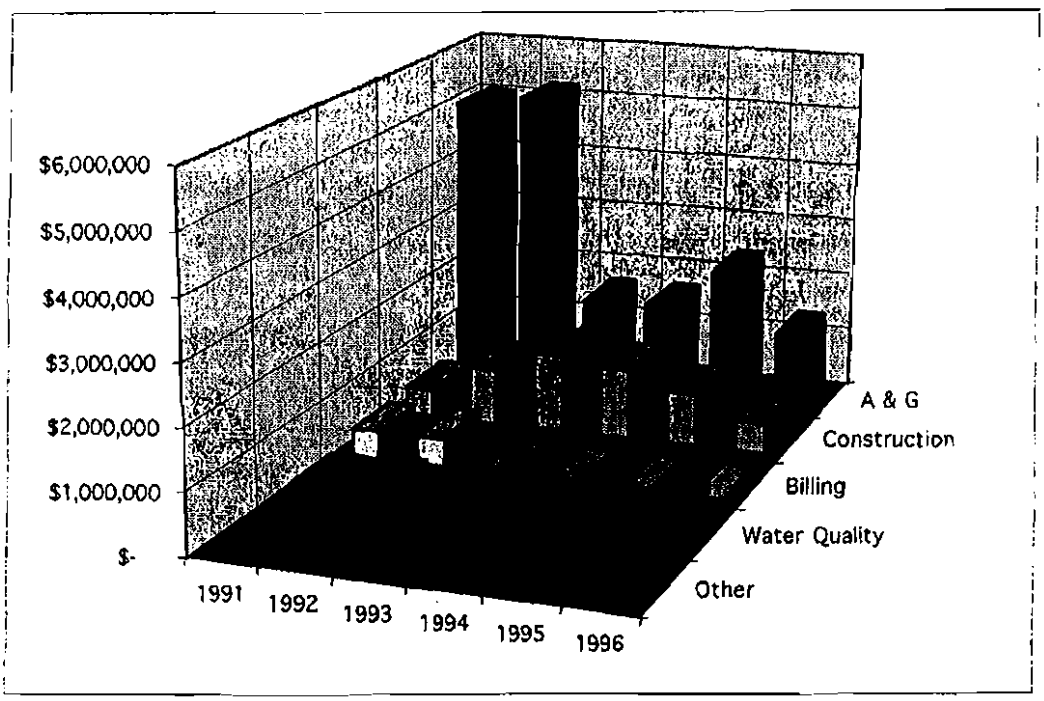
resulted in a decrease in both total Service Company billings and billings to New Jersey-American.

Exhibit 2-4
Comparison of Fees and Expenses
Allocated to Major Account Categories

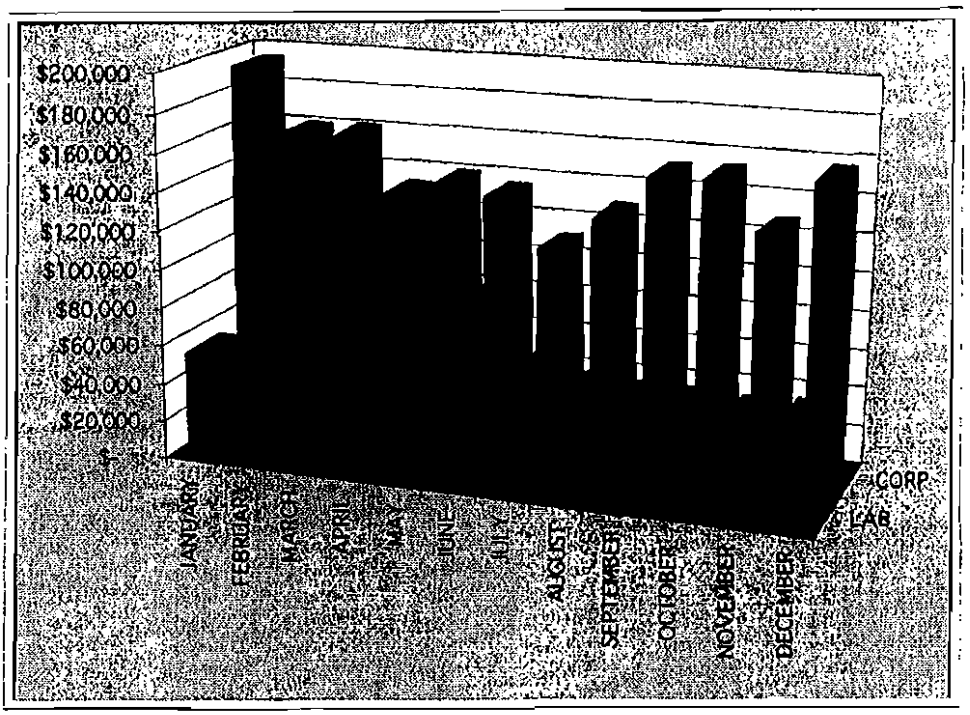


	Other	Water Qual.	Billing	Construction	A&G
1991	$10,040	$296,967	$459,456	$ 505,271	$ 5,063,195
1992	$ 7,732	$360,132	$460,898	$ 1,006,144	$ 5,240,401
1993	$ 8,061	$394,260	$ 52,183	$ 1,349,425	$ 1,637,945
1994	$ 8,647	$393,672	$ 26,813	$ 1,186,662	$ 1,651,255
1995	$ 1,577	$452,780	$ 14,363	$ 922,173	$ 2,392,244
1996	$ 99	$490,689	$ 1,661	$ 513,527	$ 1,364,191

Exhibit 2-4 shows the Service Company billing by classification of the cost. The two largest cost categories are administrative and general expenses and construction. Customer accounts expense allocated from the Service Company decreased significantly due to the transfer of the billing and collection operations from the region to New Jersey-American. Construction varies according to the level of construction activity and has been significant in recent years due to construction of the Tri-County project. With the completion of the Tri-County project the level of Service Company billing charged to Construction in 1996 was only slightly higher than the level charged in 1991. There was a significant decline in the Service

Company billing for outside services employed in 1996 due to a reduction in New Jersey-American's allocation factor and the transfer of the remaining Service Company employees who worked full time for New Jersey-American to New Jersey-American.

Exhibit 2-5
Comparison of Billings by Parts of the Service Company

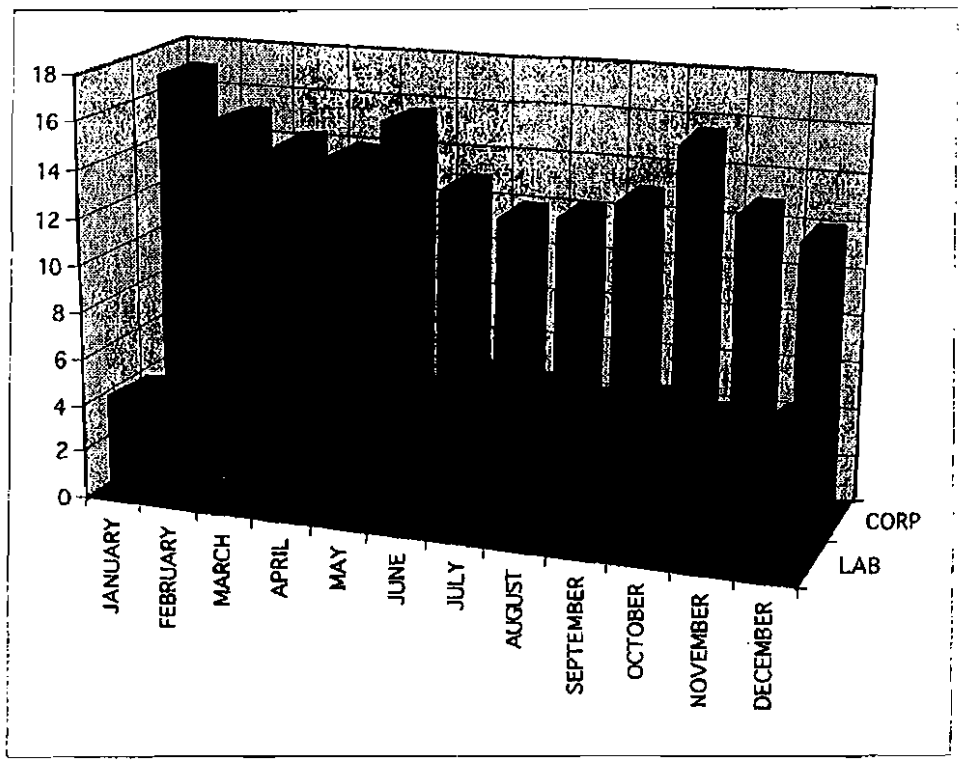


	Laboratory	Corporate		Laboratory	Corporate
January	$ 54,881	$ 193,598	July	$ 61,510	$ 110,046
February	$ 47,176	$ 159,746	August	$ 55,141	$ 128,167
March	$ 53,943	$ 160,029	September	$ 52,666	$ 151,298
April	$ 51,912	$ 131,768	October	$ 53,367	$ 152,415
May	$ 42,873	$ 139,457	November	$ 50,640	$ 127,921
June	$ 47,587	$ 134,969	December	$ 52,573	$ 155,490
			Total	$ 624,269	$1,744,904

Exhibit 2-5 details, by month, the two sources of the Service Company billing to New Jersey-American in 1996: the Service Company offices in Voorhees and the water quality laboratory in Belleville. Both billings were fairly consistent during the year. Deducting the capitalized portion of the Service Company bill and dividing the total billed for 1996 by the water sales in gallons for the year results in a cost of $0.0455 per thousand gallons. This consists of $0.0302 per thousand gallons for the Voorhees Corporate headquarters and $0.0153 for the Belleville laboratory. By

comparison, the current water rate is $3.6873 per thousand gallons plus a fixed monthly service charge of $6.72 for a standard 5/8" meter.

Exhibit 2-6
Comparison of Full-Time-Equivalent Personnel Billed to NJAWC by Each Part of the Service Company



	Lab.	Corp.		Lab.	Corp.
January	4.23	16.97	July	6.44	11.92
February	4.38	15.25	August	6.13	12.14
March	4.56	14.27	September	5.76	13.00
April	5.85	13.93	October	6.16	15.55
May	6.16	15.64	November	5.68	12.82
June	5.46	12.95	December	5.88	11.98
			1996 average	5.56	13.86

Exhibit 2-6 compares the full time equivalent personnel billed in 1996 to New Jersey-American by the Corporate office in Voorhees to that billed by the Belleville lab. It shows that for 1996 the Corporate headquarters billed the equivalent of approximately 14 full time employees while the laboratory billed about 5.5 full time employees. There are approximately 90 full time professional and support employees at the Voorhees office. New Jersey-American is able to utilize the breadth

and depth of expertise of all these employees while paying the cost of the equivalent of 15% of this number of employees.

For the month of September 1996, the month before the audit began, the hourly cost of Service Company personnel at Voorhees that was charged to the Company was calculated. The calculation was done for accounting and internal audit, engineering and management services. The total billings for these functions after deducting expenses were divided by the total personal services hours to arrive at an hourly rate. The rates calculated were as follows:

Accountants and auditors	$52
Engineers	$64
Management consultants	$128

These rates were then compared to rates charged by third party providers of these services. Accounting fees were obtained from the New Jersey Society of Certified Public Accountants, The Management of an Accounting Practice Committee, *Survey of Firms' Compensation, Fringe Benefits and Employee Policies*. The survey compiled billing rates of New Jersey Certified Public Accounting firms as of September 1995. Hourly rates for engineering services were obtained from a survey of recent proposals submitted to the Company from engineering firms. Management consulting rates were obtained from a 1996 survey conducted by Kennedy Research Services, *Kennedy Information "Consulting Fees" Survey*, December, 1996. The comparative rates for outside vendors was determined to be as follows:

Certified Public Accountants	
Partners	$131
Managers	$105
Seniors	$83
Semi-seniors	$67
Juniors	$53
Engineers	
Principal	$133
Project Manager	$123
Senior Engineer	$ 95
Engineer	$ 70

Management Consultants	
Partners	$270
Project Managers	$212
Consultants	$166
Associate/Analysts	$108

The hourly rates charged for services by the Voorhees Corporate office of the Service Company are below the rates these services could be obtained from outside vendors.

New Jersey-American provides services to Resources necessary to operate certain water systems under contract. At the present time Resources has no employees and no fixed assets, with all services required under these contracts done by New Jersey-American employees using New Jersey-American equipment. In addition, the Company provides accounting and tax preparation services to Resources and certain officers of the Company serve in the same capacity for Resources. New Jersey-American employees code their time spent on a particular contract to that contract, which is billed to Resources on a monthly bill. For those contracts that include billing and collection services, a portion of the cost of the bill processing equipment is allocated to the contract and billed to Resources. These costs are allocated based on the number of bills processed.

While the direct costs and general employee overhead related to work done on these contracts is charged to Resources, a number of indirect costs and overhead related to these contracts have not been allocated. No office or general administrative overhead is allocated to these contracts. For example, the direct cost of the hours worked by an accountant who bills the customers of Resources is charged to Resources but none of the cost of the office (including depreciation and a return on investment), furniture, computers, supplies, and supervision required by that accountant are allocated to Resources. None of the holiday, vacation, and sick time incurred by employees who do work for Resources is allocated to Resources. Most of these contracts were obtained through competitive bids that were prepared and submitted by employees of New Jersey-American, however none of the costs related to preparing these bids is allocated to Resources. None of the costs of Company officials contacting local municipal officials and informing them of the Company's interest in contracting to operate the municipality's water system is allocated to Resources. None of the costs of the Service Company are billed directly to Resources or indirectly through New Jersey-American's billing.

New Jersey-American is doing the initial implementation of the J.D Edwards software with the exception of the payroll module, which is being done by Indiana-American. The cost of Service Company personnel and J.D. Edwards personnel involved in the conversion is being allocated to all the operating companies. The cost of New Jersey-American employees working on the implementation is charged exclusively to New Jersey-American. All the operating companies will benefit from the experience gained by New Jersey-American's initial implementation.

Pennsylvania-American is doing the initial implementation of the Orcom customer information system, and New Jersey-American will benefit from Pennsylvania-American's initial work on that system, as well as from Indiana-American's initial work on the J.D. Edwards payroll module.

Findings and Conclusions
(Allocation of Resources, Costs, and Services)

C2B-1 **The services provided to New Jersey-American by the Service Company are necessary, beneficial to ratepayers, and cost effective.**

By centralizing these services all the operating companies benefit from economies of scale resulting from sharing the cost of these services. New Jersey-American is able to utilize the breadth and depth of expertise and experience of a staff of 90 while only incurring the costs of the equivalent of 14 full time personnel. The hourly cost of services provided to the Company is reasonable and below the cost at which these services could be obtained from third party vendors.

C2B-2 **The allocation of indirect Service Company costs on the basis of number of customers is simple to administer and has been accepted by almost all the state commissions regulating the American Water System companies.**

There is no one method of allocating costs that will produce a precise allocation based on cost causation. Certain Service Company expenses could be allocated on cost factors that more accurately reflect cost causation. For example, Service Company costs related to human resources might be more precisely allocated based on payroll dollars or

number of employees. Financial services might be more accurately allocated based on total capital or annual capital additions. However, a detailed indirect cost allocation plan would be costly to develop, administer, and monitor with no guarantee that the overall results would be materially different from the existing plan.

C2B-3 Service Company employees' holiday, sick, and vacation pay is allocated to the operating companies based on the number of customers formula regardless of how the employees' productive time is allocated.

An employee of the Service Company may spend 75% of their productive time doing work directly for a particular operating company, yet any holiday, sick, or vacation time is allocated based on the formula. This nonproductive element of payroll is not allocated the same as other basic payroll overheads.

C2B-4 New Jersey-American is not fully allocating costs it is incurring as a result of providing services to New Jersey-American Resources.

Only the direct costs incurred in providing services to Resources are allocated from the Company. Indirect costs such as employee supervision, office overhead and nonproductive time off are not allocated to Resources. None of the cost of preparing bids and contracts have been allocated to Resources. The Service Company does not bill Resources and none of the Service Company charges to NJAWC are allocated to Resources.

Recommendations

(Allocation of Resources, Costs, and Services)

R2B-1 Allocate Service Company employees' holiday, vacation, and sick pay consistent with other basic payroll overheads. (Refer to Conclusion C2B-3)

Holiday, vacation, and sick pay is a component of an employee's overhead similar to payroll taxes and pension costs. To ensure that operating companies are charged fairly, this cost item should be allocated the same as these other basic overheads. The existing allocation procedure of allocating this nonproductive payroll cost based on the customer

formula does not allocate this cost consistent with how the productive payroll costs have been allocated.

R2B-2 **Perform a study to determine the best cost allocation method for allocating to Resources the cost of services received from New Jersey-American. (Refer to Conclusion C2B-4)**

Cost allocation procedures are needed to ensure that all costs incurred by the Company on behalf of Resources are allocated to Resources, consistent with the results of the study. Since Resources is a new non-regulated subsidiary operated exclusively by New Jersey-American employees it is important to properly allocate all costs incurred by the regulated utility for services provided to this non-regulated affiliate. Further, New Jersey-American plans to transfer all its contracts to operate third party water systems to Resources, which will increase the level of services provided to Resources by the Company.

Also modify the service agreement between New Jersey-American and Resources to more clearly define how general overheads will be determined and billed, and to ensure that all applicable indirect costs are billed, consistent with the results of the study. (Refer to Conclusion 2C-2 in the following section)

The agreement needs to be more specific as to how general overheads are determined and insure that all overheads have been considered for inclusion in the bill to Resources. Billing procedures need to be developed to insure that the actual billing is in accordance with the agreement and captures all costs incurred by the Company on behalf of Resources. Since New Jersey-American is a regulated utility, it is necessary to allocate costs appropriately to Resources.

2C Documentation

A detailed agreement dated January 1, 1989, between the Service Company and New Jersey-American outlines the services to be provided to the Company and the billing and payment terms. This agreement calls for the Service Company to provide the following services:

- Accounting
- Administration
- Communications
- Corporate Secretarial
- Engineering
- Financial
- Human Resources
- Information Systems
- Operation
- Rates and Revenue
- Risk Management
- Water Quality.

The Service Company bills all the American System companies monthly for services provided. The operating companies are billed each month for (1) the next month in advance based on a projection that the cost will equal the actual cost for the month just ended, plus (2) a true-up for the difference between the amount paid in advance for the month just ended and the actual cost for that month. The following is a example of how the Service Company billing works.

Let's assume the Company was billed $800 in advance for September, and that actual charges were $1,000 for September and $900 for October. The bill detailing the final September reconciliation and the advance payment for October would reflect the following:

Actual charges- September	$1,000
Less: payment in advance for September	800
Net payable (receivable)	200
Plus: estimated charges for October	1,000
Total amount payable	$1,200

The $1,200 would be remitted to the Service Company in October. The bill detailing the final October reconciliation and the advance payment for November would reflect the following:

Actual charges-October	$ 900
Less: payment in advance for October	1,000
Net payable (receivable)	(100)
Plus: estimated charges for November	900
Total amount payable	$ 800

New Jersey-American receives a two page invoice each month that details the Service Company charges in three major categories. The first category details charges for services by services rendered as detailed in the agreement, including water quality lab charges from the Belleville lab. The next category are for authorizations/maintenance special projects. These include research and development projects, continuing education for employees, software implementation projects and other special projects. The final category is for engineering services charged to specific work orders. The invoice indicates the total number of hours charged by function, the total payroll and expenses and the total billed for each service provided.

In addition to that summary invoice, the Company receives a detailed invoice each month. The detailed invoice is broken down into the same functional categories as the two page summary but also details the amount allocated by Service Company employee. For each employee the invoice details hours and payroll charged directly or allocated by formula, the support personnel hours and payroll, basic overhead, office costs, travel expenses and other expenses. Expenses not directly related to an employee are listed on a separate line for each function. A summary page shows the total amount included in the bill by Service Company location. For New Jersey-American, charges only originate from the Corporate office at Voorhees and the Belleville lab.

