscopic phytoplankton in water up through grass and shrubs to trees, these organisms convert carbon dioxide and water, through photosynthesis, into carbohydrates required by both themselves and other organisms in the ecosystem.

Consumers—These higher organisms feed on the producers. Herbivores such as cattle and sheep are primary consumers. Carnivorous man and animals such as lions and wolves feed upon the herbivores and are secondary consumers. In marine ecosystems, of course, the rich variety of fish and other animal life forms are the balancing consumers.

Decomposers — Bacteria, fungi, and insects close the loop of the ecosystem when they break down the dead producers and consumers and return their chemical compounds to the ecosystem for reuse by the plants.

Growth and decay are simultaneous and continuous in the ecosystem. In nonhuman environments they tend to balance each other over the long run and equilibrium is maintained in the closed-loop system. It is human interference—or pollution—that can drastically disturb the system and its equilibrium.

Looking at the earth as a total ecosystem, it is easy to see the havoc that may occur if the current high level of land-based pollution is extended to the oceans. About 70 per cent of the earth's oxygen is produced by ocean phytoplankton. If these floating microscopic plants are killed off by oil spills, chemical and nuclear wastes, the residue from coastal sewage treatment plants, etc., then the life-supporting oxygen supply will be decreased and all animal life threatened.

Lake Erie is a localized example of what can happen to a large body of water. Almost a closed ecosystem, the lake has been classified by some groups as technically "dead" —unable to support life processes because large quantities of organic industrial waste and municipal sewage altered the ecological balance.

Clearly, our environment is threatened—but what can be done about it? It appears that there are four major tasks facing us:

(1) In the short run, pollution must be controlled through enforcement of increasingly stringent regulations. Here, current technology for pollution *minimization* and *neutralization* will have to suffice until those things that take longer can be made effective—time does not permit waiting for a NASA-type effort to advance the state of the art.

(2) In the short run, systems technology and the power of advanced computing hardware must be applied to the development of new approaches to pollution measurement and control.

(3) In the long run, technology must be adopted which will minimize the creation of pollutants in the first place and will economically *recycle* more pollutants into consumable products.

(4) In the long run, integrated ecological models must be developed which will incorporate information from engineering, the natural sciences, and the social sciences to aid man in establishing a nondestructive relationship with the environment.

The purpose of this article is to describe one short-run program which is utilizing systems technology and the power of advanced computer hardware to measure and control pollution. The program is being developed by the Commonwealth of Pennsylvania with financial assistance at the Federal level from the Office of Water Quality, Environmental Protection Agency, and the professional assistance of our Management Advisory Services Department. It is the first statewide, comprehensive system for the processing and retrieval of water quality control information.

The project's most immediate objective is to establish a workable information system which will assist Pennsylvania's Bureau of Sanitary Engineering in its responsibilities for planning, directing, evaluating, and administering the water quality management program of the state as a whole.

As a demonstration project, the program's second objective is to develop a system that can be adopted by other state, regional, and Federal water pollution control agencies. Meeting this objective will involve providing a demonstration system and a training program in management data systems for personnel of other agencies. To ensure transferability to a variety of other situations, three underlying criteria were established:

(1) Computer programs must be compatible with a second manufacturer's equipment. This will minimize rewriting of programs by another agency.

(2) The system must be modular. This will permit others to adopt portions of the system without having to implement it in its entirety.

(3) The system must have the ability to interface with the information systems of other agencies. This is being accomplished by the adoption of the uniform data elements and coding techniques which have been defined by the Joint Committee of State Sanitary Engineers on Water Quality Management Data.

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The commitment by the Bureau of Sanitary Engineering to this program has been significant. Mr. Walter Lyon, director of the Bureau, has created a project team of more than 10 state employees assigned full time. The team consists of sanitary engineers, systems analysts, programers, and forms designers. In addition, a committee of representatives from each functional area and a regional office of the Bureau advises on all aspects of the project as it progresses. Our firm provides project supervision and supplements the state's systems analysis and programing effort. The project, which will extend over several years, is currently in its second year. The first subsystems are expected to be available soon for demonstration and training.

