Post Water and Sewer Systems Study

Fort Huachuca, AZ

Project No. FEE0043-1P

FINAL 100% SUBMITTAL

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SECTION ONE - EXECUTIVE SUMMARY

1.1 PURPOSE AND OBJECTIVES:

The purpose and objective of this study is to assess the ability of the post water and sewer systems to meet the demands of the planned growth at Fort Huachuca, and provide the officials of the Fort with the required data that will permit integration of the needs of both systems into the base comprehensive planning process. In association with the Department of Defense implementation of the Base Realignment and Closure Act (BRAC), current planning indicates that the Army Intelligence System Command (ISC) will remain at the base, and the Consolidated Intelligence School (ISD) will be relocated from Fort Devens, Massachusetts, to Fort Huachuca to join the already existing intelligence center and school (ICS). To accommodate the above, as well as additional missions, including the polygraph school, and support services, the base master plan has identified numerous new facilities. The majority of the new facilities are located on the north central portion of the cantonment area, as shown on the following vicinity map, and it is projected that the Base effective population will increase to 12,840 personnel.

In accordance with the scope of work for this study, the majority of the emphasis of the assessment is concentrated around the area of new construction and the contributing portions of each system which enable the new facilities to be integrated into the post water and sewer systems. Improvements to the systems proposed in this report are oriented toward providing additional capacity, where required, to meet the increased demand. However, the issue regarding the quality/integrity of the existing system can not be completely overlooked since the additional demands may exacerbate existing deficiencies and diminish the performance of the system.

To enable this study to be utilized in advance planning, beyond the current BRAC planning process, computer models of the water and sewer system were developed. The software utilized in this modeling process contain the required flexibility to expand the systems network, and copies of the software and data files will be provided to the base for ease of accessibility to the models.

1.2 SUMMARY OF FINDINGS AND RECOMMENDATIONS

1.2.1 WATER PRODUCTION SYSTEM:

In association with the planned growth at the base the average daily demand for water will increase from 2.9 MGD to 3.5 MGD. Based on the available data, it appears that the aquifer, wells, and well pumps have adequate capacity to meet the projected demands. However, with the increased demand, it becomes ever more important to monitor the water production system to ensure an adequate water supply and the efficient operation of the wells. Based on the data gathered from a well monitoring program, a water system management plan could be implemented. That system, when

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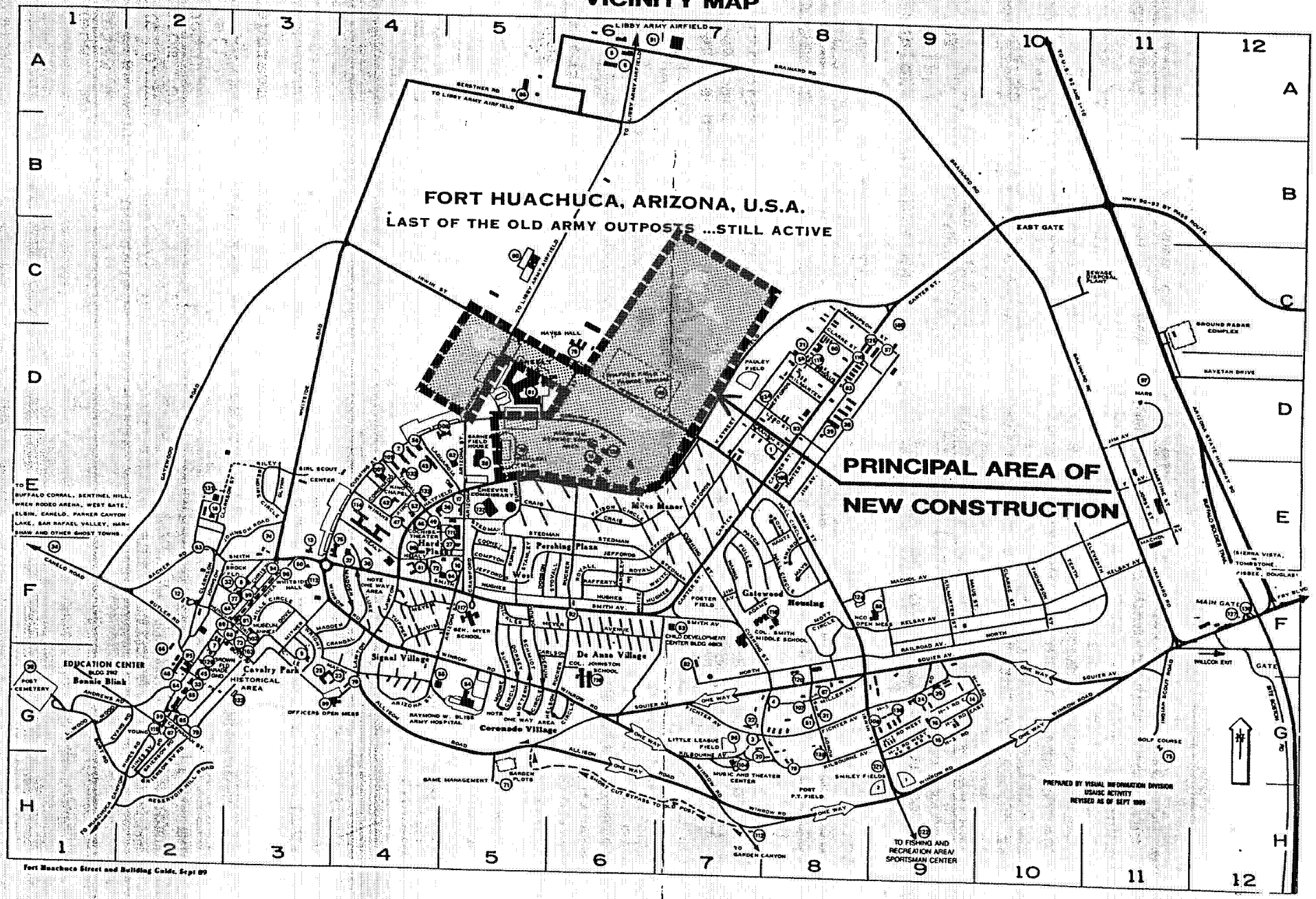
FIGURE 1.1
VICINITY MAP