As a result of consolidating the Eastern region into New Jersey-American, a number of the services listed in the agreement are no longer provided by the Service Company. For example, during 1996 the Service Company did not bill New Jersey-American for corporate secretarial, operation, and rates and revenue, which are now done by New Jersey-American personnel.

An agreement dated July 1, 1996, outlines the personnel and services to be provided by New Jersey-American to Resources as well as the monthly billing procedures and

terms of payment. Each management contract that Resources has is accounted for by New Jersey-American as a separate operating division where the costs of managing the system under contract is accumulated. Monthly these costs are transferred below-the-line on the Company's books and then set up as a receivable from Resources. A bill is provided to Resources and payment is due within ten days of receipt. The bill indicates the total amount due with no detail of the services provided. New Jersey-American's financial reporting system does produce a monthly report that details by income statement category the cost allocated to the particular Resources contract. These costs were accumulated to a particular contract as a result of charges being coded to that contract's particular division code. This provides auditors and regulators with an audit trail of the detailed transactions that are included in the billing to Resources.

Findings and Conclusions
(Documentation)

C2C-1 **The agreement between the Service Company and New Jersey-American is well documented.**

Because the agreement is common to all AWS operating utilities, however, it includes provisions for services that do not apply to NJAWC. As a result of transferring the Eastern regional office to the Company, many functions previously performed by the Service Company are now performed directly by New Jersey-American. The inclusion of non-applicable provisions is not a problem, however, and NJAWC pays only for services actually provided.

C2C-2 **The agreement between New Jersey-American and Resources is vague with regards to the determination of general overhead to be billed under the agreement.**

The agreement states that general overhead includes the "cost of administrative and clerical support as determined from time to time by New Jersey-American." There is no indication of how this element of overhead is to be determined and what items would be included. For example, there is no indication that a portion of the costs of the office

building occupied by a New Jersey-American employee whose time is charged to Resources is included in overhead. These costs would include such items as depreciation, insurance, utilities, and return on investment in the office building, furnishings, and equipment.

Recommendations
(Documentation)

There are no recommendations in this section. The need noted in Conclusion C2C-2 is covered by Recommendation R2B-2 in the preceding section.

2D Effect on Utility

As discussed in previous sections of this chapter, New Jersey-American's affiliation with the Service Company results in economies of scale. By sharing the cost of the resources available through the Service Company, New Jersey-American can utilize the breadth and depth of knowledge and experience of a staff of ninety employees while only paying the cost of the equivalent of fourteen employees. Since the Service Company bills only its costs with no profit added, ratepayers receive the full benefit of the economies resulting from the centralization of management services at the Service Company level. New Jersey-American shares the cost of services provided jointly to all American Water System companies since all joint cost are allocated to each company using the same allocation factor. Therefore, joint costs are spread to all companies on the same basis.

Included in the Service Company bills are lease charges from Occoquan, for the lease of Service Company offices and equipment, that are being passed through to the operating companies. Based on comparisons with alternative leasing arrangements with non-affiliated commercial real estate companies, the leasing arrangement with Occoquan is at a lower cost than the alternatives. Leasing office space from Occoquan results in the operating companies and their ratepayers avoiding the risks associated with investments in commercial real estate while utilizing the space at competitive rental rates.

Based on a review of recent rate orders it appears that the Company's transactions with the Service Company have been allowed full rate recovery. Since the realignment of the regional office in 1993, Service Company charges have represented a smaller percentage of total costs with more services being done in-house with Company personnel. This has reduced the impact of Service Company charges on the Company's rates.

New Jersey-American Resources Company was formed to isolate the risks of entering into management services contracts to operate other water systems from New Jersey-American and its ratepayers. Since this is an unregulated activity the revenues and expenses of providing these services must be allocated below the line.

With the formation of Resources the cost of providing these services must now be charged to this affiliate. All the work done in operating these systems is performed by New Jersey-American employees. At the present time Resources has no employees, equipment, or supplies. By entering into these contracts the Company is attempting to take advantage of economies of scale and spread its fixed costs over a greater customer base. This benefits the Company's ratepayers by lowering the cost of providing them with water service while providing Resources with the opportunity to make a profit.

In order to accomplish the stated goal of isolating the ratepayers from the risks of the management services contracts, it is critical that all costs incurred by New Jersey-American in operating this non-regulated business for Resources be fully allocated to Resources. As noted in the cost allocation section of this chapter, not all the costs related to providing management services are being allocated to Resources. This can result in the subsidization of a non-regulated affiliate by New Jersey-American ratepayers. Since Resources only began operations in 1996 the transactions between the two companies have not been examined as part of a rate filing.

Findings and Conclusions
(Effect on Utility)

C2D-1 Both the Company and the ratepayers benefit from the provision of centralized management services by the Service Company.

While a full analysis is not possible, cost comparisons discussed previously in this chapter indicate that New Jersey-American receives professional management services from the Service Company at a lower cost than if these services were acquired from outside vendors or staffed in-house. All costs of the Service Company are either charged directly or allocated fairly to all system companies with no profit added.

C2D-2 **While the concept of isolating New Jersey-American and its ratepayers from the risks of contract management of water systems owned by third parties has merit, all costs related to acquiring, executing, and performing these contract are not being allocated to Resources.**

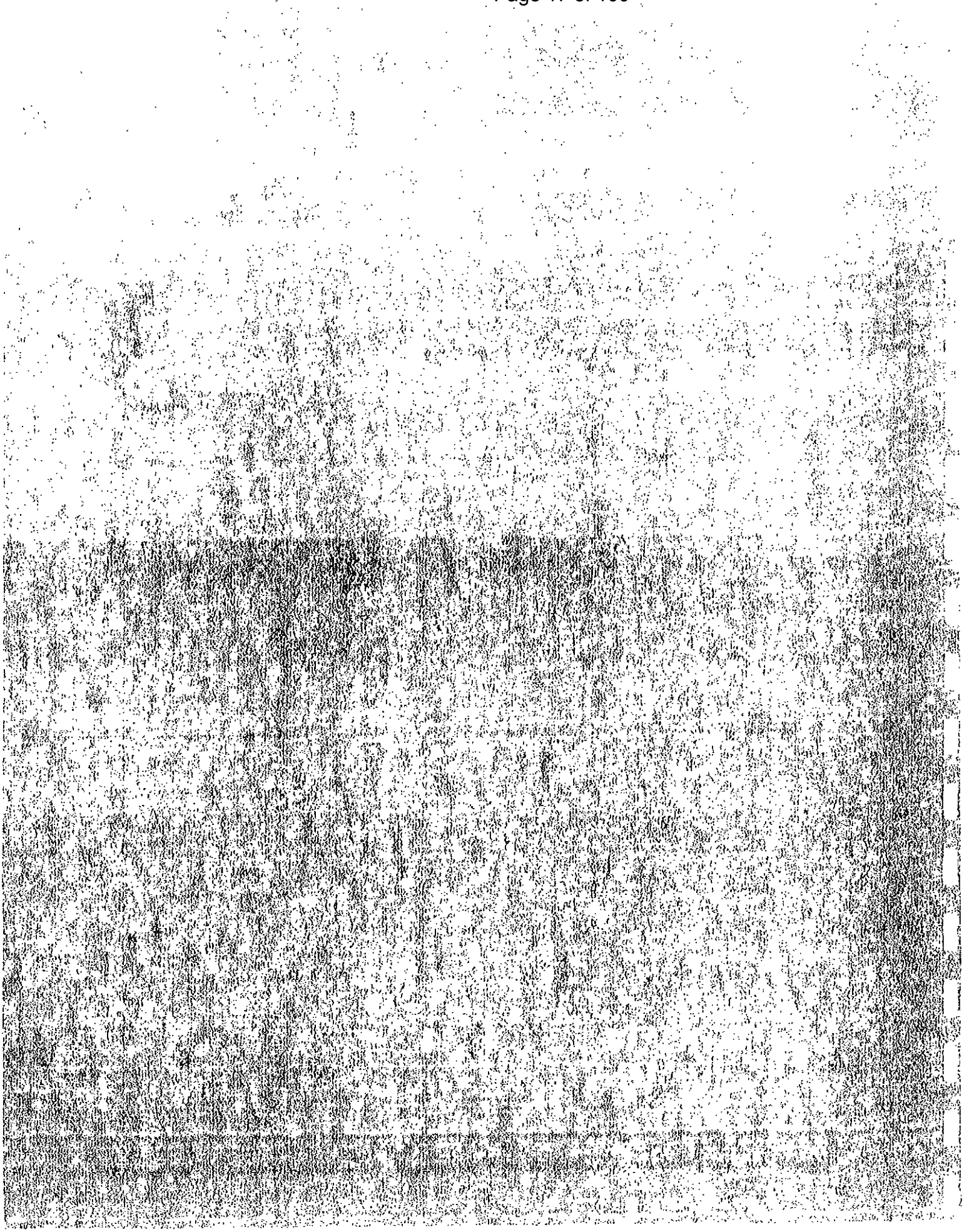
Currently only the direct costs of work performed operating a system for Resources by New Jersey-American employees is charged to Resources. Some elements of general overhead and costs of bidding, negotiating, or drafting these contracts have not been allocated to Resources.

Recommendations
(Effect on Utility)

There are no recommendations for this section. Recommendation R2C-1 in the preceding section will correct the deficiency noted in Conclusion C2D-2 of this section.

Chapter 3

System Operations



Chapter 3
System Operations

System Operations represents a major part of the Company's costs, as this is the functional organization that has the basic responsibility to acquire, produce and deliver the Company's product, potable water, to its customers. Sewage collection service is also provided in some areas, but to a much lesser degree.

Organization Structure

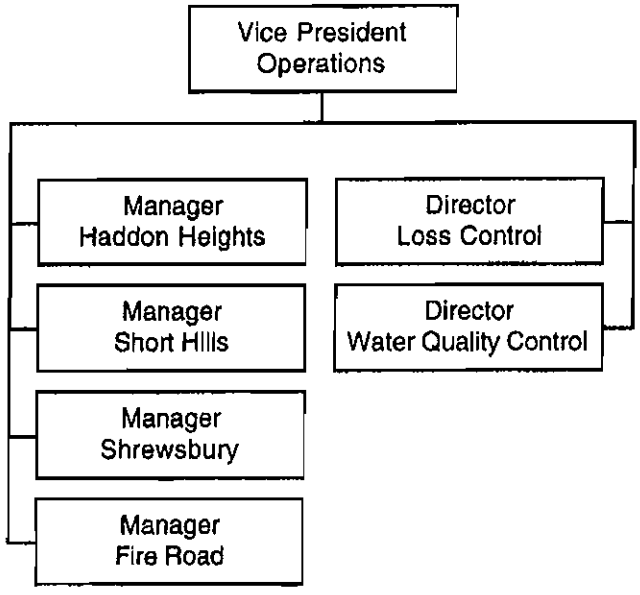
The operating groups have recently been restructured as part of the overall Company reorganization. Under the new organizational concept, implemented in late 1996, the Operations structure consists of four major operating centers and two centralized services that support the operating centers. The entire division reports to the Vice President-Operations, who in turn reports to the Company President. The structure is shown in Exhibit 3-1.

The Centralized Services

There are two centralized operations services to support the main mission of the Operating Centers. As shown on the right side of Exhibit 3-1, these services are loss control and water quality control. Until very recently they also included fleet and

materials management and certain specialized maintenance activities, all of which reported directly to a Director - Operating Services.

Exhibit 3-1
System Operations Organization Structure



Operating Center Organization

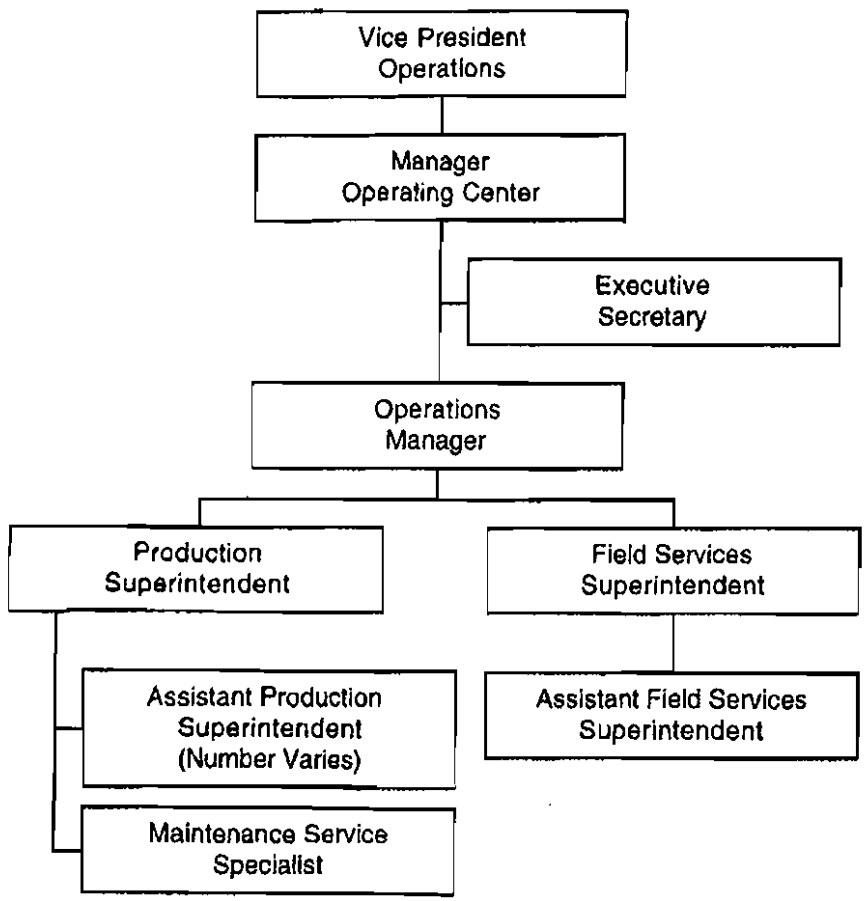
Each operating center (on the left side of Exhibit 3-1) has essentially the same organizational structure, as depicted in Exhibit 3-2. It consists of two major functional groups: Production, which is responsible for the sources of supply, production, and treatment facilities, and Field Services, which is responsible for the distribution system operation, maintenance and certain construction activities, as well as residual customer service activities, *i.e.*, meter reading, that remain at the operating center. Beyond these two major functional groups, there are some variations among the operating centers that arise primarily from special circumstances. For example, serving a remote service area (*i.e.*, non-contiguous to the main service area) or organizing all of the sewer service areas under one management responsibility.

There are four Operating Center Managers, at Haddon Heights, Short Hills, Shrewsbury, and Fire Road. In general, there is one Operations Manager reporting to each Operating Center Manager. Two of the Operating Center Managers,

however—at Short Hills and Fire Road—are responsible for two locations each, and each location has an Operations Manager. The Short Hills Manager is responsible for Washington, and the Fire Road Manager is responsible for Lakewood.

The official organization charts for Haddon Heights and Shrewsbury show the Operations Manager off to the side, in a staff position reporting to the Manager, but in reality they hold line responsibility between the Manager and the Superintendents as shown in Exhibit 3-2.

Exhibit 3-2
Typical Operating Center Organization



This chapter discusses a number of operations-related functions in the following subsections:

A System Production, Transmission and Distribution
B System Operation and Maintenance
C System Reliability and Planning
D System Construction and Bidding Practices
E Unaccounted-For Usage
F Work Force Management.

The last topic, work force management, is actually discussed where relevant in the preceding subsections, rather than in Subsection F.

It should be noted that, with respect to system operations, planning, engineering and construction, the Company has done a good job of implementing the recommendations of the 1989 management audit.

3A System Production, Transmission, and Distribution

System Production, Transmission and Distribution of potable water are the responsibility of the Operations Division.

System Production

System production includes the capture and treatment of water.

Organization and Procedures

There appears to be good cooperation and coordination between engineering and the various Operating Centers and other Operations components, although based on the interviews, there could be improvement in this. Control and coordination is more a function of established procedures and personal relationships than any organizational structure can direct. The relationship between engineering and operations is fully developed in Section 3C, System Reliability and Planning.

Organization Structure

The basic reporting relationships within the Operations Division are shown in the organization sketches in the preceding sub-section. They are logical, direct, functionally based and generally very consistent with good water works management for a large water supplier. Although the new organization had literally just been put in place as interviews were being conducted, all those persons interviewed expressed an understanding of the Company's mission and their respective roles and responsibilities in achieving that mission. All persons interviewed expressed a high level of confidence in their understanding of how much authority is delegated to them and their responsibility to use this authority in carrying out their day-to-day activities. This delegation of authority and responsibility is more fully explored in Section 3C: System Reliability and Planning, under subsections "The System Planning Process from a Budgeting Perspective,"

"The Management, Control, and Integrity of the Budgeting Process," and "Planning and Budgeting."

Although all interviewees expressed a high level of confidence in the new organization and their roles in it, the fact is that the new organization and responsibilities were only just beginning. The process should be monitored and evaluated for any corrections that may be required with respect to implementation, such as reporting relationships, authority and responsibility, communication, coordination, and the like.

There is, however one area of organizational structure that should be reviewed. On the surface, it would appear that there is redundancy between the Manager and Operations Manager positions. As explained consistently by the Operating Center interviewees, the Operations Manager primarily has internal responsibility for day-to-day activities of the Operations Centers, including budget control, while the Manager has overall responsibility, but also has responsibility for coordinating with other Operating Centers and with Corporate and for maintaining external relations, particularly with communities in the respective service areas. While this latter function is very likely an important key to maintaining good working relationships with these communities and to developing new business opportunities, there should be some clarification and review of responsibilities. Although the Operations Manager position was described as having direct line responsibility for day-to-day activities, each organization chart indicates this is a staff position with no direct line responsibility; this should be clarified.

Operations Procedures

There are a number of policies and procedures that address production, source of supply, and water quality as found in the American Water Works System (AWS) Operations Manual, Volume II. For example, the Production policies and procedures include:

No.	Subject
1.	Filter Operation, Inspection and Maintenance
2.	Calibration of Chemical Feeders
3.	Disposal of Treatment Plant Wastes
4.	Pumps and Motors - Inspection, Maintenance and Efficiency Testing
5.	Telemetering Systems - Operation and Maintenance
6.	Inspection & Maintenance of Electrical Facilities
7.	Plant and Station Water Metering

In various discussions, it was noted these procedures are good, but tend to be generalized and are not necessarily specific to a given situation. As a result, some of the procedures are more informal, based on individuals' extensive experience at a particular plant.

These policies and procedures are supplemented with a variety of other documents that have the same effect as a policy or procedure. One example is the "Production Department - Scheduled Maintenance Job Order" form, which lists the activities to be performed, as well as certain data that are to be collected. An example for well pumps is shown in Exhibit 3-3.

Other documents include vendor operation and maintenance (O&M) manuals, particularly for new equipment, as well as vendor training in O&M procedures for production staff. In addition to water supply procedures, Fire Road Operating Center has also developed procedures for sewer system operation and maintenance, including activities, such as sewer cleaning, how to deal with overflows or stoppages, etc. These documents are available to all personnel.

There are essentially measurable goals for the Operations division and its sub-units. The two primary goals are: 1) delivery of sufficient water to meet customer demand; and 2) to meet their respective budgets. To help accomplish these goals, more measurable goals, in more discreet units, are provided through the NJAWC Work Management System. One unit of the Work Management System book addresses the Production Department(s). In general, this document provides a list of productivity monitoring systems and includes standards of measurement, outlines reports detailing productivity, and the process used to establish standards. This system is anticipated to be replaced eventually by the J. D. Edwards system.

Training and Staffing at Plants

There is a significant amount of technical training conducted for both operations and maintenance personnel. These training programs cover the required skill and technical categories. Basically, the training programs address two needs: 1) the training required to become a licensed New Jersey water treatment operator and to understand water supply principles; and 2) the training required to keep the physical facilities in good operating condition, *e.g.*, pumps and motors, and to produce a good quality of water.