Among the major duties of a Bureau of Sanitary Engineering field office in Pennsylvania are to take water samples to determine if they meet approved standards; identify the need for such added facilities as water treatment plants; and then track the approval (permitting), construction, and operation of that plant until it is performing in an acceptable manner. Field engineers must not only satisfy the technical requirements for field water samples but also the legal requirements. It is possible that it might later be necessary to prove in court that the samples were taken correctly and that the water clearly does not meet acceptable water quality standards. The whole process requires much information, a lot of paperwork, and effective communication between field offices and the central office as well as with various policy boards and with legislators.

The Water Quality Management Information System being designed minimizes the routine steps performed by Bureau employees and maximizes the available information. It provides this information on a need-to-know basis through the use of such techniques as exception, key item, and stratified reporting. It is expected that these techniques will substantially alter

The management of air quality and water quality are similar and, in fact, often the responsibility of the same department and field offices in many states. The tasks performed by field engineers in air quality control include performing inspections, enforcing standards, and granting operating permits or emission registrations.

The types of reports described in this article and included as part of Pennsylvania's Water Quality Management Information System could be adapted to an Air Quality Management Information System.

A field engineer pursuing the task of enforcement management for air would request reports, as described for the facility status subsystem, which would identify those violations which have not been abated or do not meet scheduled dates for compliance.

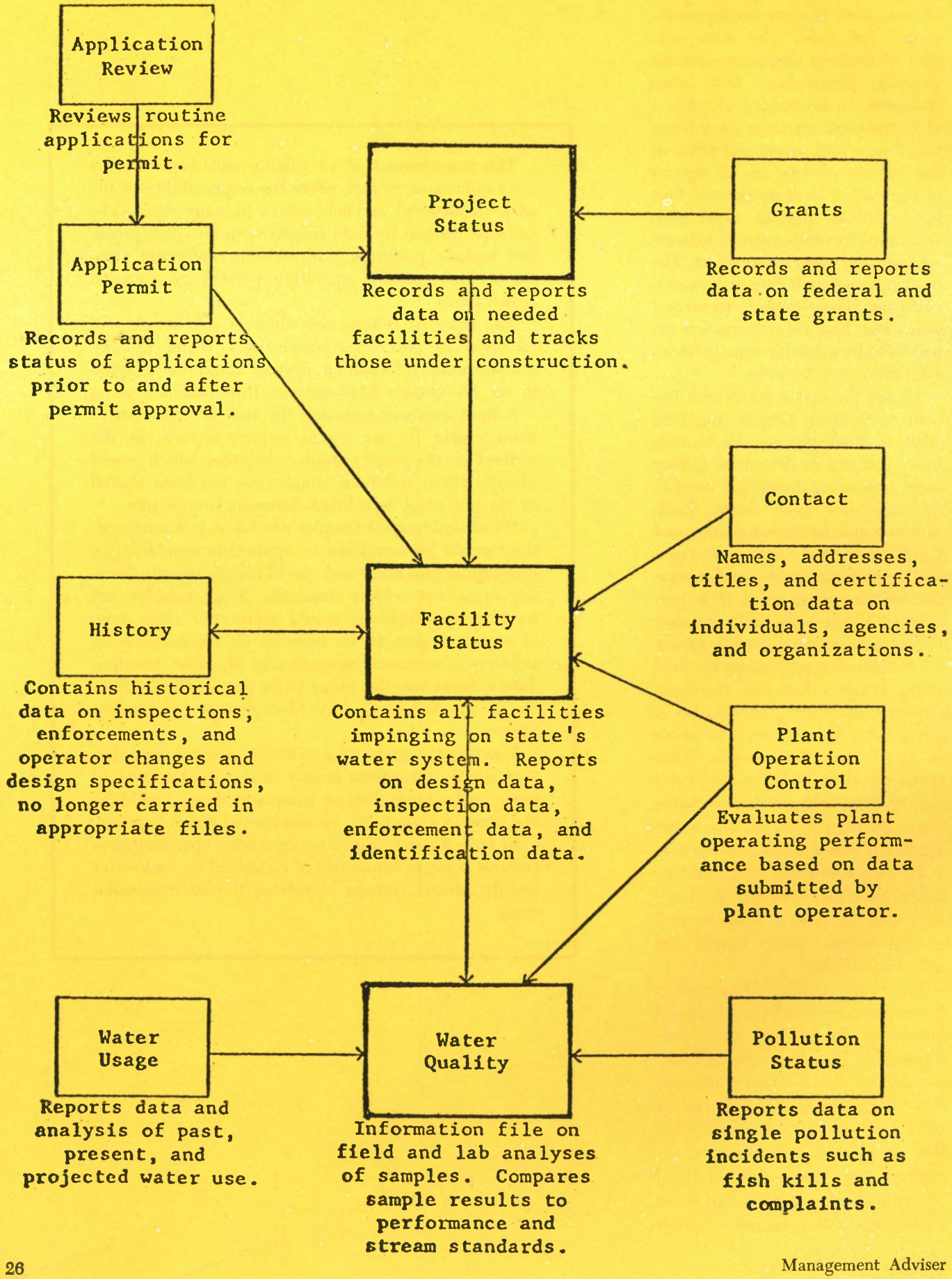
When ambient air samples are taken and analyzed, they would be compared to applicable standards for geographic grid areas and would trigger reports showing areas not within standards. Stack samples not meeting specifications would cause the same type of violation data to be inserted on an emission-inventory-enforcement management file that nonstandard effluent samples cause to be put on the facilities file in the Water Quality Management Information System.