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coupled with the recommended energy management control and instrumentation system for the water distribution system would allow for the most efficient pumping, lower energy consumption, provide advance warning of pending operational failures, and better assurance of supply to meet the increased demand.

In order to provide the basic tools for a monitoring program, the metering of the wells must be upgraded and software obtained to compile the required data. We have estimated the cost of the above equipment, including installation, to be $78,892.

1.2.2 WATER DISTRIBUTION SYSTEM:

With the construction and occupation of the new facilities, there will be additional demands placed on the middle and lower pressure zones of the water distribution system. While the existing system is generally in acceptable condition, the additional demands will necessitate these improvements to the system to provide the required system assurances.

With the additional demands, the existing excess capacity of the water storage facilities will be diminished. To enable the existing facilities to meet these new demands, the control/instrumentation system of the water system must be upgraded to allow for the efficient use of the existing reservoirs. Additionally it is recommended that the size of the manifold at the 1.5 million gallon reservoir be upsized to enable this section of the distribution system to maintain the required residual pressure during fire flow conditions.

The second primary area of concern deals with the physical condition of the booster pump stations, surge tanks, and water reservoirs. While these facilities have the capacity to store or move the required water, improvements to these facilities are necessary to protect the system's quality, reliability, and ability to meet the existing and future demands. An example of the type of improvements recommended deals with the surge tanks. Water is pumped from the wells into these holding facilities and while the water is in storage, it is subject to sunlight, dust, small insects, and wind blown impurities, which can reduce the quality of the water for both the existing and future users of the system.

The cost of the recommended improvements to the system has been estimated at $1,019,667 including design and engineering.

1.2.3 WASTEWATER TREATMENT SYSTEM:

The existing wastewater treatment plant (WWTP) does not have the capacity to meet the additional demands created by the planned growth at the base. To accommodate the additional flows the capacity of the primary process units will have to be increased. The WWTP is currently producing a minimally adequate quality effluent, however, the quality of the effluent does not comply with the standards for reuse as set forth by the State of Arizona,

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Department of Environmental Quality (ADEQ). Further, in association with the permitting process for the plant expansion, it is anticipated that ADEQ will require that the existing process units be upgraded to conform to their existing standards and regulations.

The principal modifications required at the WWTP to accommodate the additional flows include the installation of a second primary clarifier, the installation of a chlorination facility for the effluent conveyed to the east range, and the construction of a tertiary treatment filtration system. In addition to upsizing the major processing units, the WWTP required back-up equipment and other minor process equipment to allow for the continued operation of the plant during periods of maintenance and equipment failure. The cost associated with the plant expansion, including permitting, groundwater monitoring required by the permits, and the design of the facility has been estimated at $2,006,858 to increase the capacity to the design flow rate of 2.35 MGD, and $2,259,858 to increase the capacity of the plant to 2.7 MGD.

1.2.4 WASTEWATER COLLECTION SYSTEM:

The existing wastewater collection system consists primarily of a branched gravity system. The quality/integrity of the system appears adequate. However, with the planned growth at the base, portions of the system do not have the capacity to convey the future flowrates.