Exhibit 3-3
Production Department - Scheduled Maintenance Job Order

PRODUCTION DEPARTMENT - SCHEDULED MAINTENANCE JOB ORDER

Location N. Main St Estimated Hours 1

Equipment Well Pumps Actual Total Hours 1

TASKS

✓ Grease all bearings

✓ Check oil level

✓ Clean up motor of any excess oil and dirt

✓ Check motor for vibrations, running hot, and unusual noises

✓ Check the stuffing box and water lube systems

✓ Check over the air compressor and drain the tank

✓ Check all safety guards

◊ Log the following readings:
◊ system pressure 55.6 well discharge pressure 60.0
◊ station flow 605 gpm static level 75.3 pumping level 106.6
◊ voltage 240-Ø-Ø
◊ amps 110 108 103

✓ Check flow switch operation to scada system

✓ Check air release and well discharge check valves for proper operation

◊ Please make detailed notes below of any problems and important information that the Supervisor will need to know in the section below

MECHANICS NOTES

Mechanics Signature [signature] Date 9-13-96

The Company supports its staff—union and non-union—in a variety of training activities. These include, but are not limited to:

- Courses designed to lead to water plant operator certification
- Industry short courses or seminars, such as conducted by the American Water Works Association (AWWA) and the NJ Section of AWWA.
- Manufacturer or vendor training
- Specialized training, such as handling chlorine gas, which is classified as a hazardous material.
- Other hazardous materials training
- In-house seminars, including a variety of tailgate lectures
- Trade or craft training
- NJAWC facilities, used in certain training exercises that attract wider participation than only Company staff, *e.g.*, backflow prevention training.
- State courses for water and sewage operation certification, also being conducted at the Delran plant.

The training program provides for reimbursement of costs. It was noted that staff are not required to take any particular courses or training, but are encouraged to do so, particularly if they wish to advance in certain areas. Generally, a high percentage of management, including first line supervisors, hold New Jersey T-4 Water Treatment Operator licenses (highest level). Certain production staff (by NJAWC classification) are not required to hold state certifications, but many do, and several others are in training to obtain a license (see below). With regard to encouraging staff (particularly at union level) to acquire or upgrade skills through training, the Haddon Heights Operations Center has recently negotiated a new union contract that definitely encourages this by developing definite career tracks. If a person wishes to move into a higher classification, he/she must have taken courses appropriate for that position and must continue to take courses to move along that track. Since the implementation of the new program, the number of people voluntarily participating in various training programs has more than doubled. It was noted that training for production and distribution personnel starts on a parallel track, but then diverges to focus on the information needed for either area.

This approach is not uniform across all operating centers, largely because union staff are represented by different unions and there is a difference in scheduled negotiations for new contracts. There is a desire to achieve a similar program in each

operating center as new union negotiations are begun. There should be a strong effort to achieve this and then to monitor the results.

Also, as noted above, with the new reorganization, there is a dedicated effort to cross-train first line supervisors to be able to cover various activities, particularly in the field services functions.

The use of outside contract personnel for O&M needs is generally limited to meeting short-term needs, such as an emergency or specialized work such as high voltage electrical work. Timeliness is a key factor in deciding to use outside contractors. There is an established procedure to evaluate use of outside help, entitled "Criteria used to determine in-house versus contract labor." (See Exhibit 3-4.) One particular type of emergency that requires outside contract personnel is sewer cave-in, especially if it is deep. The Company can generally deal with a shallow cave-in, but is not equipped for deeper work. Due to the infrequent need for the equipment or expertise to deal with these types of situations, the Company would not be justified in acquiring its own equipment or personnel.

Exhibit 3-4
Criteria Used to Determine In-House versus Contract Labor

- Our collective bargaining agreement provides some definition concerning the use of contractor or in-house labor.
- If an emergency condition exists that would adversely affect water quality or quantity we would use the most expeditious labor force.
- Do we have adequate manpower to perform the task?
- Do we have the necessary equipment and/or qualifications to perform the task?
- Will performance of a specific task prevent us from doing our normal work?
- For those tasks that meet the above criteria such that we can exercise discretion and assign the work to either in-house or contract personnel:
  - Estimates are requested from contractors to perform the task.
  - An estimate is prepared detailing the cost to perform the task in-house.
  - The task is assigned to the most cost-effective work force.

Maintenance Scheduling and Staffing and Preventive Maintenance Programs.

Effective planning and scheduling methods are used at the water plants, including a predictive maintenance program. The AWS provides several policies and procedures that support and direct a wide variety of maintenance activities. For example, Production Procedures No. 4 (Pumps and Drives) and No. 6 (Electrical Facilities) require a variety of activities with respect to pump and electrical maintenance, *e.g.*, weekly monitoring of pumps for unusual noises, hot bearings, excessive vibration, etc.; checking motor starters annually, etc.

In addition, the maintenance management system has good information on when various types of equipment, under various operating conditions, are likely to experience characteristic problems. As a result, coupled with operating records such as pump or motor running time, predictive maintenance is a key component of the Company's overall maintenance program. For example, if a certain type of pump can be expected to exhibit characteristic problems at 25,000 hours of operation, and the running time is known to be approaching 25,000 hours, that pump can be scheduled for specific maintenance or replacement. The above information, along with the productivity guidelines of the Work Management System, allow for very effective scheduling of routine, as well as more major, maintenance activities.

Generally, the maintenance scheduling process allows for:

- Identifying essential activities to be accomplished
- Developing a short-list of non-essential, non-routine activities
- Developing a short-list of non-essential routine tasks
- Recognizing that non-programmed emergencies may occur, taking precedence over other tasks.

Overtime appears to be very effectively controlled, as it is essentially limited to emergency situations or major unscheduled activities (*e.g.*, an NJDOT highway project). The low overtime utilization was attributed to two points. The first is an effective predictive maintenance program, which tends to minimize emergency situations. The second is that a supervisor or superintendent is always on call who can control overtime by evaluating a given situation, *e.g.*, does the situation require attention immediately (possibly requiring overtime) or can it wait till the next working day?

Maintenance Planning

With regard to maintenance planning, perhaps the best comment on this is from a new NJAWC manager who previously spent nearly 30 years in the municipal water supply sector: "In the municipal sector, if maintenance meant spending money, they didn't do it. At NJAWC, it's a different story: explain the need and proceed with the necessary repair, replacement, etc." The Company's approach to maintenance planning is that it is an ongoing commitment to protect its (and its shareholders and customers) investment in facilities to ensure reliable service. The approach is based on a predictive and preventive maintenance philosophy. As noted in the preceding section, the procedures to support maintenance planning include a number of maintenance related policies and procedures, a maintenance history database, a predictive maintenance program specific to NJAWC (AWS) equipment, and a Work Management System that defines estimated maintenance labor requirements.

Job planning and scheduling were addressed in the preceding section.

The criteria used to determine the use of NJAWC versus contractor personnel for O&M work was discussed in "Training and Staffing at Plants."

Maintenance Management

With regard to maintenance costs and comparison with other water utilities, a ready available source is the National Association of Water Company's (NAWC) annual report on Financial and Operating Data for investor-owned water utilities. This annual report allows easy comparison among larger, investor-owned water companies across the country. The 1995 report was used to compare basic O&M costs of the Company against several other investor-owned companies that are roughly comparable to NJAWC in terms of average daily production and number of customers (or population served), including two other New Jersey water companies. The companies used for comparison are listed below with their abbreviated code names:

Elizabethtown Water Company (NJ) - ELIZ
Philadelphia Suburban Water Co. (PA) - PSWC
St. Louis County Water Company (MO) - SLWC
Southern California Water Company (CA) - SoCAL
United Water New Jersey (NJ) - UWNJ
New Jersey American Water Co. - NJA

Measures of comparative cost that were considered were cost per million gallons of production and purification, and transmission and distribution costs per mile of main. One other comparative statistic reviewed is the number of employees per 1,000 customers. The comparative figures are shown in Exhibit 3-5, below:

Exhibit 3-5
Comparative Figures for NJAWC

	NJA	ELIZ	SoCAL	SLWC	PSWC	UWNJ
Production Costs Per Million Gallons	$537	$418	$903	$167	$117	$346
Purification Costs Per Million Gallons	$349	$78	$60	$154	$176	$200
T&D Costs Per Mile of Main	$2557	$3107	$2255	$3064	$5572	$3632
Employees Per 1000 Customers	1.90	2.10	1.88	1.92	2.04	2.43

In reviewing the figures shown in Table 3-1, it should be kept in mind that a number of factors can significantly influence these figures. The sources of water, water quality, mix of surface and groundwater, regulatory requirements, geographic coverage of a system, and similar factors can greatly influence the figures shown. Accounting treatments can also differ in spite of general uniformity throughout the industry, and there can be differences in what goes into the costs. With this in mind, NJAWC's production costs would appear to be higher than those of the other two New Jersey water companies, but its pipeline and O&M costs are lower per mile of pipe. Its purification costs seem to be significantly higher than any of the other companies considered. However, this could also be due to the fact that NJAWC has numerous sources throughout a large geographic area as compared to at least Elizabethtown, United Water New Jersey, and Philadelphia Suburban Water. Even with this in mind, it would appear that purification costs, as well as production costs, should be given a thorough study by the Company to determine if savings can be made. (Note: See Energy Management and Residuals Management sections for cost savings examples.) With regard to number of employees per 1000 customers, its staffing (1995) appears to be very much in line with the other systems.

As to productivity measurement and improvement, it was noted that prior to the Work Management System, maintenance assignments, "productivity measurement," and similar tracking procedures were based essentially on "dead-reckoning." That

is, supervisors basically knew what had to be done and how long it should take to do it based on their own experience. Implementation of the Work Management System (WMS) has lead to significant improvements in scheduling and assigning work, tracking productivity, developing backlog reports, and similar work management activities. A work order system is used to assign and track job assignments. It was also noted that the various maintenance related policies and procedures and maintenance records contribute to productivity by allowing predictive and planned actions to be scheduled into an overall program and by minimizing unscheduled interruptions of service. Assignments are made based on the WMS guidelines. One interviewee commented that a major advantage of the WMS is that when customer call-ins require a diversion from a crew's schedule, it is relatively easy to re-schedule work and keep track of backlog requirements. Various interviewees noted that if an assignment's actual time varies from that scheduled, the crew is de-briefed on what problems occurred to cause the variance. There is no process to compare productivity to other systems or for benchmarking. It should be noted there is relatively little information on productivity in the water supply industry. This, along with benchmarking, is just beginning to emerge as a new activity in the water industry. Perhaps the best benchmarking opportunity for NJAWC is within the AWS.

As a result of the WMS and a review of the crew sizes for the work to be done, it would appear that work crews have been optimized at this point in time, generally consisting of only one, two, or three persons.

There are information systems in place, but as one interviewee noted, it is "mostly paper and files and crates," and much of the communication is verbal and informal. Up to six people are committed just to the paperwork aspect of the present system and one common problem noted was the transposition of numbers that can occur with such a system and the associated problems. The Company is moving toward a major improvement in the entire work force management area with the J. D. Edwards program, including significantly improved information systems. At the present time, a large amount of data is captured by the WMS, but there is an "incredible amount of work" to use the data or extract answers from it. The new system is expected to improve capture, tracking, and utilization of data, as well as to provide for better staff utilization.

In conjunction with the J. D. Edwards program, an associated activity is a current program to review all of the current forms and related documents used in each operating center. NJAWC is generally finding that while much of the data being collected by each operating center is the same, it is being collected in different formats. One key objective of this project is to develop uniform forms and reports for all centers. This work is directed by a committee of various Company staff, and is being reviewed both by people who will eventually work with the forms and reports on a daily basis and by management who will make decisions based on this data.

For example, there are different reporting needs for ground and surface water, different purposes for which various AWS and NJAWC departments want the information, and different formats required by different agencies —BPU, DEP, EPA, etc. It is anticipated the new form and report system and the J. D. Edwards system will be able to fully integrate maintenance, operations, accounting, construction and other functions so that a variety of reports can quickly utilize data from a single entry.

This system is also expected to result in substantial productivity gains in the field, although these remain to be created. Some anticipated areas of improvement are the potential ability to get information, such as work schedules and customer call-ins, directly to people in the field and thus improve customer service. Since there is potentially constant access to field people, it will be much easier to direct their work and, if daily quotas can't be met, supervisors will know almost immediately and can quickly reschedule work. Also, instead of paper or laminated valve books, intersection sketches, etc., a CD-ROM will be able to store the entire system and provide instantaneous information for field staff. A pilot project with two fully outfitted vans is expected to start in 1997.

An additional area may be eventual conversion of the distribution maps to electronic database, preferably in the form of a geographic information system (GIS). This would have potential for improving distribution maintenance, as well as engineering design. However, the actual gains remain to be identified and evaluated.

As to job tracking procedures, one key technique used at NJAWC is that a supervisor will accompany an individual or crew on his/her assignments. In this process, the supervisor and crew will go through the various work activities on a

step by step basis to confirm the individuals' knowledge of work to be done and to evaluate whether a given activity can be moved from, for example, a daily event to a weekly event, and thereby improve productivity. Also, as noted earlier, supervisors will also review with individuals or crews the reasons for variances in work activities. It was also noted that there is no "loop" to update job times, which may be a result of the cumbersome nature of the present paper system.

There is an effective materials planning system in place. While Section 7D specifically deals with materials management, materials management is also discussed in several other areas including Section 3D, under "Procurement and Bidding," and in the QA section in 3C (Testing of Treatment Chemicals). Both Production and Field Services managers stated they have adequate materials and supplies without being overstocked and that replacements are readily available, including more major items such as pumps and motors, because of good relations with suppliers. It was also noted that if an operating center feels it is overstocked on a given item, it will let others know of that item's availability.

As indicated above, short-term job scheduling procedures are very effective, including being able to address unscheduled short-term work, especially that resulting from customer call-ins and minor problems.

First line supervisor performance is evaluated similar to other non-union and management staff. Performance reviews are performed annually in the first quarter of the year. The review is performed by a person's immediate supervisor, with input from the next-senior level of management. The desired process is to give each person a development plan, and supervisors are directed to work more closely with those persons experiencing "problems" as the "whole purpose (of the review) is to make people successful." However, other interviews conducted in connection with the study of the Human Resources function indicate that the desired process and the actuality may be different. This topic is treated in Chapter 5, Human Resources.

There is seldom a need to coordinate plant maintenance work with other utilities or with customers, unless the work affects incoming electric service, because of the redundancy that is required to be built in to water system production and storage facilities. That is, with the largest unit of any type of equipment out of service, a water utility must still be able to meet maximum day demand.

During the various interviews, it was noted that first line supervisors have a $300.00 limit on purchase orders, above which the Operations Manager's signature is required. Management staff did not feel this presented any particular problems, as they can usually obtain this authorization rather quickly, and generally the items they need are in inventory somewhere in the NJAWC system. However, in light of today's costs, it would seem that perhaps this limit could be raised, particularly for emerging conditions.

Other System Production Considerations

Energy Management

Municipal water plants and pump stations are very good candidates for demand side management with respect to energy management. Since the 1990s, energy management has become a major focus of NJAWC, as well as of the entire AWS. In its paper entitled "Utility Partnership Reduces Operating Costs" submitted to the National Association of Water Companies (NAWC) Annual Management Innovation Competition, the summary states:

"In 1990 New Jersey-American Water Company, in an effort to reduce increasing energy costs, joined one of its primary energy suppliers to develop a cooperative business plan that could benefit the two utilities. New Jersey-American's partnership with Jersey Central Power and Light Company (JCP&L) has evolved into several energy efficiency accomplishments including an acclaimed variable speed drive program. The variable speed drives are installed on treatment plant and pump station motors to control the speed of the pumps and reduce the electricity needed to deliver the water. The innovative use of variable speed drives has helped reduce water main failures through better pressure control, allow better process control and has influenced more efficient designs for new pumping stations. Most importantly, the energy efficiencies are conserving power and rewarding New Jersey-American customers with reduced operating costs."

This program won the 1992 NAWC Energy Management Award. The first variable frequency drive (VFD) installation occurred about 1990 and along with energy curtailment was the primary effort early in NJAWC's energy management program. The Company had been getting about 15 requests per year from the electric utility for power curtailment. These curtailments resulted in energy credits in the range of

$58,000 to $75,000 per year. In the same time period, the power utility was offering a flexible rebate program, which provided 50% of capital and installation costs of facilities installed to reduce electric use. The Company participated in this program and in one example cited reduced its energy bills for one item (intake) by about one-third ($20,000 down to $14,000) with a payback period of three months. The Shrewsbury system alone now has about 18 VFDs in service. It was noted that the program's early focus was energy management, but it was also found that the VFDs permitted significant operations benefits to be derived by closer management of the water system itself. By better controlling the flow of water, the Company can maintain lower pressures, which does not affect water availability but does result in less water used or lost through leaks, and at the same time, can retain more water in storage for emergencies. Similarly, water hammer is reduced and standby power start-ups can be controlled by starting a VFD on standby power much more slowly and then ramping up to the necessary speed. Staff from the Shrewsbury Operating Center led this effort and have had input to the Delran plant and other operating centers with respect to energy management. They have also been active in the Electric Power Research Institute's Municipal Water and Wastewater Project, which is a cooperative effort among electric, water and wastewater utilities, to improve energy efficiency at municipal facilities.

Beyond the capital program itself, the Company has worked with its maintenance staff to become very proficient with VFDs and the associated instrumentation, SCADA systems, and related equipment. As a result, there can be significant savings by having in-house staff provide more "high-tech" maintenance rather than calling in vendor maintenance specialists who, in addition to charging high daily rates, may have to travel a significant distance.

AWS Production Procedure No. 4, Pumps and Motors - Inspection, Maintenance, and Efficiency Testing, directs that wire to water efficiency will be checked at periods not to exceed one year and provides guidelines on how to do these checks. The AWS also completed a research project in 1995 entitled "Energy Management Opportunities in the American Water System." This has been published as a hard-copy book and addresses topics such as how to evaluate an electric bill, an energy survey of the AWS, energy audits of selected systems, energy savings and costs, and a discussion of optimal operation of water supply systems.

Residuals Management

In addition to energy management, one other notable area of cost control by the Company is that of residuals management. The residuals are essentially the solids, or sludge, removed as a result of the water purification process. A mini-case study from the Shrewsbury Operating Center is a good example of residuals management:

> Disposing of water plant residuals at the Monmouth County sanitary landfill was very costly. Because it was not clear that water plant residuals should be considered a hazardous waste, NJAWC applied to the NJDEP for permission to dispose of the residuals elsewhere. That permission was granted.
>
> Now, as long as a variety of parameters fall below certain levels, the Company is able to make alternative disposal arrangements, such as at a Township leaf composting operation, where the residuals are added. This material ultimately becomes a soil conditioner.
>
> Under this scenario, the Company pays a net of only $300 per dumpster vs. $2,000 per dumpster of material sent to the landfill. It is believed that it may be possible to reduce disposal costs from $400,000 per year to $200,000 per year, using this and a variety of other techniques that are being explored.

Transmission and Distribution

Policies and Procedures Relative to T&D O&M Functions

The Company utilizes a standards manual (The Operations Manual), which includes a number of policies and procedures that tie directly with transmission and distribution O&M. As found in AWS Operation Manual, Volume I, the Distribution section policies and procedures include:

DISTRIBUTION INDEX

No.	Subject
1	Disinfection of Tanks - New & Existing
2	Distribution System Flushing
3	Fire Hydrants - Installation, Operation, Inspection & Maintenance
4	Hydrant Flow Testing
5	Hydrostatic Testing & Leakage Testing of New Pipelines
6	Polyethylene Encasement for Ductile Iron Pipe
7	Water Loss Control & Leak Detection
8	Facilities to Serve Multiple Occupancy of Individual Properties, Apartments, Condominiums, Shopping Centers, Etc.
9	Relocation or Repair of Company-Owned Facilities at Customers' Expense
10	Corrosion Control
11	Disinfection of mains - New & Existing
12	Inspection of Pipe and Fittings
13	Relocation of Water Company Facilities in Connection with Highway Construction
14	Steel Tank Maintenance
15	Pipeline Bidding Procedures, Contracts - Approval and Invoice Payment
16	Valves - Installation, Operation, Inspection and Maintenance
17	Distribution System Records
18	Asbestos Cement Pipe - Work Procedures

The discussion in Section 3D under "Operating Policies, Procedures, Standards and Criteria Pertaining to the Performance of Engineering and Construction Functions," with regard to specifications also applies here.