Many applications (for example, contact or pollution status subsystems which deal with retrieval of name and address lists or complaint data) would be the same in almost any environmental control system.

In fact, the similarities in day-to-day operating procedures point to future use of combined air and water quality control systems in solving the environmental crisis.

WATER QUALITY MANAGEMENT INFORMATION SYSTEM

System Modules



and improve the field of water quality management.

The system includes 11 subsystems. These 11 subsystems and their interrelationships are shown in the exhibit appearing on the facing page. Each is described briefly in the following sections.

The Water Quality Management Information System maintains data for the Bureau's five water quality programs. These programs encompass, respectively, water supply, sewage, industrial waste, bathing places, and mine drainage. Through the use of the project status subsystem, a Bureau employee (for example, a field engineer or a central office enforcement officer) can get key data on the need for a new facility such as a treatment plant or collection system. He can track the construction status of facilities that have been permitted by the Commonwealth and funded and are under construction by municipalities, sewer authorities, private companies, or others. The field engineer regularly receives the project status report and also receives exception reports, including lists of all projects currently out of compliance with laws and regulations, and an action report which lists schedules which have not been met.

These reports are used by the field engineers to identify the need to initiate action against the owner/operators of facilities to meet scheduled dates. Owner/operators or their consulting engineers receive a computer-printed turnaround card on or about the date on which the succeeding construction step was to have been completed. The construction status is entered on the card, which is returned to the department for use in updating the project status file. The monitoring of construction of new facilities and upgrading of existing facilities is a key part of the work of the Bureau.

Another task of the Bureau is to provide to state legislators, the Federal Government (for information on grants, etc.), and interested citizens information on construction activity throughout the state. Information is required on the locations of projects under construction, expected completion dates, and estimated costs. The compilation of these data has traditionally taken many hours by Bureau personnel. Using the reporting elements of the project status system, these hours are minimized, the reports are obtained on a timely basis, and the Bureau can more effectively accomplish its mission by assigning its personnel to more critical tasks.