The principal interceptor lines downstream from the area of major new construction consists of 15 and 18 inch lines. At locations were the slope of the lines are reduced due to the topography, the lines will have to be upsized to 18 and 24" respectively. Other restricted areas include the trunk line west of Greely Hall, and the trunk line downstream of the hospital. In these lines, selected sections of the line will be upgraded and upsized. The cost associated with the required improvements to the wastewater collection system has been estimated to be $582,905.00.

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SECTION TWO: INTRODUCTION

2.1 GENERAL

Fort Huachuca is located in the western portion of Cochise County, in the southeastern quadrant of the State of Arizona. The Fort is bounded by the City of Sierra Vista on the east and Huachuca City on the north. While the adjacent cities have municipal water and sewer systems, Fort Huachuca operates private utility systems to service all of the facility's demands for water production, water distribution, wastewater collection, and wastewater treatment.

In association with the Department of the Army's implementation of the Base Realignment and Closure Act (BRAC), Fort Huachuca is preparing for an influx of new personnel and facilities. Under the current planning scenario, the Army Intelligence System Command will remain at the base and the Consolidated Intelligence School will relocate from Fort Devens, Massachusetts, to Ft. Huachuca. To accommodate the above, as well as the construction of a new Polygraph School, NCO Academy, and other missions and support services, the base master plan identifies numerous new facilities. These new facilities include troop housing, dining, training, academic, administration, and community/recreation facilities. As shown on Figure 1.1, the majority of the new construction will be located within the north central portion of the cantonment area.

Based on the information provided by the planning personnel of the Directorate of Engineering and Housing (D.E.H.), the population of the Fort will increase from an existing effective population (EP) of 9,938 personnel to an effective population of 12,840 during this planning period. The increase in population will include both resident and non-resident components. The resident population will be housed typically in barracks or off-site. There are no plans to increase the number of single family residential units to accommodate the population increase.

To accommodate the changing missions and requirements of the Fort, base personnel have been preparing a comprehensive master plan, considering all of the implications of the changing needs of the facility. As part of this planning process, the base determined that additional data regarding the post water and sewer systems were required. This study was commissioned, to provide an assessment of both systems in order that the systems needs could be incorporated into the comprehensive planning process.

2.2 PURPOSE AND OBJECTIVES

The purpose and objectives of this study are to evaluated the post water and wastewater systems to determine their ability to meet the demands of the planned growth at the base. The data presented in this study will permit for the integration of the needs of the systems into the base comprehensive plan.

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As set forth in the scope of work, the major emphasis of this study is directed towards the capacity of the systems and their ability to handle the additional flow-rates. While, capacity was emphasized, the quality/integrity of the system could not logically be completely overlooked. Due to the nature of the underground system, the available data regarding the piping and appurtenances were very limited. However, existing integrity concerns that were observed have been noted since the deficiencies in the system will be exacerbated by the additional demands placed on the system.

Due to the evolutionary nature of the BRAC planning process, the base requested that this study be prepared in such a manner that it could be utilized in future planning processes. To provide the flexibility that the base requires for long term planning, this study has been prepared using computer modeling techniques for both the water distribution and wastewater collection systems. The software and data files will be provided to the base to allow for compatibility in future planning.

2.3 METHODOLOGY

In the effort to prepare this comprehensive study in an expeditious manner and to provide the technical resources required, a design team was put together consisting of representatives of F&D/**GLHN**, Inc, Environmental Engineering Consultants, Inc., and Maher Environmental. Responsibilities were divided among the team members, with F&D/**GLHN**, Inc., being responsible for assessing the water distribution, water storage, and wastewater collection systems, Environmental Engineering Consultants, Inc., assessing the wastewater treatment plant, and Maher Environmental assessing the groundwater production system.

Each team member conducted field investigations, reviewed the available documentation, and met with representatives of the Fort. After the existing data were compiled, each portion of the system was evaluated in accordance the guidelines contained in the Department of the Army technical manuals and governing rules and regulations. Utilizing the above, this report has been complied to present our findings and assessment to the base to allow for the efficient planning of the anticipated growth at Fort Huachuca.

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SECTION THREE - WATER PRODUCTION SYSTEM

3.1 SUMMARY OF THE EXISTING SYSTEM

There are a total of nine production water wells that comprise the water production system on the Fort. Wells number one through eight are used regularly to provide water to meet existing demands of the Fort's permanent and itinerant population. One additional well, referred to as the SR Well, is located in the east range and is used only occasionally to meet the needs of field operations, whenever they are conducted on the East Range. A detailed water well inspection report form, indicating the production system's current well status, pump and motor condition, and operational capabilities, plus recent photographs of each of the wells, can be found in Appendix A.