The policies and procedures are supplemented with a variety of other documents which have the same effect as a policy or procedure. One example is the "Distribution System Maintenance Report," which collects a variety of information relevant to distribution work (an example sheet follows on the next page as Exhibit 3-6. The discussion earlier in this section concerning other sources of information, such as vendor O&M manuals also applies to distribution activities. These documents are available to all personnel.

Exhibit 3-6
Distribution System Maintenance Report

Location _____

Date _____

Facilities

Main ☐ Hydrant ☐
Valve ☐ Other _____
Size ☐

Emergency ☐

Time Reported _____
Time of Closure _____
Time On _____

Routine ☐

Time Reported _____
Time of Closure _____
Time On _____

List of Valves Operated to Effect Complete Shutdown

	OPEN R-L	NO. TURNS
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Nature of Repairs

Material Report

Faulty Valves Discovered

Street Damage

Number of Men Engaged in Actual Repair Work _____

Repairs Completed _____

Property Damage Report in Detail on Reverse Side

Signature _____

Cross-Connection Control: One key situation for which no specific procedure has been developed is cross-connection between the potable water system and potential contamination sources. Sources and Meters Policies/Procedures No. 1 and No. 7 do include provisions to check fire service connections for possible cross-connection (No. 1) and that no service will be provided where it is known that a potential cross-connection may exist (including private wells). According to interviewees, the most likely sources of cross-connection are:

- "Mom and Pop" landscape services who may illegally tap a fire hydrant to fill chemical tanks.
- New services to homes previously on private wells, especially if groundwater in the area is contaminated (but see Policy/Procedure No. 7).
- New construction sites using a fire hydrant as a source of water. (The company will typically temporarily provide a meter and backflow preventer for these situations.)

The company has certified cross-connection control specialists who accompany NJDEP personnel to hospitals, service stations, sewage plants, etc., but has no formal cross-connection control program of its own. While industry is a relatively small portion of NJAWC 's customer base, there are significant commercial customers, *e.g.*, funeral homes, and residential customers who may use appliances such as hose attached chemical sprayers for their lawns, who may not be aware of potential cross-connection problems. An ongoing cross-connection control education program would be beneficial.

Performance of the Operations and Maintenance Functions

The company maintains a significant amount of documentation and records with respect to monitoring operating and maintenance performance. These include a variety of backlog reports, status reports, scheduled work, work-in-progress report, unscheduled maintenance reports and the like.

Most of the work tasks for a water distribution system are relatively straight-forward, limited in scope, and repetitive in nature, *e.g.*, replace fire hydrant, correct curb box, flush main, etc. The WMS has resulted in significant productivity gains and as a result, major deviations with respect to a specific type of activity do not

appear to be a major problem. A specific assignment may experience problems that cause deviations from the established criteria. When there is a deviation, the immediate supervisor does attempt to determine the cause and to devise a solution. Typically, these problems, or deviations, are not a result of company action or inaction, but are more likely a result from external sources, such as changing directives from a local municipal official. (See further discussion in Section 3D.) The WMS has resulted in significant productivity gains and improved management of distribution O&M functions according to company management and supervisory personnel. While it appears individual problems or deviations are addressed, there has been no attempt to review the overall results to attempt to further improve management control and workforce productivity. This situation is recognized by senior management. The general problem is acknowledged to be the extensive effort required to use the data in a larger sense. The J. D. Edwards system is expected to make significant improvements in the ability to perform these larger evaluations. (See "Maintenance Management" under System Production for more discussion.)

In addition, the monthly distribution department reports provide a very general rolling three year comparison of maintenance work completed for that month, as well as a brief manpower analysis (overtime use) and reasons for being ahead or behind in scheduled work. Senior management does review summary reports of information as it is consolidated and does look at identified variances and what is being done about these. It was also recognized that all the various AWS policies and procedures, WMS schedules, vendor O&M manuals, personal experience, etc. don't always agree, and there is a need to review, and revise and upgrade these documents.

The modern Supervisory Control and Data Acquisition (SCADA) systems, discussed in the following section, will also result in collection of a large of amount of operating data, which can be sorted in many ways for various uses in improving system O&M.

NJAWC Information Systems to Track Operation of the Distribution System

This section deals with equipment age and performance data. Equipment in the distribution system consists of pipes, services, storage tanks, booster pump stations,

fire hydrants, a variety of valves, instrumentation and control (I&C systems), and related appurtenances. Equipment age can range from brand new to many decades old (*e.g.*, pipe). Simply because an item is old in a water system does not mean it cannot provide good service. In particular, ductile iron pipe (DIP) has a history of very long life in water service.

NJAWC has undertaken two key activities related to tracking and improving the performance of the distribution system. One is the identification and replacement of small water mains with larger pipes, generally 8-inch diameter, primarily to upgrade the system for fire flows, but also to gain improved flow and pressure for routine service. The second is the upgrading of essentially all I&C systems to state-of-the-art Supervisory Control and Data Acquisition (SCADA) systems. A SCADA system allows the ability to collect performance data on a timely basis, which in turn contributes to better analysis for future maintenance needs and allows more "real-time" response of the water system to changing conditions in the water system on a daily basis, *e.g.*, decisions concerning which sources to use in response to heavy demands. Day-to-day maintenance productivity will also be improved. Prior systems could report there was a problem at a remote location, but could not identify what the problem was. The new SCADA systems identify the problem and allow more expeditious assignment of the work. In situations where purchased water is a major factor, relatively new SCADA systems are anticipated to be a significant aid in monitoring water demand and evaluating these purchases, especially where the purchase contract is one of "take or pay."

The various policies, procedures and other documentation are indirect measures of performance data, but lead directly to activities that are intended to ensure the reliable performance of the system. For example, fire hydrant and valve inspections include verifying equipment locations, determining that a local municipal road department has not paved over a valve box, and exercising the valves (and making necessary repairs).

Other examples of performance related activities include annual flushing of lines to maintain water quality and hydraulic capacity; fire flow tests (in cooperation with local fire departments); and steel tank maintenance.

The current philosophy and approach of NJAWC, coupled with the anticipated enhancements of the J. D. Edwards system, should lead to many decades of useful equipment life.

Perhaps the major problem area with regard to the items discussed above, comes with the acquisition of other systems by NJAWC. Many of these systems have undersized mains, frequently lack log books for items such as valves or fire hydrants, and often have not had a valve exercising program. One of NJAWC's objectives in these acquisitions is to bring the acquired system up to their standards, which equal or exceed industry standards.

As to pipe breaks, these are occurrences that are to be expected in any water system. Pipe breaks can occur on both main lines and services. The Company records a variety of information about main breaks, including type of pipe, type of break, cause of break, equipment utilized, man hours (regular and overtime) required, costs, time to repair, etc. However, from the information provided, there does not appear to be a uniform form to collect this information, and it would be helpful if data were collected and organized in a uniform format throughout the system. (As noted elsewhere, there is a current program to standardize this type of information.)

It was reported that most breaks can be repaired in less than four hours. As to the number of customers affected, this can vary significantly, depending on the break location. For example, a service break may affect only one customer, but a major line break can affect a much larger number of customers. The company attempts to place valves at key locations either to minimize the number of customers interrupted by a break or to re-route water around the break. On occasion, fire hoses have been used to supply customers, if a break is anticipated to be a problem or of longer duration. Field Services also has copies of distribution maps, which are updated annually, which aid in quick identification of the area to be isolated and how to implement the isolation. It is anticipated this function may be automated in the future in connection with the J. D. Edwards work.

There is no formal risk analysis based on break history and other relevant information for pipe replacement. Presently, engineering with input from field services personnel makes decisions about whether certain pipes experiencing breaks should be replaced. These appear to be based more on subjective judgments than on a formal decision-making process involving specific replacement or repair criteria.

In general, while these subjective judgments do not appear to differ greatly in terms of net effect, there was no strong sense of uniformity in the Company on the "replace or repair" decision-making process. (Also, see next section concerning predictive maintenance for pipelines.)

In the event of planned down time (planned customer outages), there is an entire procedure for this process. The procedure includes the following steps:

1. Apply for street opening permit
2. Notify affected municipalities
3. Notify affected police and fire departments
4. Contact N. J. One Call
5. Notify affected customers (via letter)
6. Notify customer call center

In situations involving planned outages, the company has on occasion inserted new valves at key locations to minimize the number of customers affected by the outage.

Policies and Procedures Pertaining to Planning, Scheduling and Performance of Maintenance Activities

Most of the items under this section have been discussed elsewhere. Programs and procedures concerning preventive maintenance and scheduling were discussed under 3A System Production, and apply here as well, as does the "Performance of the Operations and Maintenance Functions" above.

Policies and procedures regarding the routine inspection, repair, and replacement of distribution equipment are covered in Section 3D.

One additional point concerns predictive maintenance for water lines with respect to breaks. As noted earlier, there is no predictive maintenance program to evaluate when a given section of pipe could be a candidate for replacement. There has been some work done in this area in the water industry, and as yet it has found limited application. However, considering the size of NJAWC, it should evaluate a "predictive maintenance" program for its applicability to NJAWC.

Emergency Procedures

The company has clearly established emergency procedures, which are in accordance with industry (and state and/or federal) standards and guidelines. Most emergencies would likely fall under four broad categories:

1. Water main breaks (discussed earlier in this section)
2. Hazardous materials incidents (see 3B, Environmental Compliance Activities)
3. Loss of Power - Generally, either standby power or portable generators are available for all key facilities. Generators are run under load once per month and for critical areas, twice per month.
4. Drought - The company has provisions for dealing with drought, including purchase of water from other suppliers, and complying with New Jersey and Delaware River Basin Commission and other agency directives in such situations.

A fifth area, although not an emergency situation *per se* for the company, is fires. All interviewees reported excellent relations with local fire companies. Areas of mutual cooperation include activities such as:

- Fire companies report to NJAWC on which hydrants are used, along with an estimate of the water used.
- Providing each fire company (or municipality) with distribution maps showing fire hydrants and main sizes.
- Letting fire departments know if a main is out of service.
- Annual meetings with fire chiefs.
- Providing hydrant flows, if requested.

Other Transmission and Distribution Considerations

New Jersey One Call System

Very basically, the NJ One Call System is a program to mark utility locations wherever work is planned in an area where utilities are likely to be found. The recently instituted program was discussed with several NJAWC staff. Generally, the feeling is that the program is a very good idea that works well, but that may sometimes be applied more aggressively than necessary. Similarly, there is a general sense that the program has resulted in fewer NJAWC lines being broken, but has

also resulted in the need to add more staff to manage the program. One operating center reported calls to mark over 1200 lines, which required the allocation of more than two people—one field person to mark locations and one to handle the associated paperwork. The two major criticisms of the program are the level down to which the program is carried and the level of fines. There is concern that some of the items now required to be marked are going too far and should be re-considered. For example, a simple buried meter tile now requires a mark-out by all other utilities. Main breaks also require a mark-out and lost time (and water) while waiting for the mark-outs. Previously, the Company would call the utilities directly and begin work immediately. Similarly, there is concern that One Call started as a non-financial program, but now carries heavy fines, and there is concern that the fines are disproportionate to the infraction. One example cited was a $2,000 fine where a line was marked incorrectly, but the mark-out was based on the best information available. Yet in another situation, the fine was $1,000 even though the line was marked correctly, but was still ripped out by the contractor. While several thousand events might occur in a year, one person estimated that 25 might result in some type of fine and that the total One Call fines to be paid by the Company in 1996 could be on the order of $50,000.

Customer complaints have also increased significantly due to the color marking requirements. In response, NJAWC has been using a marking paint that dissolves a few days after it is sprayed.

It would appear that the company should monitor this situation and, acting either independently or through an industry group such as the New Jersey section of the American Water Works Association, request modifications to the program.

Findings and Conclusions
(System Production, Transmission, and Distribution)

C3A-1 **With respect to system operations, planning, engineering and construction, the Company has done a good job of implementing the recommendations of the 1989 management audit.**

These recommendations included a project management system for the Tri-County project, implementation of a formal maintenance management program, and improved reporting of customer outages.

C3A-2 **All interviewees expressed a high level of confidence in the new organization and their roles in it, but it is too early to know whether fine-tuning may be required.**

The new organization and associated responsibilities are only just beginning, and the reorganization process should be monitored and evaluated for any corrections that may be required with respect to implementation, such as reporting relationships, authority and responsibility, communication, coordination, and the like.

It is possible that additional consolidation may be possible or that staff has been reduced too far in certain areas, and not enough in others. As a result, the overall impact should be monitored with respect to reporting relationships, authority and responsibility, communication, staffing needs, coordination and the like. In particular, there is some concern that Company engineering may be understaffed. This situation should be monitored on a continuing basis and staff added, if necessary.

C3A-3 **The organization structure of the Operating Centers appears to be top-heavy, with too many managers at the top and not enough people reporting directly to them.**

In general, there is both a Manager and an Operating Manager cooperating to supervise only two Superintendents (except that where a Manager is responsible for two locations, there is a second Operating Manager and two more Superintendents at the second location.) A very narrow span of control can often cause managers to micro-manage their

subordinates because they haven't enough work of their own to keep them busy. This is both inefficient and harmful to the development of their subordinates.

In defense of this arrangement, the Company explains that the Manager's responsibilities include an outward look toward the community, while the Operations Manager's duties are focused on internal management of the organization. Furthermore, the Operations Manager often fills in for an absent Superintendent, or for a Superintendent who is filling in for an absent subordinate. Nevertheless, that still leaves one-and-one-half managers supervising only two direct subordinates. Even a ratio of one manager to two subordinates is normally questionable.

It is important to note that the number of managers in the Operating Centers has actually decreased since the consolidation and reorganization of the Company, while the total span of hours of supervisory coverage has increased.

C3A-4 The Company supports union and non-union staff with a variety of technical training activities.

These activities include:

- Courses leading to water plant operation certification
- Industry short courses and seminars
- Vendor training
- Specialized training, *e.g.*, hazardous materials handling
- In-house seminars
- Trade or craft training

C3A-5 Union contracts have been negotiated in some operating centers, *e.g.*, Haddon Heights, that encourage staff to acquire or upgrade necessary skills, through training and with Company support, that will eventually strengthen technical capabilities and possibly lead to reduced costs in the future. This has not yet been accomplished in all operating centers, however.

Some of the operating centers have a much less dynamic contract in which personnel may have to be accepted in positions for which they are not suitably qualified, and this would seem to have a tendency to decrease the reliability of the Company's service to its customers.

We understand that since the conclusion of our interviews, contracts similar to that at Haddon Heights have been negotiated at all operating centers except Lakewood. This is to be commended.

C3A-6 **The Company has an effective maintenance management program, which includes a strong element of predictive maintenance. There is need for improvement in the feedback mechanism, however, which the Company anticipates addressing with the planned J. D. Edwards program.**

The Company has implemented a Work Management System (WMS), in which crew sizes have been optimized, and tasks and associated completion times have been identified. Work is scheduled and monitored by supervisors. There is a work order system. However, the feedback mechanism at present is cumbersome and difficult to work with in terms of upgrading workforce productivity and management control. The Company anticipates the J. D. Edwards program will address these issues and permit much more effective use of feedback data.

The operating centers collect a wide variety of essentially the same data but in different formats. A committee is reviewing these forms with the objective of developing uniform forms and reporting formats for all operating centers. The J. D. Edwards program is anticipated to result in substantial productivity gains in the field. This effort should be monitored to document any such gains.

C3A-7 **Production and purification costs per million gallons of water are significantly higher than those of roughly comparable water companies, including two in New Jersey, although there may be valid reasons for the higher costs. Transmission and distribution costs per mile of main, however, tend to be significantly lower than the comparable utilities.**

C3A-8 **First line supervisors have what seems to be an unnecessarily low limit of $300 on purchase orders before requiring higher approval.**

While many items needed are likely to be in stock, it would seem that $300 is relatively low, considering present material and equipment costs, and consideration should be given to raising this limit.

C3A-9 The Company has done an excellent job with respect to pursuing cost savings in energy management and residuals management.

The energy and residuals management programs have resulted in significant savings. The residuals management program holds additional potential, and the responsible staff should be encouraged to pursue their work in this area.

C3A-10 Cross-connection education (of customers) and control is presently not a high priority of the Company.

Cross-connections are recognized as a potential problem by the Company, but at present, there is not an aggressive program to educate customers to recognize and control these.

C3A-11 The Company has a variety of policies, procedures, WMS schedules, vendor O&M manuals, personal experience, etc., that relate to operation and maintenance of the system, but these procedures don't always agree with each other.

There is a need to review, revise and upgrade these documents.

C3A-12 The Company has been effective in upgrading the deficiencies of acquired companies.

Water systems acquired by the Company frequently lack adequate records, are deficient in maintenance and have undersized mains. A key Company objective in these acquisitions is to bring the acquired system up to NJAWC standards. The Company should be encouraged to continue in these efforts.

C3A-13 For transmission and distribution piping, there is no formal risk analysis or predictive analysis, based on break history and other information relevant to decisions to repair or replace pipe. These decisions appear to be based more on individuals' subjective judgments than specific replacement or repair criteria.

With the extensive amount of pipe in its system, the Company should consider implementing a risk based program to aid in making repair or replace decisions. If such a program is found to have merit, perhaps the

development and implementation costs could be shared with other water utilities, either in the American system or in New Jersey.

C3A-14 The Company has effective emergency procedures to deal with situations commonly found in water utilities.

The Company's emergency procedures encompass water main breaks, hazardous materials incidents, loss of power, drought and cooperation with local fire companies and are appropriate and adequate.

C3A-15 The Company has complied with the New Jersey One Call System requirements, but those requirements may have been applied too aggressively in some cases.

While there was support for the One Call program, there was also concern about the level down to which the program is carried and the level of fines, *i.e.*, are they appropriate to the situation?

Recommendations

(System Production, Transmission, and Distribution)

R3A-1 Review the organization structure of the Operating Centers to determine if the span of control can be increased. (Refer to Conclusion C3A-3.)

Consider expanded cross-training, retraining, job enlargement, and other opportunities.

R3A-2 Strengthen the feedback mechanism for the Work Management System (WMS) to support quick, easy and accurate information to upgrade workforce productivity and management control. (Refer to Conclusion C3A-6.)

Improvement in feedback would generally result in more efficiency in the area of scheduling work and crews.

Management is aware of the feedback situation, and it is anticipated the J. D. Edwards system will make a significant improvement in this area. If

the J. D. Edwards system is delayed or does not work as projected, an alternative means should be found to provide the necessary feedback.

R3A-3 Raise the limit on purchase orders that may be signed by first line supervisors, probably to $1,000.00. (Refer to Conclusion C3A-8.)

Although many needed items are in inventory, the present $300.00 limit seems low in light of current material and equipment costs, and raising it to some higher figure seems justified and would eliminate some minor "red tape."

R3A-4 Give increased support to cross connection control and related customer education. (Refer to Conclusion C3A-10.)

The Company has an excellent water quality program in terms of producing water and is conducting significant research into water quality in the distribution system. However, while there is some cross-connection control work, it appears this could be a weak link, at the customer end, in an otherwise excellent program. A cross-connection control program, particularly oriented to sources of higher risk commercial customers. *e.g.*, funeral homes, should be implemented.

R3A-5 Implement a formalized risk analysis program to aid in the repair or replace decision for transmission and distribution pipe. (Refer to Conclusion C3A-13.)

Repair or replace decisions for pipe seem to be made more on the basis of personal experience and "methodology" than on any more formalized basis. The Company should review available technology for risk-based evaluation of pipelines using factors such as age, type of pipe, history of breaks, and similar data to determine if there is a cost-effective advantage in implementing such a system.