The data base of the Water Quality Management Information System includes information on all facilities within the state which by law or regulation are included in the water supply, sewage, industrial waste, bathing places, and mine drainage programs. The term "facilities" applies not only to water treatment plants but also, for example, to sewage collection systems, interceptors, sewers, and sewage discharge points. The facility status subsystem maintains and processes the identification, design, inspection, and violation data for each facility encompassed by the Commonwealth's five water quality programs.

Identification data, including the name and exact location of each facility, design data on which facility permits were based, and construction data, are provided to the central and field offices in catalog form for day-to-day reference. Probably the most important aspect of the facility status subsystem, however, is violation and enforcement information and exception reporting. All violation orders and enforcement steps are tracked on the facility status subsystem. The nature of violations, dates on which they occurred, and the steps to be taken and dates to be met by owner/operators are all part of the facility status subsystem data base. This information is reported to the central and field offices in a manner which enables assigned personnel to carry out their tasks of abating pollution and enforcing water quality standards in Pennsylvania.

Exception reports on steps which must be taken to abate water pollution are submitted to the field

As a demonstration project, the program's second objective is to develop a system that can be adopted by other state, regional, and Federal water pollution control agencies. Meeting this objective will involve providing a demonstration system and a training program in management data systems for personnel of other agencies.

engineers. The Bureau personnel, upon request, can obtain information on the status of particular enforcement actions, whether they fall within the purview of the Bureau or have been assigned to the Legal Department. Preprinted inspection reports are forwarded to the field offices prior to the dates of required scheduled inspections. The issuance of these inspection reports is based on schedules submitted each year by the field offices and based on violations which have occurred. Other items of importance to the Bureau are reports which identify the possible need for new facilities, based on the populations served by facilities (such as treatment plants) which exceed the design populations for which plants were constructed.

Checking water standards

A most important task of the Bureau is, of course, monitoring the quality of waste and waters of the Commonwealth. Samples are taken from both the effluents of particular facilities and throughout the streams and rivers of the state. The samples are then laboratory-analyzed and the results entered and compared to the water quality file. The system comparisons are to lists of standards for either particular facilities or particular portions of streams to determine if samples meet acceptable water quality standards. Reports are issued to the central and field offices identifying those samples which have not met water quality standards. These reports include background data on past samples and the complete details of current samples. Data on sample results can be obtained upon request for any samples for any facility or stream and within specified dates.

The water quality subsystem, therefore, is a key element in the Bureau's work, since it supplies sample data for meeting reporting requirements, for stream or facility water quality trend analysis, and for water system modeling and stream profile development. The data availability on a timely basis enables the Bureau to perform functions not previously possible by manual methods.

The state grants operator's certificates to all sewage and water supply treatment plant operators. The Bureau can obtain data on these certified operators through the contact subsystem. Information such as previous experience, test results, educational background, and the type of treatment plant the individual is authorized to operate are all available through the contact subsystem. Certificates and wallet cards (similar to automobile licenses) are issued annually or as required.

Another aspect of the contact subsystem is the availability of a mailing list for all individuals, corporations, agencies, etc., that the Bureau contacts throughout the year. Through the use of an open-ended coding system, the Bureau can retrieve various lists and/or mailing labels for designated levels within a particular type of organization or for a specific individual. This is useful, for example, when it is necessary to send mailings to chairmen of all watershed associations or citizens committees through the state.

The contact system is not as sophisticated an application as, for instance, a modeling application or even the facility status subsystem, but it is extremely important in saving many man-hours on the part of technical personnel to enable them to perform other tasks.

Much of the funding for new or upgraded water supply and sewage facilities comes from Federal or state grants. A significant portion of the operating funds of a state environmental agency comes from the Federal Government. Data concerning grants are maintained and are available to the Bureau upon request. Federal and state reports are prepared through the grants subsystem as are those status reports required by the Bureau to better perform its work.