3B System Operation and Maintenance

This section addresses additional issues related to operation and maintenance of the NJAWC system.

Meter Shop Operations

Meter shop operations include testing and repair operations. With the relatively expensive cost to repair a meter, particularly residential meters, versus the cost of a new meter, the emphasis of the meter shop is on testing rather than repair. Previously, meter shop functions were performed in all operating centers. This function has recently been consolidated in a modern, well-equipped meter shop at Lakewood.

The meter shop staff consists of three people—a Meter Shop Clerk who basically provides administrative support, but who can also test the smaller meters, and two Meter Tester/Repairers who work primarily on meter testing, as opposed to repair. Before consolidation, eight people were involved with meter testing and repair. Lakewood staff noted that a fourth person could likely be justified based on the workload that is being experienced. The meter shop staff are union and are generally experienced in their work. They received training from the current meter supplier, Schlumberger, regarding testing and repair of Schlumberger meters.

The meter shop is equipped to test up to 8-inch meters. While testing of small meters is essentially a one-person operation, large meter testing can require up to three people to set a meter and operate the various controls and valves. Automation at the Lakewood facility has reduced this to essentially a one-person operation, with perhaps occasional help from a second person. The New Jersey State Department of Weights and Measures certifies as to the accuracy of the testing equipment used at Lakewood. Although the state's requirement calls for certification on a two-year cycle, at NJAWC's request, the state certifies the test equipment annually.

In addition to the main shop, NJAWC maintains a meter test bench at each operating center, including Lakewood, for customer meter verification. If a customer questions the accuracy of their meter, this arrangement allows the customer to witness the test of his/her meter directly at a location near his/her service location.

The Meter Shop Clerk's data entry for meter check-in allows meter data to be automatically categorized by BPU reporting categories, e.g., periodic test, frozen meter, customer complaint, stopped, leaking, new, etc.

With the meter shop consolidation, it was found there was a significant amount of administrative and "paperwork" to be done, and the present Lakewood Operations Manager therefore conceived of and researched bar coding as a way to increase productivity and to increase efficiency and reliability. It was found that bar coding could be done relatively inexpensively and simply, and the process was therefore implemented. The bar code label records meter make, size, and serial number. Bar coding allows data entry to proceed much more efficiently and allows the processing of much more information related to meter operation.

In addition, there are significantly fewer errors because it is no longer necessary to type 8 or 10 digit numbers repetitiously to get the same information as provided by the bar coding system. It was noted there is some small number of customers who may try to peel the bar code off, but each meter also has its serial number that can be used to track it, if necessary.

In response to a question concerning whether there is ever evidence of tampering with a meter, *i.e.*, theft of service, it was indicated there is no program to deal with this.

Generally, the majority of meters are accurate, even at the end of their 10-year cycle. Test accuracy failure is less than four percent of meters (and some of these are under readings). However, this "four percent" is based on a stricter current standard than the standard in effect when many of the meters were first installed. The current standard is +/- 1.5% (between 98.5% and 101.5%). The key point here is that the meters essentially read as accurately as ever, but the standards have changed. This continued accuracy would tend to support a meter changeout cycle of 15 years, rather than the current 10-year cycle.

In further support of a 15-year meter cycle, NJAWC constructed a mock-up to simulate typical house use over a 15-year period. The mock-up consists of a series of solenoid controlled valves which regulate flows to create the simulated residential use at different flows. The mock-up when through 1,500,000 gallons of water to represent 15 years of typical residential use at 100,000 gallons per year. Meter accuracy was maintained, and the data collected is being reviewed and organized by Engineering for presentation. The potential savings to NJAWC customers is estimated to be on the order of $1,000,000 per year, in current dollars, if the 15-year cycle is adopted.

Meter sizing for commercial and other non-residential customers is done by operating center staff with assistance from Engineering.

Some additional advantages of the meter shop consolidation are: 1) there are fewer meters in inventory; and 2) NJAWC orders fewer meters at one time, but on a more frequent basis (i.e., 5,000 meters per month versus perhaps 12,000 meters per quarter when all four operating centers each had a meter shop).

If was noted that copper for meter installations is ordered directly from the manufacturers, which results in an estimated savings of over $100,000 per year.

There is a meter quality control program. A group of meters has been identified and are pulled each year for an ongoing accuracy test to verify the continuing reliability of the meters.

Accuracy and Adequacy of Performance Records

Whether O&M performance is improving or declining in recent years and whether there are opportunities for improvement are topics that were discussed under "Maintenance Management" of Section 3A. In addition, it was noted that record-keeping and reporting requirements imposed by regulatory agencies, such as the N. J. Department of Environmental Protection (NJDEP) and the U. S. Environmental Protection Agency, has grown significantly in recent years and are expected to continue to grow. An example of this is the Information Collection Rule, discussed in the "Research and Development Function" in Section 3C. Also, see the "NJDEP Perspective of the Company" discussion at the end of this section. The performance

of NJAWC with regard to record-keeping and utilization of this information exceeds that of the water supply industry.

The subject of analyzing problems and their probable cause was discussed under "Performance of the Operations and Maintenance Functions" in 3A, Transmission and Distribution. The same comments concerning problem analysis and resolution also apply to the Production Department, especially for more routine activities, *e.g.*, filter maintenance, pump maintenance, chemical feeders, etc. Concerning unique problems, such as source water quality issues, the "Research and Development Function" in 3C discusses this subject.

With regard to questions such as cleanliness, operational enhancements, passing information from shift to shift, routine maintenance, housekeeping, and disciplined, proactive maintenance program, the answer is that there is a very effective, comprehensive program that exhibits a high level of pride and professionalism. This Chapter 3 has referred to numerous policies, procedures, reports, WMS schedules and related documents that mandate such an approach. A variety of older and new facilities were visited in each operating center of NJAWC. They were very well maintained and housekeeping was immaculate. Even at the Canoe Brook water plant, which is one of the oldest plants and which was visited immediately following a flood, it was obvious that the facility was very well cared for. Such an effort is achieved not simply through policies and procedures, but by a staff who take pride in their work.

The remainder of the issues in this section were addressed in Section 3A, System Production, under: "Organization and Procedures," "Training and Staffing," "Maintenance Scheduling and Staffing and Preventive Maintenance Programs," "Maintenance Planning," and "Maintenance Management."

NJDEP Perspective on the Company

A meeting was requested with senior NJDEP management personnel to gain their perspective on NJAWC with respect to issues such as overall compliance with DEP regulations, responsiveness and cooperation, level of water quality complaints, and how NJAWC compares with other NJ water utilities. Their comments can be summarized as follows:

- No other system comes close to magnitude of diversity of system and size, yet their compliance record is "very, very good," especially in light of this diversity and size.
- Company is very responsive to NJDEP requests.
- Company is very responsive to customer complaints, especially considering its size.
- NJAWC is clearly above average compared to other investor-owned water utilities and is well above average compared to municipal water systems.
- There is a broad social benefit from programs undertaken by NJAWC/AWS. One key benefit is the research program of NJAWC/AWS. This program is on the forefront of new water issues and has been a huge resource to NJDEP. There have been several joint projects of mutual benefit where NJDEP is looking at NJ water systems and AWS is looking at its systems nationally. One such area was evaluation of giardia and cryptosporidium, which are microbial water-borne diseases.
- NJDEP has been able to conduct some training programs for its staff at NJAWC facilities; *e.g.*, operational experience on the pilot plant at Swimming River.
- NJAWC has been beneficial to the DEP and to New Jersey's environmental goals; *e.g.*
  - source water protection leadership, including wellhead protection.
  - work with individual counties to provide assistance on household hazardous waste collection days.

In summary, NJAWC is considered to be a "good, forthright aggressive company that is technically a leader and above average."

Title 14. Board of Public Utilities - Chapter 9, Sewer and Water

This section reviews the Company's compliance with Title 14. Board of Public Utilities - Chapter 9, Sewer and Water, as related to operations and construction activities.

With regard to 14:9-11, Plant Construction, it would appear that based on reviewing Company policies and procedures, interviews, visits to a number of facilities, and meeting with NJDEP (see above), the Company complies with this requirement. In

connection with 14:9-12, Inspection of Property, the Company has a dedicated program for valve and hydrant testing and main flushing. However, the programs within different operating centers may not be consistent with each other or with Title 14. For example, one interviewee stated that valves 12-inch or smaller are inspected every five years and 16-inch or larger, every two years. (Title 14 calls for 12-inch and over to be inspected once every two years and other valves once every four years.)

It also appears that the Company provides adequate pressure and volume, in particular for fire hydrants. (See "Emergency Procedures.")

The meter operations appear to be in compliance with Title 14 requirements.

Environmental Compliance Activities

Within roughly the past 15 years, a number of federal and New Jersey environmental laws and regulations have been enacted which may have impacts varying from highly significant to relatively minor on the activities and operations of the NJAWC. As a result, the parent company, the American Water System, developed a policy concerning Environmental Audits, which was approved by the Board of Directors in September 1993. The policy states that "The American Water System is resolved to conduct business in a manner that complies with environmental laws and regulations." The policy requires:

- That an Environmental Audit be conducted for each operating center at least every three years,
- That all applicable environmental laws and regulations be identified along with an evaluation of the operating company's compliance with these.
- That a written report on the audit be prepared, and
- That progress reports on the audit report recommendations be submitted annually to senior management until all recommendations have been implemented.

The initial environmental audit activity was begun by a person from the Service Company Water Quality Department. This initial phase was intended to provide an overview of the environmental compliance situation and included an inspection of related NJAWC facilities and a brief report on the findings.

The second phase of the environmental audit was conducted by NJAWC's Director of Corporate Compliance, who also has a degree in engineering. This second phase identified applicable federal and New Jersey environmental laws and regulations and evaluated how these would affect NJAWC facilities. The NJAWC Environmental Regulations Compliance Audit is dated December 7, 1995. The applicable laws and regulations, per the audit report, are:

- Safe Drinking Water Act
- Clean Water Act/Water Pollution Control Act
  - Wastewater Discharges
  - Storm Water Discharges
- Spill Compensation and Control Act
- Petroleum Product and Hazardous Substance Storage Tanks
  - Underground Storage Tanks
  - Above Ground Storage Tanks
- Solid and Hazardous Waste
- Clean Air Act/Air Pollution Control Act
- Freshwater Wetlands
- Flood Hazard Area Control Act
- Toxic Substances Control Act
- Toxic Catastrophic Prevention Act
- Community Right-To-Know Act

All NJAWC facilities were then evaluated with respect to the above laws and regulations. Activities associated with the audit included:

1. Site visits to selected NJAWC facilities, including treatment plants, distribution and commercial department garages, and maintenance shops, reservoirs and locations with chemicals or petroleum products on site;
2. Interviews with certain NJAWC management personnel and operating personnel concerning operating procedures and conditions of facilities;
3. Review of NJAWC files, operating records and permits associated with environmental compliance; and
4. Review of applicable environmental statues and regulations and evaluation of existing facilities and operating practices.

The results of the environmental compliance audit indicated that the NJAWC facilities were generally well in compliance with the various laws and regulations. The issues that were identified were of a relatively minor nature and were scheduled to be addressed for compliance or corrections. In many cases these issued were administrative in nature; *e.g.*, "closing the loop with respect to notifications;" "paperwork;" and similar activities.

In many cases, the activity to be addressed is basically a determination of the regulatory statutes of an item and, if necessary, then complying with the appropriate requirements; *e.g.*, status of certain underground storage tanks, which may have been part of a water system acquired by NJAWC.

Certain of the audits findings applied across the NJAWC system, such as determination of the statutes of compliance with local Industrial Pretreatment Programs where wastewater is discharged to the local sewer system. With respect to this item, in most, if not all cases, it is anticipated that these discharges will be found to be a "nonproblem" in the Industrial Pretreatment Programs. Other findings applied to specific facilities of the NJAWC system.

All findings of the audit are scheduled for follow-up and compliance with the intention that all action items found as a result of these audits will be completed before the next scheduled environmental compliance audit.

Responsibility for action items has been assigned to the NJAWC Vice Presidents for Operations and Engineering and the Director of Corporate Compliance.

In contrast to the AWS policy, which requires only an annual progress report on compliance issues, NJAWC prepares a quarterly progress report on the status of compliance work to be done.

The Director of Corporate Compliance is responsible for tracking the internal environmental compliance program as a whole as well as monitoring federal and New Jersey legislation and regulatory rule-making for new compliance requirements.

Hazardous Material Incident Plan

A Hazardous Material Incident Plan, dated March 1996, has also been prepared for NJAWC. The original draft was written by a consultant but was found not to be very useful in the field. The Director of Corporate Compliance redrafted the plan for field use and all operations units have access to it. In addition, there was a one-half day seminar for senior staff on the importance of how to deal with hazardous material incidents. The seminar provided information from both the legal and environmental perspectives and provided information on items such as these are the types of problems to expect, how to handle the problems, when to report it, etc. The seminar also included some role-playing related to hazardous material incidents.

There have been some minor events where the plan has been called into use. A typical event is a minor spill that may occur when a chemical supplier is transferring chemical from a vendor truck to an NJAWC storage tank. The company has used these incidents in a positive way to reinforce with its vendors the necessity for strict precautions in chemical handling situations.

Discussions with operating center personnel at various levels indicated that they were, indeed, familiar with the requirements for hazardous spill containment and on a few occasions their personnel had to address some minor items. As noted, staff members have had relevant training, understand reporting requirements and know they have authority to take initial action. Each service vehicle is equipped with certain basic equipment; *e.g.*, absorbent pads, to initiate a rapid response to problems such as minor spills or leaks. In addition, containment areas have been constructed for each chemical storage tank. For example, at the Delran water treatment plant the containment areas can hold the full contents of a tank, there is a sump in which to place a pump and have overhead discharge lines connecting to a containment vault. Also, at Delran, methane detectors and vents have been installed to monitor fugitive gas from a nearly landfill.

Hazardous Waste Materials

NJAWC does not produce hazardous waste as such. There are some distribution materials; *i.e.*, asbestos cement pipe and lead pipe jointing materials and lead services, that are allowed to continue in use, but, if retired from service, need to be removed and disposed of in accordance with Resource Conservation and Recovery

Act (SWWA) requirements. The quantities of asbestos and lead materials that are retired are relatively small in amount and applicable regulations have been followed. There are specific procedures for these items. Services and Meters Procedure No. 5, Elimination of Lead Services, and Distribution Procedure No. 18, Asbestos Cement Pipe—Work Procedures. Some mercury has also been found from discarded monitoring instruments. This was disposed of by a hazardous waste contractor.

Treatment residuals from the Aberdeen, Jumping Brook and Swimming River Treatment Plants are hauled by a contractor and disposed of at the Monmouth County Reclamation Landfill in accordance with NJ DEP regulations. Residuals from the Jumping Brook and Swimming River Water Treatment Plants are also permitted by NJ DEP to be land-applied on NJAWC property at the Glendola Reservoir.

NJAWC is also an NJ DEP registered solid waste transporter for domestic sludge resulting from maintenance and repair activities at the Lakewood and Ocean City sewer system. Sludge from Ocean City is disposed of at the Woodbine Landfill in Cape May County. Sludge from Lakewood is disposed of at the Camden County Municipal Utilities Authority treatment plant. All disposal is done in accordance with the approval of the respective disposal sites.

One site was also identified near Well C at the Short Hills Station where unauthorized trash was being dumped by unknown parties. NJAWC plans to clean up and fence this site to prevent further dumping here.

There are a variety of other miscellaneous items that were identified as needing attention. These include:

- relocating soil stockpiling from the Balusrol Well Station to avoid encroachment on wetlands.
- determining whether backstop materials from a former pistol range must be managed as a hazardous waste. The materials include lead and creosote-coated timbers.
- Millburn Township has an NJ DEP permit to operate a leaf-composting operation at NJAWC's Canoe Brook Reservoir. NJAWC has begun monitoring the Township's compliance with this permit's requirements.

Findings and Conclusions
(System Operation and Maintenance)

C3B-1 The current pilot project to evaluate a 15-year life cycle for meters appears to have merit and represents considerable potential savings for customers.

Adopting a 15-year life cycle for a customer meter has the potential to save on the order of $1,000,000 per year in meter costs without sacrificing meter accuracy. This program should continue to be developed and be presented to the BPU for approval. Converting to a 15-year cycle could also likely eliminate the need for an additional person at the meter shop.

The disadvantage of increasing the life cycle is that the change-out to newer-technology meters, including those equipped for automatic meter reading, would be delayed.

C3B-2 The Lakewood meter shop is well-equipped and well-organized, and has resulted in a significant staff reduction. The staff may now be under-sized, however.

There may be a need for at least one more person, especially if the meter changeover cycle is not increased from 10 to 15 years.

C3B-3 Meters for larger applications must be individually sized because no manual or policy exists for sizing them.

Some staff time could be reduced if a manual or policy were available to readily size larger meters.

C3B-4 Senior administration in NJDEP considers the Company to be very responsive, cooperative and a leader in New Jersey.

In summary, NJDEP considers the Company's compliance record to be "very, very good," especially in light of its size and geographic diversity. The Company is very responsive to NJDEP requests; very responsive to customer complaints; clearly above average to other investor-owned water companies; provides broad social benefits, especially through its

research program; and has provided a leadership role in source protection.

C3B-5 Overall, the Company is in compliance with NJ Administrative Code Title 14. Board of Public Utilities - Chapter 9, Water and Sewer.

While the Company is essentially in compliance with the items related to operations, engineering and construction, it appears there may be some inconsistency among operating centers and lack of strict compliance on the question of valve inspections. This relates to the size and scheduled cycle of inspection for valves. Title 14 calls for 12-inch and over valves to be inspected once every two years and other valves once every four years. One interviewee stated that valves 12-inch and smaller are inspected every five years and 16-inch and over every two years. This situation should be checked and, if necessary, all operating centers be brought into compliance with Title 14 for valve inspection.

C3B-6 The initial environmental regulatory compliance audit has been very well prepared, although some minor environmental compliance issues still exist.

The initial audit identified and reviewed all applicable environmental laws and regulations as pertains to the Company. A review of each specific facility in the NJAWC system was also undertaken in light of these laws and regulations.

The Company's facilities were largely found to be in compliance with the various laws and regulations. The issues to be resolved were generally minor in nature. In many cases, this includes determining or confirming the current status of certain facilities, particularly underground storage tanks in water systems acquired by the Company. Similarly, completing the necessary documentation for selected facilities is also necessary.

C3B-7 The Company has an aggressive, ongoing program of environmental compliance, and the operating center staff at various levels are aware of the importance of environmental regulatory compliance and hazardous materials management.

A progress report related to environmental audit recommendations is prepared quarterly. This report describes the recommended item, identifies who is responsible for implementation, and provides the status or comments on that item. Staff are trained, certain vehicles are equipped for immediate measures, and facilities are constructed to deal with a variety of environmental issues.

Recommendations
(System Operation and Maintenance)

R3B-1 Convert customer meter change-out from a 10-year life cycle to a 15-year life cycle, except for problem meters such as inside meters that lack an outside register, and other non-encoding meters if that is determined to be an economic decision. (Refer to Conclusion C3B-1.)

This change will save $1,000,000 per year and might eliminate the need for an additional meter shop person. The cost advantages must be weighed against the meter-reading disadvantages that would result from a slow-down of the changeover to new meters equipped for gun or automatic reading.

Each meter change-out costs about $91 ($55 for the new meter + $30–35 for labor + $3–4 transportation). If the 330,000 meters are replaced every 15 years instead of every 10 years, then the annual number of replacements will be reduced from 33,000 to 22,000. The reduction of 11,000 change-outs each year times $91 equals an annual savings of $1,000,000.

If the cycle were abruptly extended from ten years to fifteen, then there would be, at least in theory, five years with no replacements followed by ten years with the present rate of replacements, followed by another five years with no replacements, etc. To avoid this irregularity, the cycle should be gradually extended from ten to fifteen years over a period of about fifteen years—so that each year the cycle extends by four months. In

fifteen years, meters that were installed today will then be coming due for change-out.

This can be accomplished by reducing the rate of changeout immediately by one-third, so that eight months worth of meters are replaced each year. This yields the reduction of 11,000 change-outs per year. The actual change in the change-out schedule need not follow the theoretical model exactly, of course, because the age distribution of existing meters is probably not uniform from zero to ten years, and for other pragmatic reasons.

Since meters exhibit no tendency to fail at ten years of life, the near-term change-out priorities can be revised to emphasize the replacement of inside meters regardless of age.

Coordination with the BPU Engineering staff will be required, because current BPU regulations would require a test at ten years in order to extend the life.

R3B-2 Review the need for one additional person at the meter shop, especially if the 10-year meter change-over cycle continues. (Refer to Conclusion C3B-2.)

Coordinate this review with the review of meter life cycle, because an extension of the life cycle would reduce the need for more personnel.

R3B-3 Develop a policy, manual, or other guide for the sizing of large meters. (Refer to Conclusion C3B-3.)

R3B-4 Review the valve inspection program in all operating centers to assure compliance with Title 14. (Refer to Conclusion C3B-5.)

The valve inspection schedule does not appear to be consistent across all operating centers or with the Title 14 requirements. This should be reviewed as quickly as possible and, if necessary, be set on uniform schedules and be brought into compliance with Title 14.

3C System Reliability and Planning

This section evaluates NJAWC's (1) demand forecasting, (2) system planning and design, (3) quality assurance, and (4) research and development.

As the planning, engineering, and construction functions of many water utilities, including NJAWC, are very closely inter-linked, the introduction to this Section will address the construction as well as the planning and engineering organization at NJAWC. This section will then concentrate on the planning and engineering aspects and Section 3D will address construction activities.

Introduction to NJAWC Planning, Engineering and Construction Organization

NJAWC serves on the order of 315,000 customers (or about one-fifth of New Jersey's population) over a wide geographic area of the state and has an average daily production on the order of 130 million gallons per day (mgd). The construction budget for the past three years totaled about $264,000,000 and projected projects for the next three years total about $201,000,000.

As a result, planning, engineering, and construction are key activities within the Company to expand, upgrade, and improve the physical facilities to serve these customers. These physical facilities include, but are not limited to, pipelines, wells, water treatment plants, pumping stations, storage tanks, and related facilities.

There are essentially four groups that play a role in the planning, engineering, and construction process in NJAWC. These include:

- NJAWC Engineering Department
- American Water Works Service Company (AWS) System Engineering Department
- Operating Center Staff
- Consultants and Contractors

NJAWC Engineering Department

The NJAWC Engineering Department consists of a Vice President-Engineering, an Engineering Manager, and five staff engineers, all of which are located in Haddon Heights. As has the rest of NJAWC, the Engineering Department has participated in the restructuring and centralization of its functions. Previously, Engineering had a staff of sixteen people who were located in all operating centers. As noted above, the staff has been reduced to seven people, with the closing of the engineering offices in Short Hills and Linwood.

While NJAWC engineering staff will have some involvement with all engineering projects of the Company, the lead responsibility for overall project management for major projects lies with AWC System Engineering. NJAWC will take lead responsibility for small scale (both in complexity and cost) projects. Projects typically managed completely by NJAWC for engineering and construction have a construction value of $300,000 to $500,000. Typical of these projects are maintenance of steel tanks, minor pipelines, small booster stations, small well projects and some storage tanks and pump stations. On major projects, the NJAWC staff serve as a resource to System Engineering with respect to local issues, coordinating with local planning agencies, and leading the effort to acquire all required permits.

NJAWC Engineering also prepares designs for and manages certain aspects of construction for development projects which will be incorporated into the NJAWC system. In these situations, NJAWC will provide materials, pre-qualify developer contractors, bid installation, and inspect (or have a consultant inspect) the construction.

AWS Systems Engineering Department

System Engineering is a component of the American Water Works Service Company and is located at AWS headquarters in Voorhees, New Jersey. While System Engineering is not structurally a part of NJAWC, it serves in a full-service engineering capacity for NJAWC, as well as for the other operating companies of the American Water Works system. System Engineering's specific activities are concentrated in four principal areas:

- Preparation of the Comprehensive Planning Study
- Project Management of Major Engineering Projects

- Construction Management of Major Projects
- Miscellaneous support to the operating companies

Within System Engineering there are three functional groups providing these services and which report to the AWS Vice President of Engineering. These three groups are:

- Planning
- Design
- Construction

Each of these groups is led by a Director and total Systems Engineering staffing averages on the order of 35 to 40 people. System Engineering undertakes about 70 to 80 projects per year across all the operating companies in the American Water Works System. The entire AWS construction budget has been running about $325 million per year and about half of this is managed by Systems Engineering. As a result, the Systems Engineering staff is exposed to larger and more complex projects on an on-going basis and is able to develop more expertise in these areas. For example, whereas an individual operating Company may be involved with a major water treatment project only infrequently, Systems Engineering may be involved with five or six such water plant projects every year.

With such a large volume of work, one question to be considered is why not expand System Engineering's staff? It was noted that, to accomplish this, the staff would have had to double or triple in size in a very short period of time. From a management standpoint, it would be difficult to absorb so many people at once and at the same time maintain a high standard of quality and production and meet regulatory deadlines. A significant amount of work has been a result of Safe Drinking Water Act requirements; once this work is completed, the level of new construction is expected to decrease. In addition, since much of the work needs to conform to local conditions, *e.g.*, local municipal ordinances, state regulatory requirements, etc., local consultants who have a daily working relationship in the area of a specific project are much better able to provide this expertise. The AWS also benefits from the ideas resulting from use of a variety of consultants.

Planning: The planning staff (at the time of the interview) includes a Director of Planning, six planning engineers, 2 technicians, 6 planning engineers, 2 technicians, and a coop student. The focus of this group's efforts is on long-term capital needs

and their principal product is the Comprehensive Planning Study (CPS). The CPS has a 15-year time horizon, but incorporates shorter term needs as well. The CPS addresses likely future needs based on supply and demand forecasts, needs due to regulatory requirements, and improvements to existing facilities.

Design: This group presently consists of a Director and Assistant Director of Design, nine project engineers and four drafters. The staff represents most of the key engineering disciplines needed for water supply projects, including civil, structural, and electrical (power, and instrumentation and control) engineering. The design group's primary areas of responsibility include:

- In-house engineering design, primarily for smaller projects
- Project planning and management when outside consultants are retained, primarily on larger projects
- Monitoring of engineering issues of current interest in drinking water
- Development and maintenance of engineering standards
- Acting as a technical resource to the engineering groups in the individual operating companies

Each project engineer handles about three major projects per year in addition to providing his/her technical support to other projects. Until about the mid-1980s, almost all engineering was done in-house by the design group. Due to a variety of events that significantly increased the consulting workload, including the requirements of the Safe Drinking Water Act (and its various amendments), almost all major projects are now done by consultants. Under the present scenario, the design group is primarily responsible for developing project concepts and managing the overall project, including the consultants' work. The project breakpoint is in the $40,000 range. That is, projects under this amount are more likely to be done in-house by the design group, while projects over this amount are more likely to be done by consultants.

Construction: The Construction group, at the time of the interviews, consists of a Director, seven construction engineers, and three full-time construction inspectors. As workload fluctuates, the in-house construction staff is supplemented both with personnel from consulting firms and with contract employees. The Construction group's major responsibility is the planning, execution, and cost control of the construction effort.

Within the Construction group, the construction engineers have primary responsibility for overseeing the bid preparation and selection process. They are also responsible for general management of the construction effort, which includes reviewing all field reports, maintaining contract integrity, approving all bills, and troubleshooting. Typically, construction managers are engaged in several projects at a time.

Unlike the construction engineers, the inspectors are assigned on-site to one project at a time. The inspector monitors work progress, maintains the daily contact with the contractor's on-site representative, ensures that the contractor is delivering the specified product and quality, and prepares daily and weekly field reports. The inspector has authority to stop all work on a job when necessary.

NJAWC Operating Center Staff

The operating center staff is also strongly involved in the planning, design and construction process. From a planning perspective, staff members provide field support and information for the Comprehensive Planning Studies, as well as the 1 and 5 year planning programs, discuss development of the plans while they are under development, and have an opportunity to review the draft plans. During design, work is coordinated with NJAWC and Systems engineering staffs, *e.g.*, planned outages, size of pipe, problem areas, coordination with local officials, etc. During construction, especially for pipeline projects, the operating centers provide the construction inspectors. Also minor construction such as main breaks and repair or replacement of existing services are operating center responsibilities.

Consultants and Contractors

Consultants and contractors are also an integral part of the engineering and construction process of NJAWC. Both the NJAWC and AWS engineering programs use consultants for larger projects (as defined by each group). There is a pre-qualification and competitive selection process for consultants (see later section for more details on this) via a Request for Proposal (RFP) process. The firm with the lowest priced proposal is usually, but not necessarily, the selected firm.

Almost all construction is done by contractors. Only relatively minor work such as certain emergency main break repairs, work on existing laterals, etc. is carried out by NJAWC field services staff. Similar to consultant selection, construction firms are

also subject to a pre-qualification screening process followed by competitive bidding. Design-build concepts and partnering concepts have also been used in selected situations. Projects where there is a difficult retrofit situation, specialty work, or where the work needs to be done quickly are typical candidates for a design/build approach.

System Planning and Design

While several items under this subject were incorporated in earlier sections, in particular in Section 3A under "Transmission and Distribution," some additional comments are added here. With regard to procedures and practices to ensure safe, reliable, and efficient distribution, NJAWC has some key activities that accomplish this. These are summarized as follows:

- A program to selectively replace small mains with 8-inch lines (this provides better flow for peak demands, fires, etc., provides better pressures, helps with water quality) and to add fire hydrants and valves, if necessary. This is particularly an issue with newly acquired systems.
- A dedicated leak survey and repair program.
- Good working relationships with local fire companies.
- Good working drawings of the distribution system.
- On call staff to repair main breaks
- A dedicated program of preventive maintenance for valves and fire hydrants, as well as predictive maintenance for (booster) pumps in the distribution system.
- A work management system to enhance and monitor productivity.
- A program to minimize disruption to customers affected by outages.

Parallel efforts are conducted for the sewer service areas.

The Role of Management in Overall System Planning and Design

The NJAWC has clearly articulated short and long term goals and objectives which derive from its primary mission as a water supplier, and to a lesser extent, sewer service. These are developed in a planning and implementation process which encompasses three time horizons of 1, 5, and 15 years. From interviews with various levels of management ranging from first line supervisors to vice presidents, it is

clear that there is generally an excellent understanding of and participation in the planning and design process. There were some isolated concerns, however, in which operations staff may not always see the larger picture from a planning perspective. The concerns of items such as effective methodology for identifying strategic and operational alternatives, evaluation criteria to judge planning objectives, the ability to monitor and adjust plans in response to changing conditions are discussed at length in the rest of Section 3C, as well as parts of Section 3D.

System Planning and Design Organization

As described above, each of the NJAWC and AWS System Engineering groups has a clearly defined mission and each group clearly understands its role in the planning and design and related operational functions. Each group also clearly understands the mission of the other groups as well as the relationship among the various groups and the purpose of the three planning horizons as discussed in the next section. There are definitely appropriate levels of responsibility and authority within each group to carry out its assigned mission.

The planning and design organization is complete with respect to the required functions of such an organization, including management and technical staff with strong water systems planning and design capability. Sound management practices are followed with appropriate organizational layers, spans of control and management titles. There are no apparent redundant or unnecessary functions. The system planning and design organization is adequately staffed with numbers of employees, technical skills, and experience. As described above, most of the technical needs are in the civil and related engineering disciplines and these are well represented in the NJAWC/AWS organization. However, other necessary disciplines such as structural, electrical, and instrumentation are also represented. With regard to staffing, the NJAWC engineering staff has been significantly reduced with the recent Company-wide downsizing, and the staff loads and Company engineering needs should be monitored over the near term to see if possibly some staffing increase is warranted as the new centralized approach gets more experience.

System Planning Process

Planning occurs at several levels for NJAWC and has three primary time horizons. The organizational elements primarily directly responsible for planning include the

four operating centers, NJAWC engineering, and AWS Systems Engineering's planning group. The NJAWC has well articulated short and long-term goals and objectives that are well described in the three planning time horizons, which are 1, 5, and 15 years, and which are associated with the annual investment budget, the Five Year Capital Budget Plan, and the Comprehensive Planning Study (CPS), respectively.

The NJAWC has established an effective methodology for identifying operational alternatives that are consistent with corporate goals and objectives, including the key one of providing "safe, adequate, and reliable service to its customers...." A review of various plans indicates that these plans are based upon a solid understanding of current and market conditions, issues, trends, and uncertainties.

The alternatives are evaluated and selected based on a variety of criteria and through the three-level planning process there is clearly a mechanism to evaluate and adjust projects on a continuing basis. For projects with a smaller value, the operating staff appear to be well-aware of their budget status and are prepared to revise (or to recommend revisions to higher management, if warranted) to project scheduling consistent with meeting the key goal of providing a high level of service.

Various levels of management and staff are involved in the planning and implementation process. As plans are developed, they are also reviewed at several levels of management, with the Board of Directors having final approval over the projects finally recommended for implementation.

The NJAWC system planning process is discussed in the following sections.

Comprehensive Planning Study (CPS):

The CPS is the major component in the planning process and is the basic driver for identifying and implementing major capital improvements for NJAWC. The stated purpose of the CPS process is to recommend the capital improvements necessary to enable NJAWC to continue to provide safe, adequate, and reliable service to its customers in order to meet their domestic, commercial, industrial, and for fire protection needs.[1]

[1]New Jersey-American Water Company, Monmouth County Service Area, Comprehensive Planning Study, 1993, p.1-1. (Similar statements are found in other CPSs for other NJAWC operating centers.)

The CPS is prepared on a five year cycle by Systems Engineering and describes a fifteen-year program of improvements.

Past practice in NJAWC has been to prepare a separate CPS for each operating center. Due to the size of each operating center, it is expected that this practice will continue and will not be consolidated into a single CPS for all of NJAWC, similar to other activities.

The CPS establishes the general direction and scope of the Company's major engineering and construction efforts for each operating center. Each operating center plan is organized into five major analytical sections:

- Demand Projections,
- Source(s) of Supply,
- Regionalization,
- Engineering Overview of Existing Production Facilities with Recommendations for Improvement,
- Engineering Overview of Existing Distribution Facilities with Recommendations for Improvement

Each CPS costs on the order of $200,000 to $400,000 and requires from 18 to 30 months to produce, and provides a very detailed planning analysis of each system.

Although the primary focus of a CPS is a fifteen year time frame, the Planning Group does work closely with the one-year operating plan and the Five-Year Capital Budget Plan in order to integrate all major projects that are anticipated for a given operating center.

The overall planning and design process appears to be well-understood at all levels of NJAWC, which may be a result of the effective downward and upward flow of information related to the overall planning process. This is reflected in the integration of the 1-, 5-, and 15-year planning and implementation programs. Typical of the upward flow of information is the information requested by System Engineering from NJAWC for preparation of a CPS (see Exhibit 3-7). In addition, NJAWC will also coordinate with local municipalities, planning agencies, and state regulatory agencies for relevant planning data.

The overall system planning and design function allows for the effective integration of other related corporate functions. Market research (with respect to long-term

demand trends, etc.), forecasting and budgeting of projects. The lead time of the CPS, in particular, as well as the 5-year capital budget plan allow considerable time for financial planning to support the recommended projects and to evaluate subsequent rate-making needs.

With regard to the impact of key regulations such as the Safe Drinking Water Act (SDWA), this is factored into the planning process primarily in regard to production issues. For example, System Engineering (Planning) will work closely with NJAWC water quality personnel on an issue, such as how to optimize turbidity removal. In this example, assuming a chemical change would be needed to achieve the desired results, there would be an assessment of whether an operations change would meet the new requirements or whether new capital facilities are needed (and therefore be included in the CPS).

Planning and Design Methods and Procedures

NJAWC uses adequate analytical models, tools and procedures to evaluate its future needs and to develop a projected construction program. Demand forecasting and supply side analysis are discussed in the next major section. This section discusses other related planning issues.

The planning group has recently begun to use an Integrated Resource Planning (IRP) approach in developing the CPS. IRP has been used in other types of utilities, but only recently has received recognition as a useful planning tool by the water supply industry, and to date has seen only limited applications, usually by larger water systems or by those on the "cutting edge" of new techniques. As stated in the Monmouth County Service Area (now Shrewsbury Operating Center) 1993 CPS, IRP "is a comprehensive planning approach which encompasses developing and evaluating alternative planning scenarios, considering the goals of the regional water supply plan developed by various local and state agencies, evaluating water demand and supply side management options where such measures could potentially eliminate or defer capital projects and reduce operating costs, assessing the costs and benefits of energy management based projects, and considering various externalities which are not easily quantified, such as the ability to show the migration of contamination or salt water intrusion in fresh water aquifers."

Exhibit 3-7
Water Company Preparation for a Comprehensive Planning Study

- Model updates - piping additions
- Model: demand update and allocations
- Model calibration
- Verify availability and accuracy of meter route or area code information, and eliminate "000" area code information
- Verify accuracy of various data to be used in CPS, and bring up problem areas to Systems Engineering *before* a CPS.

  Example: Make sure charts are of good quality
- Maintain data by service area, rather than administrative breakdown (Division)

  Example: Consumption data by customer class for each service area; customer information, etc.
- Fire flow tests
- C-factor flow tests
- Tracer study tests
- "Real-time" documentation of issues

  Examples: Drought impact, peak day problems, system failures or problems, treatment problems, maintenance problems, power outages, source contamination
- Energy management opportunities
- Document leak detection program activities and costs
- Map showing main break locations
- Filter inspections
- Tank inspections

Prior to proceeding with a more detailed evaluation of a possible alternative, one of the first steps in the evaluation process is a pre-screening feasibility analysis to determine if the alternative is "real, or do-able;" if it is, it is further evaluated with a least cost analysis. The Company uses a least cost analysis based on present worth which incorporates capital cost and annual operating costs to evaluate and rank major projects. This analysis is particularly used in evaluating regionalization alternatives such as purchasing water from another utility versus developing

NJAWC's own source of supply. The least cost evaluation is primarily economic in nature, but a variety of non-economic factors may be considered in the overall cost-effectiveness evaluation. Among these non-economic factors are ease of implementation, timing (scheduling) questions, local acceptance, environmental considerations (*e.g.*, presence of wetlands), ease of rights-of-way acquisition, water allocation rights, and others. It appears that the various assumptions used throughout all phases of the system planning and design process are consistent. The economic model used in these evaluations includes a variety of variables from the finance group, including tax rates, inflation rates (may vary for different items, *e.g.*, power, chemicals, etc.), depreciation rates, etc.

Although least cost planning has less applicability to NJAWC Engineering projects (due to the type of work, *e.g.*, pipeline construction, tank maintenance, etc.), consideration is given to this at the design stage. For example, upsizing a new pipe may add very little to the cost, but provide for future growth. In another situation, a street for which a pipeline was originally planned may have been repaved recently by the municipality; in this case the Company may elect to move a block over, if possible, to a street with an older surface, rather than tear up a relatively new surface.

While overall system planning follows the model identified earlier (*i.e.*, demand projections, source of supply, regionalization, etc.) and now encompasses IRP principles, perhaps the single most extensive technical model for a water utility is the system hydraulic model. System hydraulic modeling is a very important component of NJAWC planning, construction and operation. One consideration in the recent NJAWC Engineering consolidation was to get the various operating center models based on the same software program. Similarly, hydraulic models are an important component of the CPS to develop scenarios for improvements to most effectively deliver water to customers. The models have been upgraded from the older LQSS software to Cybernet, which is faster and easier to use. The models are updated on a periodic basis as they may be used to make operational decisions as well as for routine expansion (*e.g.*, development projects) and upgrading of the existing system. There is a specific technical procedure for acquiring data for these models.