The state issues permits for construction and operation of treatment plants. Therefore, significant tasks in the central and field offices are review and approval of applications for permits and then assuring that permit conditions are met. Through the application permit subsystem, a field engineer can obtain the permit history of particular facilities or of all facilities within his region. He can refer to his permit application status report to answer many daily questions on the current status of particular applications. Central and field office personnel receive reports on permit conditions which are not being met and which should result in some form of action on the part of field personnel. The permit application, project status, grants, and facility status subsystems interface to permit the Bureau to take prompt and effective action in this area.

Field offices, as part of the process of approving applications for permits, perform an initial review of submissions from municipalities, industrial plants, and others to determine conformance with rules and regulations and to assure consistency within the application. Applications not meeting overall standards, not including all necessary paperwork, or not having internal consistency are returned for completion before a detailed investigation is made of the plans themselves. Many of these tasks are routine and can be performed more efficiently using a computer.

Subsystem cuts processing time

The application review subsystem provides reports for the field office on those applications which should be returned on the basis of this initial review. This subsystem reduces the time required to process an application and the amount of manual, routine work which has previously been necessary in evaluating permit applications, thereby enabling field engineers to spend more time on the more extensive analytical work necessary prior to the issuance of permits.

The Bureau's central office and its field offices require information

on "single" pollution incidents such as fish kills, accidental spills, or complaints. Information here includes the date and location of a particular incident or complaint, the agency or individual reporting it, the type and nature of the condition causing the incident, and the disposition of the complaint. Reports are issued listing open complaints not resolved and listing pollution incidents or complaints within particular geographical areas.

The Bureau is primarily concerned with improving the quality of water in Pennsylvania. This concern, particularly in problem areas, is extended to the need for data on water usage. Field engineers through the use of inspection reports, permits, and laboratory sample results can obtain current water use data such as flow or type of use for particular locations or facilities.

Water samples taken by operators of water and waste water treatment plants throughout the Commonwealth are forwarded to private, state-approved laboratories for analysis. Sample results, as well as other information on the actual operating characteristics of the treatment plants, are carried by the Water Quality Management Information System. Data are submitted on such items as operating problems; influent and effluent readings of biological oxygen demand, suspended solids, or dissolved oxygen; hours operated and bypassed; or chlorination and gallons bypassed. Various validity and consistency checks are made to assure proper submission of samples, and sample results are then compared to acceptable levels for each quality indicator to determine if facilities are meeting required standards.

Thus, the field office obtains current operating data on each treatment plant within the region, without the necessity and expense of inspecting every facility. It can obtain weekly reports of plant operator samples not meeting standards or of operating characteristics which suggest the need for actual inspections or directives for change in operation of the plants. A major objective of this subsystem when used in conjunction with the contact subsystem is to ensure maximum possible efficiency in plant operation.

Past data available, too

The need for current data on the quality of water and current enforcement status is critical. Equally important is the need to know past violations, design characteristics, and inspection results. The facility status subsystem carries all open violations as well as those resolved within up to two years previous. However, the evaluation of an owner/operator for permit approval to upgrade a plant might require a complete history of the violations of a facility since its original operation date. The granting of a certificate to an operator for a higher-level treatment plant might be influenced by the history of operating efficiency of that operator at a previous facility. The data to answer these types of requests by field engineers are obtained through the interface of the history file with the applicable file carrying the current data.

A statewide system to manage the quality of water requires the ability:

(a) to process massive volumes of data,

(b) to interface with other agencies on water quality problems, and

(c) to retrieve data quickly and to act with speed and precision in making decisions.

Pennsylvania plans to take advantage of advances in the state of the art of computer and information systems technology and to use established uniform data coding systems to establish these abilities. This is a long-range program, of which many initial important steps have been completed. It is expected that this system will enable Pennsylvania to better manage the quality of its water, as well as to provide a model system from which other states and agencies can benefit.

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