Scenario and uncertainty analysis are addressed in the Demand Forecasting section.

With respect to NJAWC Engineering and System Engineering participation in industry study groups, committees and trade associations, they are well represented in such organizations. The American Water Works Association (AWWA) is by far the most prominent trade and technical association. It is a national organization with state associations, including one in New Jersey. NJAWC and System Engineering staffs are very active in a variety of functions with the AWWA and the American Water Works Research Foundation (see Research and Development Function). NJAWC staff has been or is involved with organizations such as NJDEP's State Water Plan committee, regional source protection programs such as Fire Road's participation in wellhead protection, and the Electric Power Research Institute on energy conservation.

Output of the Planning and Design Process

As the inputs to the NJAWC planning process are driven from two basic perspectives: 1) user requirements; and 2) regulatory requirements, *e.g.* the Safe Drinking Water Act, so are the outputs to satisfy these requirements. The outputs of the planning process are geared to providing an adequate system of sources of supply and production, storage, and pipe network to provide the necessary water quality and quantity for system users and to comply with regulatory requirements of the U.S. EPA and NJDEP. The plan recommendations are easily transferred to engineering and construction functions. One example of the procedure to effect this transfer is the prioritization of projects into "A" or "B" priorities. (See discussion in "Planning and Budgeting.") While projects "tend to flow right on through" as per the plan (CPS), the results of the system planning process are reviewed on a regular basis as part of the development of the annual investment budget and the Five Year Capital Budget Plan. Projects that have been identified in the planning process may be reviewed for re-prioritization as new information becomes available or as conditions and needs in a given service area may change. In addition, if there are significant changes, System Engineering may be asked to undertake a "mini-study" to evaluate the situation. For example, if there were to be a change in water quality standards, such a mini-study might evaluate whether the plan is still valid, and, if not, what other alternatives are available.

During the visit to the Canoe Brook water treatment plant, it was noted that flooding is a recurring problem at this plant. (A flood had occurred just prior to our visit.) There has apparently been some discussion concerning a new relocated plant, but it

appears the Tri-County project took priority over this work. The 1993 CPS for Northern Division does not seem to address the flooding problems at Canoe Brook. It should be noted that the plant is equipped with flood doors and looked to be in good shape for just having passed through a flooding event.

The System Planning Process From a Budgeting Perspective

The capital (and O&M) budgets, along with project priorities established in these budgets are consistent with NJAWC goals, particularly that of providing "... safe, adequate, and reliable service to its customers ...." There is strong emphasis on maintenance of reliability while attempting to provide this service in the least-cost manner possible. Maintenance of system reliability is addressed in several ways. These may include improved source protection and water quality issues to satisfy new regulatory requirements, as well as customer concerns for a safe product, *i.e.* potable water. Other projects are addressed at maintaining adequate sources of supply and facilities to deliver the required quantity of water to satisfy both existing customers and growth and economic development. The budgeting process is explicitly linked in terms of timing, information flow and assumptions to system planning, design, engineering and construction. These functions are linked through a well-defined budgeting process, the basis for which is set out in two key operating procedures: Administration No. 9 (Policy p. 21/p. 29), Investment Budget Detail and Budget Project Memoranda; and Engineering No. 1, Comprehensive Planning Study.

The basis for the above findings is discussed further in both the following section (The Management, Control and Integrity of the Budgeting Process) and in the Planning and Budgeting section, which follows Demand Forecasting.

The Management, Control and Integrity of the Budgeting Process

NJAWC has formalized procedures for identifying, evaluating, reviewing and authorizing capital (see Planning and Budgeting Section) and O&M budgets, including senior management review. First line supervisors are responsible for developing O&M budgets for the annual operating plan for their part of the NJAWC operation. In addition to routine O&M activities, these first line supervisors may also develop budgets for routine and recurring construction projects which typically include main replacements, main reinforcement, new meters, small mains replacement, etc. (referred to as 1A1-5 projects). Generally, these projects will have

been identified in the Five-Year Capital Budget Plan and are now being integrated into the annual operating plan. These are reviewed with successively higher levels of management including review between the Operating Center Managers and the Vice President of Operations. It was noted that this is an iterative process up through senior management and that final review and approval of the overall NJAWC budget lies with the Board of Directors. The overall O&M budget development is about a five month process. All levels of operating staff who were interviewed for this audit indicated they understood their role with respect to budget preparation and accountability, which is discussed below. Upon O&M budget authorization, each manager, supervisor, or superintendent with budget responsibility has authorization to execute and manage their respective budgets. It was also indicated that within the context of budget control, an individual "can't be a renegade and go off and do his/her own thing."

The O&M budgets (including the 1A1-5 projects) may be revised throughout the year as unusual circumstances may necessitate, *e.g.* a very wet year for precipitation, which may result in lower revenues than projected for the year. Senior management noted that the supervisors have responsibility and authority to maintain their respective budgets under these circumstances. Because of the good history of O&M expenditures in each operating center, coupled with various O&M guidelines, the supervisors have a good understanding of what activities "absolutely have to be done" and which can likely be deferred. As a result, there is an ability to control a certain level of scheduled and unscheduled expenditures. It is noted that each manager/supervisor interviewed understood that they had the authority and responsibility to make budget adjustments as necessary to control and provide reliable service to customers while attempting to be financially responsible to NJAWC.

With regard to management mechanisms to monitor budget performance and to identify adjustments, the Operating Center Managers and Vice President of Operations regularly monitor budget progress and report to the Board of Directors. At the end of the first quarter of an operating year, the Vice President of Operations reviews actual budget results for unusual items or trends. If something is identified, the respective Operating Center Manager(s) is directed to develop a budget contingency plan that can be implemented, if needed.

Budgets are prepared based on a number of cost centers which are then aggregated by Operating Center and then to NJAWC as a whole. As a result, it would appear that the number of cost centers is adequate and that the budgets are prepared consistently across cost centers, primarily due to the management methods and systems in place that essentially direct how budgets are developed. The operating manuals identify activities that are to be carried out for a variety of functions and these in turn tend to govern the associated maintenance costs. For example, Production Policy and Procedure No. 4, Pumps and Motors - Inspection, Maintenance, and Efficiency Testing, sets out the requirements for this type of equipment. Regulatory agency requirements, such as the BPU's meter changeout policy, also tend to govern certain costs. The labor budget is projected in the 5-year plan. This information is provided to the various management staff and, along with past experience, is the basis upon which an annual O&M budget is built.

With regard to budget variances, budgets are tracked very closely on a regular basis and overall annual actual budget is typically within ±5 percent of approved budgets. It was expressed that even with a major main break or a major lightning strike on a facility, the annual O&M budget could be adjusted to maintain compliance with original projections.

Demand Forecasting

With regard to supply and demand forecasts, which are critical to determining the need for major capital projects, System Engineering (Planning) uses an extensive variety of data sources including census data, county and local planning commission records, local subdivision activity, leak detection efforts, status of unaccounted-for water, and meter records. The data analysis includes statistical analysis of historic consumption records, application of engineering judgment, meetings with NJAWC field people and local planning officials to discuss supply and demand issues. Also reviewed are documents such as the New Jersey Planning Commission's State Development and Redevelopment Plan. As there was little, if any, data on ***water conservation*** efforts in New Jersey, NJAWC has also carried out a pilot water conservation project to determine the impact of a dedicated water conservation program as a demand side management tool as a factor in integrated resources planning.

Using these various data sources, the CPS will typically assess a base demand scenario, which is considered to be the most likely future demand scenario, as well as low and high future demand scenarios. Typical assumptions for a low scenario include increased retrofits of low flow plumbing devices and reduced unaccounted-for water rates. For the high scenario, assumptions may include no plumbing retrofit occurs by existing customers (only new customers will use low-flow devices, per current legislation), unaccounted-for water occurs at a somewhat higher percentage, etc. With this information, statistical analysis is performed for maximum day projections based on 50, 95, and 99 percent confidence intervals. Similar to demand projections, the CPS will also develop several scenarios for future sources to address various demand alternatives; for example, the Ocean County/Middlesex County CPS considered seven sources of supply alternatives for the Lakewood system.

The demand planning by NJAWC well exceeds the level of planning practiced by the water industry as a whole. Planning incorporating price and consumption analysis, or price elasticity have little relevance in the water industry. Generally, in water supply, the physical facilities are sized on being able to meet maximum day requirements and/or fire flow conditions which typically exceed the size of facilities needed to meet average day demand. Also, it has generally been found in the water industry that pricing for water has generally had no or extremely limited affect on water demand, except for modest decreases that may occasionally be experienced if a very large rate increase is implemented. But even in these cases, use has typically recovered shortly thereafter.

The basic forecasting assumptions and methodology used by NJAWC System Engineering are the same as those generally accepted and used in the water supply industry. As noted elsewhere, NJAWC/System Engineering, however, are at the cutting edge of new procedures in water supply planning by using IRP techniques. This concept has only recently been introduced in the water supply industry and only a handful of larger water systems are actually using this technique, which includes a variety of key factors which were not stressed in earlier planning in the water industry. The IRP process also allows for greater effort in addressing the impact of future uncertainties; *i.e.*, high and low scenarios. While projections in water supply have historically been subject to variables over which a water supplier has no or very little control (*e.g.*, local government planning and growth controls), the underlying process of the CPS provides a good foundation for reasonable

projections, given the amount of variation that can occur. The IRP process will enhance the ability of NJAWC to have reasonable forecasts based on the data that is available. The fact that the CPS is updated on a five-year cycle helps to refine forecasts within a relatively short time frame. In addition, the 5-year capital budget plan and the one-year annual investment budget allow for a ready ability to make quick adjustments in response to significant changes from the forecasts. Also, if there are significant changes, System Engineering may perform a "mini-study" as an addendum to the CPS.

As indicated above, the CPS forecasting techniques provide a sensitivity to planning variables that is significantly better than many other utilities. A variety of variables such as weather patterns, conservation and demand management are considered in the CPS analysis. Increased costs are particularly considered in the 1- and 5-year planning horizons as projects may be deferred, re-scheduled, and re-evaluated to address a situation where increased costs (or decreased revenues such as in a "wet" year) are a factor and impact on short-term budgets.

Management plays a strong role in the planning and forecasting process as evidenced by the resources that are directed to these activities on a regular and consistent basis. In addition to management review of the material used in forecasts, some of this material is provided directly by management through interviews with key managers, and by providing information on local economic and political conditions and system operations. The long-term forecasts are used directly in the CPS and implemented or adjusted via the 1- and 5-year programs, or "mini-studies." In addition to NJAWC's planning efforts, the State of New Jersey has developed the State Water Supply Plan and NJAWC's efforts closely parallel those of the State Plan. (The Vice President of Operations also serves on the Governor's committee for the statewide planning effort.) The Tri-County project was developed with strong participation with regional and state organizations and officials.

Long-range forecasts are updated on a 5-year cycle, but all projects are reviewed annually as a part of the 1-year annual investment budget and 5-year capital budget plan processes.

Planning and Budgeting

A number of system planning issues dealing with defining planning assumptions and justification of engineering projects were discussed in earlier sections of this chapter. This section further addresses planning issues and particularly the relationship to the budgeting process.

The CPS process described earlier results in two categories of recommended projects which are prioritized as "A" or "B" projects. "A" projects are to be implemented within one to five years, while "B" projects are to be implemented in years six to fifteen. There is no formal ranking system and the categorization of projects as "A" or "B" projects tends to be established as a result of discussions between NJAWC staff and System Engineering, along with an informal evaluation process. Under this informal process, "A" projects are generally based on satisfying issues such as water quality, safety, short-term capacity needs, regulatory requirements and environmental issues. "B" projects tend to deal more with reliability issues and "what if" situations, for example, power outages. Similarly, if new regulations are under consideration or recently issued with a longer term compliance schedule, the CPS may identify a potential project as a "B" project in the longer term, but a final determination may depend on much more information as to whether it is needed or not. Some projects may get their priority rating as a result of critical path activities; *e.g.*, need to acquire land for a new booster station.

With regard to project development and related cost budgets at the planning stage, the Planning group tries to scope out the project as closely as possible and typically will consider several alternatives to the issue at hand. Projects are categorized "A" or "B" designations (see above) with "A" projects receiving more attention with respect to cost details because of their greater immediacy.

The Planning group also makes extensive use of the System Engineering Design and Construction groups in developing projects and cost estimates. These personnel will look at planning recommendations from an implementability and practicality standpoint. They may also make a reconnaissance level review of facilities on site, *e.g.*, will the existing available space be adequate to accommodate a proposed new chemical feed system. As noted by one participant, the System Engineering staff has a combination of extensive institutional knowledge and numerous experiences in

water supply ("have seen just about everything there is, except Delran type plants") which when coupled with site specific issues provide very good input for developing cost estimates.

Once major capital projects are identified in the CPS, there is a definite process by which projects are implemented.

Specific project planning and development is driven by the capital budgeting process, which consists of two iterative tasks:

- Development of the Five-Year Capital Budget Plan,
- Development of the annual investment budget.

As these two plans are developed, projects are defined, budgeted, and scheduled, and management and control mechanisms are specified.

There are four major categories of projects delineated in the capital budget as related to operations and construction:

- *Budget Projects*, indicated by the designation "BP,"
- *Main and Hydrants, Extension, Replacement, and Reinforcement Projects*, generally referred to as "1A1-5 Projects,
- *Item 1-B Services*, to install new and replace old service lines,
- *Item 1-C, Meters* to purchase and install new meters and replace old meters.

Budget Projects are generally those projects that are either identified in the CPS or are in response to a need identified after a the CPS was prepared, although no formal guideline was identified that specifies whether a project is to be classified as a BP or a 1A1-5.

There are, however, informal guidelines that are followed. These guidelines specify that if either a pipeline project is estimated at over $100,000 or if a unit of property other than pipelines is estimated at over $50,000, a Budget Project (BP) Memorandum will be prepared. Projects estimated at less than these amounts are considered 1A1-5 projects.

A key procedure in this process is Administration Procedure No. 9, Investment Budget Detail and Budget Project Memoranda. This procedure directs that all CPS projects to be budgeted will require the preparation of a BP Memorandum.

To initiate a Budget Project, a Budget Project Memorandum is prepared. The Service Company Operations Manual describes the use and contents of the BP Memorandum. Exhibit 3-8 summarizes the key sections of the BP memo.

Exhibit 3-8
Summary Of Budget Project Memorandum Topics

1.	Title	brief description of the project
2.	Reference	to be used if there is other information on the same project
3.	Subject of Study	brief outline of the situation causing the need for a capital expenditure
4.	Recommendation	result of the study made for the situation involved
5.	Estimated Cost	total sum of project cost with estimated annual expenditures
6.	Adequacy	estimated service life
7.	Discussion	review of pertinent information and clarification of earlier statements in the memorandum
8.	Detailed Cost Estimate	schedule of estimated costs by detailed line item
9.	Sketches	

Procedure No. 9 recognizes that certain projects by necessity will have a significant financial impact on the Company, and these require the preparation of a separate memorandum by the financial officer. This memorandum will include the potential impact on accounting rates and financial issues.

The Budget Project Memorandum is revised each time there is a modification due to project scope, cost or scheduling changes. The revision must explain the reasons for the cost change. The revised budget, after approval, becomes the new project cost on all subsequent project cost reports. As a general rule, 1A1-5, 1B and 1C projects—main and hydrant extensions, replacements, reinforcement, new service and meters projects—are first proposed in annual operating plans. They may have been identified in the CPS, however. When these plans are approved, (when the Company's Annual Operating Plan is approved), they become eligible for funding in that year. The planning and design of these projects is typically the responsibility of the NJAWC Engineering and the Operations Centers.

Five-Year Capital Plan

The Five-Year Capital Budget Plan identifies the anticipated capital spending levels for the current year and subsequent four years. For example, in the 1996_2000 Five-Year Plan, the expenditure shown for 1996 is essentially the same as that approved in the 1996 Annual Operating Plan. Expenditures for the next four years are taken from both the CPS and prior year estimates of 1A1-5 items. Each year the Five-Year Capital Budget Plan is updated and approved by the Board of Directors. It is used as a general planning tool, not as a definitive statement of projects to be implemented. The Company may move projects within the five year plan from year to year; however, if the total expenditures for any given year exceeds the amount forecast or a project is moved into the five year plan from a year outside the plan, the Company must receive board approval for the change.

The Five-Year Plan provides a vehicle for future budgets to have input both from current budgets and from budgets from the recent past. As a result, the Company experiences essentially a "rolling budgeting" process which builds upon the experiences of the past but has a keen sense of future needs well in advance of the actual need so there are few, if any, major unanticipated expenses.

With this approach, the second Five-Year Plan becomes the basis of the next Annual Investment Budget. From the array of BP projects shown, a smaller number of projects are selected for actual consideration and BP Memos are prepared and submitted. This results in a change in the capital program for that year. As indicated earlier, a variety of factors may lead to these changes, *e.g.*, an exceptionally wet year and reduced revenues, changed conditions, etc.

Exhibit 3-9 depicts the general process for the preparation of budgets and the proposal and management of projects.

The originator of a Budget Project Memorandum is assigned the responsibility for detailed planning of the project. A project submitted by the Service Company will likely be managed by the Service Company. It would then be up to System Engineering to determine whether the project will be planned and designed in-house or whether a consulting engineer will be engaged. If a consulting engineering firm is to be employed, the Operations Manual prescribes the process by which the firm is selected.

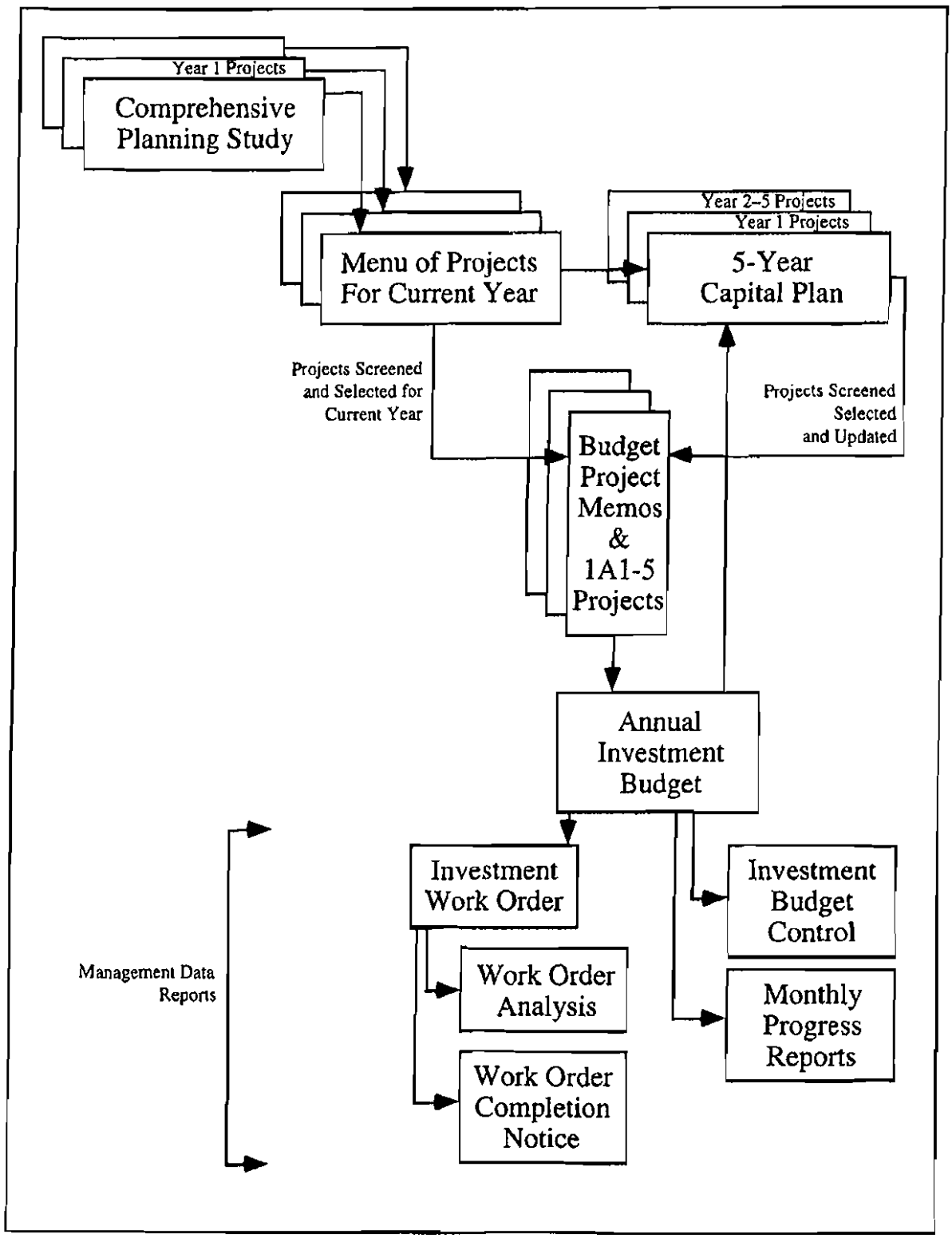
Similarly, it would be the NJAWC Vice President of Engineering who would decide whether to involve System Engineering or an outside engineer, perhaps after consulting System Engineering.

There appears to be no formally documented process for determining who will direct an engineering and construction effort, but as noted earlier, System Engineering takes the lead in the larger, more complex, or more sensitive projects.

There is strong interaction between the two processes: planning and budgeting. One key reason is that in many situations essentially the same people responsible for planning the projects are also responsible for developing project budgets.

In many cases 1A1-5 projects are planned and budgeted by Operating Center personnel who are also responsible for implementing the projects. On larger projects System Engineering (Planning) will often request budgeting (cost estimating) input from the design and construction groups of System Engineering, as well as from NJAWC Engineering and Operating Centers. In short, excellent interaction exists between the two processes.

Exhibit 3-9
Overview of Budget Process and Control Documents



Quality Assurance

Although a formal quality assurance program as such does not exist in NJAWC, there are many indications of the key elements of such a program throughout the Company. In particular, the engineering and water quality groups have programs that are more structured with regard to quality assurance and are discussed in more detail in this section.

First, from an overall standpoint, numerous procedures and directives exist for various functional elements of NJAWC. In particular, these include the two volumes of the American Water Works System's Operations Manual, which have procedures dealing with Production, Services and Meters, Sources of Supply, Water Quality, Administration, Engineering, and Distribution. In addition, various functional areas such as engineering and water quality have further developed technical and administrative guidelines applicable to their respective areas of responsibility.

The current work management procedures, while oriented toward productivity, also entail a certain element of quality assurance vis a vis customer rates and reliability by establishing anticipated levels of effort for routine and recurring activities and then monitoring these for deviations.

With regard to engineering and construction, there are three points concerning quality assurance. Almost all NJAWC planning is done in-house (NJAWC and Systems Engineering). The details required for this planning are well documented, and the level to which planning is carried generally exceeds the industry efforts as a whole. (Even though the water supply industry supports and encourages the type of planning at NJAWC, it very frequently falls short in actual implementation.) The planning process, which includes both System Engineering and NJAWC staff, basically includes a built-in mechanism of a certain level of quality assurance.

Engineering Design incorporates several quality assurance mechanisms. First, the design process, in which consultants are used for most larger projects, has inherent quality assurance as part of the process. The process includes preparation of detailed design parameters by Company staff, a very structured procurement process, use of pre-qualified consultants, and detailed reviews of design work, including that of consultants. Engineering Policy Procedure A-1, Professional Engineering Services—Request for Proposal (RFP), is exceptionally well detailed, but does not include any

reference to a consultant's QA program. The key QA elements that exist in engineering include the following:

- Larger projects (generally in excess of $10 million to $15 million in construction costs) are subjected to a Value Engineering (VE) analysis. The VE analysis is directed by a VE facilitator and generally costs on the order of $25,000 per VE analysis. This cost is generally of the magnitude expected by the industry for a study of this type. A contractor is part of the VE team and typically concentrates on costs and construction techniques.
- System Engineering has found that after several VE analyses, many of the same items tend to show up over and over again. If such an item does occur, it is incorporated into the Engineering procedures as a standard.
- System Engineering and NJAWC do vigorous reviews of design work. On larger projects, revisions will be performed at the 30%, 60% and 90% completion levels. If Engineering is not satisfied with work of a consultant, they will notify the consultant early on with their concerns, in writing, and will ask the consultant to respond in writing as to how they will address these concerns. The Company reserves the right of refusal if they are dissatisfied with a consultant's performance.
- Systems Engineering (Construction) becomes involved with design projects, generally in the 60 to 80% of completion range, to review the projects for items such as constructability, how are existing facilities to be kept in operation during construction, are specifications clear, do phases of construction make sense, etc.
- For larger projects, a review meeting is scheduled six months after project completion to discuss the project and identify what could have been done differently or better.
- There is also an internal engineering forum held twice per year at which engineers from throughout the American system meet to review and critique the engineering standards. If an engineering standard is up for review, it will be sent to all system engineering departments for review. A decision to conduct a review is determined either by age of the standard or by need. About three procedures per year are reviewed.
- With regard to equipment that is specified and used throughout the American system, their network is starting to generate specific information about different pieces of equipment. The database looks at successes, problems, operating data, costs, etc. and as it builds, will provide significant feedback on actual performance.
- Indirectly, NJAWC's dam inspection program is also a QA activity, as it exceeds regulatory requirements. Operations staff inspect system dams quarterly, engineering inspects annually, and a consulting engineer inspects bi-annually.

Although these are all individually good QA activities, there is no formal QA program, and such a program should be developed.

The water quality function also includes a variety of QA activities. The System Operations Manual Water Quality section includes a number of QA related procedures; some of the more notable are:

No. 3, Testing of Treatment Chemicals
No. 5, Water Quality Goals
No. 6, Water Quality Monitoring Program
No. 11, Assurance of Laboratory Results

In particular, policy No. 11, Assurance of Laboratory Results, requires participation in a QA program conducted by the Belleville laboratory of the Service Company. This program includes periodic performance evaluation and on-site visits by personnel from the AWS's principal laboratory at Belleville, Illinois, minimum requirements for on-site quality control work, and record keeping.

There is an extensive NJAWC QA program for water quality including QA Policies and Procedures Manual as well as a specific laboratory QA/QC manual for Delran. The documents reviewed include the following.

1. Example of Daily Sample Schedule for Wells and Distribution Systems
2. Monthly Sample Schedule for:

   Delaware Valley System
   Camden System
   Haddon System
3. Weekly Sample Schedule for DRRWTP
4. 1996 Belleville Schedule for DRRWTP
5. Section Copies of NJAC 7:18 *Regulations Governing the Certification of Laboratories and Environmental Measurements* for:

   Microbiological Analysis
   Requirements for Environmental Equipment and Instrumentation
   Quality Control Checks
   Control Charts
6. Section Copies of the QAPP Manual and DRRWTP Laboratory's QA/QC manual for:

   Quality Control Checks
   Check Standards
   Records and Data Reporting

7. Copies of SOPs for:

   Ammonia
   TOC

   Copies of representative analytical data sheets and chain of custody forms.

   Copy of the 1996 Belleville schedule.

   Copy of NJDEP certification documentation.

The NJAWC water quality function is subject to other outside QA measures as well as an internal QA program. All NJAWC laboratories are NJDEP certified, and the laboratories receive performance samples from an outside contractor via EPA and NJDEP in which the NJAWC laboratories conduct proficiency tests. In addition to Belleville, NJDEP also conducts laboratory inspection. With regard to internal QA, the water supply regulations require that 5 to 10% of water samples be run for QA purposes. NJAWC runs 20% of its water samples for QA purposes. The level of proficiency required for laboratory analysis is 90%, while the NJAWC laboratory personnel are operating at a proficiency level of about 97%.

There is also an internal NJAWC quality assurance committee comprised of people from each NJAWC laboratory. An NJAWC chemist is designated each year as the QA officer and is responsible for performing internal QA audits similar to those conducted by NJDEP.

The Company's water quality program has the following responsibilities:

- Compliance (*e.g.*, federal and New Jersey Safe Drinking Water Acts)
- Establishing treatment parameters
- Customer issues (complaints, inquiries)
- All sampling and analysis
- Serving as a sounding board for environmental issues.

Other components of the QA program include:

- Testing of micro-samples, which are blind samples, with the results verified by an independent contractor.
- A high quality of staff. Each of the 19 staff members has at least a bachelors degree, several have masters degrees, and one has a Ph.D. The Director of Water Quality Control has relevant BS and MS degrees, prior experience in environmental compliance with the U.S. Army, and 15 years of experience with the American system; the last three with NJAWC.

- High quality equipment. There are atomic absorption analyzers at each operating center, and these will be replaced in 1998 with ICP/MS units, which will greatly improve productivity. (It is anticipated that the increased availability of water quality personnel will be directed to consumer confidence—one aspect of this is required by the federal SDWA amendments of 1996—and to expand efforts in surface water protection, which includes watershed monitoring by a variety of volunteer watershed groups.)

Each site also has a "micro" laboratory for local process and quality control. All water quality decisions, including setting of chemical dosages, are established by water quality personnel, while production staff are responsible for seeing to it that chemicals are fed at the proper dosages, equipment is operating and that there are adequate chemicals in the feeders. A significant amount of work has also been done to characterize water quality in the reservoirs and to provide a basis for operating parameters at the surface water plants. While water quality in Canoe Brook and Swimming River is relatively stable, that in Jumping Brook and the Manasquen Reservoirs are not particularly stable.

Research and Development Function

NJAWC has a dedicated research and development (R&D) program related to water quality issues. The R&D program is located in the Water Quality Control department and is directed by the Director of Water Quality Control. The R&D activities selected tie directly to specific NJAWC concerns, but may have applications to the larger water supply industry. Since the R&D activities are essentially water quality oriented, the principal resources directed at R&D are those of the water quality personnel and laboratory equipment. Company personnel currently serve on five American Water Works Research Foundation (AWWRF) committees of interest. The overall thrust of the American Water System R&D is directed by the system headquarters, and NJAWC is currently participating in six projects with them. In addition, NJAWC Water Quality also collaborates with regulatory agencies and AWWRF programs, which may include academic institutions and consultants, on various R&D projects including:

- Identifying indicator organisms for certain biological factors.
- Developing biological indicators of water quality coming out of water plants.

- Doing prototype work with the Information Collection Rule (ICR), which is discussed later in this section.

One key R&D project is aimed at improving surface water quality by controlling two compounds that result from the respiration process of algae in the reservoirs and in turn result in taste and odor problems in the water. It was noted that the most desirable solution would be to control this from happening in the first place, but NJAWC is not in a position to control the influx of nutrients and other materials from an entire water basin. Therefore, the next best thing is to attempt to find a solution for the problem such as by stabilization, aeration, chemical bonding, etc. This R&D project is attempting to find such a solution and preliminary results will be tested to see if they can be applied on a production level. As noted above, NJAWC participates in AWWRF projects that have a possible application for the Company. In this algae situation, NJAWC is working with Virginia Tech on a separate project on control of algae in water supplies.

Some other projects of interest include the following:

- There has been some evidence of re-growth of bacteria in the Monmouth County area distribution system after water leaves the water plant. Investigation indicated the plant produced a good quality water, but high nutrient concentrations supported the bacteria re-growth. The Company is working with Montana State University on control of bacteriological growth in distribution systems with a desired goal to develop a model to predict such growth.
- Current methods of chlorine dioxide (ClO_2) generation are very inefficient and this R&D project is looking at new methods to generate ClO_2. One possibility is to use sodium chloride (salt) instead of chlorine and to create ClO_2 and thereby avoid some byproducts of other processes which appear to have some negative health aspects.

As noted earlier, the Company is participating in a program that is on the leading edge of work with respect to EPA's Information Collection Rule (ICR). This is the most intensive water quality data collection effort ever undertaken for drinking water supplies and covers all aspects of a system from reservoirs to distribution systems. The ICR applies to systems serving over 50,000 people, with additional requirements for systems serving over 100,000 people. EPA requested 35 water utilities to participate in the first phase (alpha test) of the ICR program and 10 water utilities to participate in the second phase (beta test). NJAWC was asked by EPA to

participate in both tests and the Company's Director of Water Quality was asked to serve as a national advisor on the ICR.

With regard to whether the results of in-house R&D projects are disseminated, the Water Quality Director receives about 20 to 40 calls per week from around the country on the ICR. In addition, he and his staff make presentations at various state and national water quality conferences and some of the staff are also well published in the area of water quality.

Other System Reliability and Planning Considerations

Source of Supply

A number of source of supply issues have been addressed indirectly as part of other subjects in this Chapter 3. This section addresses a few additional items. There are two specific procedures in the Operations Manual which deal with surface watershed protection and wellhead protection programs. NJAWC has multiple surface and groundwater sources, the mix of which may vary among operating centers. In addition, some operating centers may have agreements to purchase significant amounts of water from other suppliers, while others may purchase little, if any, water from another system. Conversely, NJAWC also sells water to other systems.

The Company is very active in protection efforts for and managing of its sources of supply. With regard to protection, the Company has very little direct control over the sources themselves. This control lies, generally, in the hands of local municipalities and state or regional regulatory agencies, often supported by volunteer groups. However, the Company has been very aggressive in working with these groups to protect its sources of supply. With regard to wellhead protection, the Fire Road Operating Center is a very active participant in local efforts to coordinate and adopt the necessary management tools, *e.g.*, public education, municipal ordinances, etc.

As discussed elsewhere, the Water Quality department is actively involved with a variety of watershed associations and anticipates that as staff become more available

as a result of increased equipment productivity, they will be able to devote more time to watershed protection.

With regard to managing surface supplies, a good example is provided by the Short Hills system. There are very definite regulatory requirements imposed on the various water suppliers in the general area with respect to diversion rights, quantities of water withdrawn, daily limits, times of the year where water may or may not be taken and similar points. This situation also involves a number of agreements to purchase water from other suppliers. Discussions with the production staff indicate they are very knowledgeable in knowing the availability of or restrictions on water supply and specific sources, the cost of purchasing water from others versus producing it in Company facilities, and the likely demands from NJAWC customers. As a result, they are careful to coordinate their raw water sources, reservoirs, and related facilities in a manner to be able to provide water at the least cost consistent with responsible water supply management.

On a related note, the Short Hills production staff commented that they are aware of and have good relations with all upstream potential polluters and if a spill does occur, these commercial/industrial sources will notify the Company of the spill. The reservoirs here are all off-line, so that if spills, high turbidity or other water quality problems occur, they can stop taking water until the problem passes. It was noted that spills are rare, there being about six calls in the past 15 years.

Critical Area Designations: One of the key events in New Jersey water management in the last two decades has been the designation of Critical Areas by NJDEP. As a result of a significant water supply planning effort in the 1980s, it was determined that certain areas of New Jersey were in danger of no longer being able to sustain a reliable supply of water to meet water demands of these areas. These were eventually designated as Critical Areas No. 1 and No. 2, and withdrawal of water from these areas was severely curtailed, leading to development (or purchase) of new sources of supply outside the Critical Areas. The situation in Critical Area No. 2 and the Tri-County Regional Water Supply Project is discussed in the following section.

One concern has been whether other critical areas affecting, in particular, the Atlantic and Cape May Counties area would be designated. Informal discussions with senior management at NJDEP indicated that designation of a third critical area

is not likely (at least not at this time) due to the problems with implementing the first two areas.

Tri-County Regional Water Supply Project (Tri-County Project)

There has been significant discussion about the Tri-County Project related to need for the project, size of the project, cost, etc. Although the proposal states that "In accordance with the Board's directives, the prudence of past construction will not be examined" (Introduction to 3D), the Tri-County Project did come up several times. While NJAWC staff presented a history of the project, perhaps the best summation was presented by a senior NJDEP administrator in Trenton.

- In 1982, the state undertook several water supply master plans, which identified three possible critical areas.
- This led to feasibility studies for the Middlesex/Monmouth, Greater Camden, and Atlantic County areas.
- In 1986, Critical Area No. 2 (Camden) was designated. The study indicated a need to reduce groundwater pumping by 35%.
- During the process, a water resources advisory committee had been formed and had significant public input about the situation. The plan was to look at regionalization options and a variety of options were studied, including purchase of water from Philadelphia, using the NJ Water Supply Authority as the implementor, creating a new regional authority, etc. The advisory committee adopted the overall plan and chose the implementation option designating NJAWC as the implementing organization.
- This solution was accepted ("blessed" by DEP), and DEP orders were sent to various towns to proceed with a plan that was based either on a local option for water supply or tying in with the accepted regional plan (*i.e.* what came to be known as the Tri-County Project).
- In 1988, there was a court challenge by certain towns which basically said the state Water Supply Management Plan didn't allow these orders. The court found that existing permits were "grandfathered" and that changes in the law were needed to implement the plan.
- In 1992, DEP established the critical areas and sent out new orders, and a letter was sent (dated January 19, 1993) to NJAWC supporting and encouraging the Company to proceed with the Tri-County Project.
- Legislation was passed in July 1993 that gave the state the authority to implement the necessary cutbacks.

- Basically the new orders directed cutbacks to be effective by January 1, 1996, and specified that signed contracts with NJAWC (or, alternatively, local solutions) were needed by December 31, 1996. The current DEP commissioner is reported to be serious about regulatory action if there is failure by the towns to comply. Fines and additional regulatory action are expected to be imposed about mid-February of 1997.
- There has always been a feeling of resistance by the towns so that officials can "blame the state" for forcing connection to the regional system and an associated increase in rates.

Howell Township

During the course of the audit, the Company acquired the Howell Township water system. From a planning and operations perspective, the acquisition was a good decision. Three NJAWC water systems that essentially "surround" Howell are in Critical Area No. 1, where allocations were cut 40 to 50%. The estimated savings in NJAWC projects to serve these three systems that could be avoided by purchase of the Howell system is $12.5 million. The depreciated net plant is $27.0 million (compared to approximately $28 million calculated by Howell's consultant). The resulting Howell purchase price of $35.1 million is $4.4 million less than the organization value of $39.5 million ($27.0 M + $12.5 M).

Findings and Conclusions
(System Reliability and Planning)

C3C-1 **The Company exhibits a high degree of reliability for its customers.**

This results, generally, from: (1) very effective planning to identify future system needs, including alternative scenarios to cope with possible changed future conditions; (2) a program to construct the needed facilities identified in planning; and (3) a very good operations and maintenance program to care for systems' physical facilities.

C3C-2 The Company uses an effective mix of engineering and technical resources for its planning, engineering and construction.

These functions are provided in varying degrees by NJAWC Engineering, System Engineering, operations and maintenance staff, and engineering consultants and contractors. There is a rational, logical, although informal basis for the division of the planning and engineering work.

Appropriate communications, involvement and participation between the various parties takes place without the use of formal, prescribed procedures and without direct line authority. This approach is effective for NJAWC. NJAWC Engineering readily consults with or involves System Engineering when appropriate, and those organizations readily solicit operating assistance, as well. Knowledgeable personnel are contacted about a project regardless of their organizational affiliation.

Although there are no direct organizational reporting relationships between the groups and no stated policy requiring this activity, we find no compelling need to change the structural relationships.

C3C-3 NJAWC Engineering has recently been centralized and downsized, and its ability to perform its mission may be affected.

There is some concern that NJAWC Engineering may be under-staffed. This situation should be monitored on a continuing basis and staff added, if necessary.

C3C-4 Management at several senior levels is involved in the planning process which encompasses 1, 5, and 15 year time horizons, with the primary component being the Comprehensive Planning Study (CPS).

All planning recommendations are approved by senior management and eventually by the Board of Directors via the annual budget approval. The CPS process has begun using Integrated Resources Planning; and considers virtually every aspect of the physical system, incorporates engineering and non-engineering considerations, evaluates alternatives, uses engineering and economic models, and evaluates projects on a least cost basis.