An assessment of the water wells on the Fort revealed that the wells are not pumped at their maximum capacity, nor for excessively long durations in order to meet current system demands. These are high capacity wells (in excess of 500 gallon per minute) that in some cases have been operational for over forty years. The wells have been maintained and operated in a manner that has kept production in step with increases in the Fort's demand for water. A well by well inspection revealed that improvements are needed to insure that the wells, and their related appurtenances, remain in an operational status sufficient to meet projected future demands.

With a few exceptions, the daily operation and pumpage of the wells are controlled and monitored manually. Wells and booster stations are turned on and off to meet current and short term projected demands on the system. Records of pumpage, by well, are reported; however, not every well is equipped with its own meter. Some wells have no meters on them at all, others have meters that are improperly installed for making accurate flow rate measurements. Some of the reported pumpage for specific wells may actually be booster station pumpage from openair surge tanks that have been filled using the adjacent well. This method of reporting pumpage does not allow for performance monitoring of the wells and pumps.

3.2 ABILITY/DEFICIENCIES OF SYSTEM TO MEET FUTURE DEMANDS

3.2.1 THE AQUIFER

A comprehensive water supply study for the Fort was made by the Corp of Engineers in 1974. This report evaluated the potential of the regional aquifer and assessed where the potential for obtaining additional supplies was the greatest. As a result of this report, a number of test wells were drilled, and, based on the available data, it would appear that the aquifer has adequate production capacity to meet the projected future demands.

Water quality is not a serious problem with the Fort's water supply. The inorganic water quality data that were located during

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this study indicated that the total dissolved solids, (TDS) is less than 500 ppm from all wells.

There are groundwater monitoring wells located on the Fort to monitor the potential for contamination from leaking underground petroleum storage tanks. Additionally there are three groundwater monitoring wells located on the East Range to investigate the potential for contamination due to past dumping practices. An assessment of the groundwater protection monitoring program is outside of the scope of this study, however we would like to point out that the quality of the monitoring program will have lasting impact on the quality of the aquifer.

3.2.2 GROUNDWATER WELLS

An inspection of the existing well system disclosed that there are nine water supply wells on the Fort. Eight of the wells (Nos. 1 thru 8) comprise the production system for the post-wide demands, while the ninth well, the spatial resolution (SR) well, is utilized for only field operations on the East Range. Some of the wells have reported pumpage rates of 700 to 800 gallons per minute. Nine additional test wells exist on the East Range. One of them, #9, has already been tested and evaluated. It is the closest well to existing water mains and would be the most logical well to equip, if additional capacity were needed. Discussions with the Fort's designated water and wastewater plant operator, revealed that the water supply wells were monitored and maintained by an on-base service contractor. The daily pumpage information is collected and tabulated by well. These tabulated data indicate that the Fort currently pumps 2.90 million gallons per day, or about 3,250 acre feet per year, with peak daily rates as high as 6.0 MGD.

Utilizing the existing well production data, and an existing effective population of 9,938, equates to the following per capita water demand:

$$\text{Current usage} = \frac{2.90 \text{ MGD}}{9938 \text{ EP}} = 292 \text{ GPCD}$$

This daily usage includes domestic demands as well as non-domestic usage. To approximate the domestic water demand we will compare the well pumpage to the flow into the wastewater treatment plant.

$$\%\ \text{Domestic} = \frac{\text{Q Treatment Plant}}{\text{Q Wells}} = \frac{1.7 \text{ MGD}}{2.90 \text{ MGD}} = 59\%$$

$$\text{Domestic usage} = 292 \times 0.59 = 172 \text{ GPCD}$$

In projecting the above data to a future effective population of 12,840 (an increase of 2,902), we assumed that for the existing population, the domestic demand would remain at 172 GPCD. However, due to the water conservation measures constructed at the new facilities, the additional population would utilize 150 GPCD in accordance with TM-5-813-1. Thus the design domestic demand is:

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(9938 EP) (172 GPD) + (2902 EP) (150 GPD) = 2.14 MGD

In projection of the total future demand, it was assumed that the ratio of domestic use to the non-domestic use would remain at 0.59 for the existing population. Since the additional population will be located either in barracks or off-site, and will not have a requirement for lawn irrigation that is currently associated with the single family units, and since the new facilities will be constructed with more efficient devices, we proposed that the ratio of domestic use to non-domestic use would be approximately 0.75. Utilizing the above factors the total future water demand was estimated to be:

(9938 EP)(172 GPD)/0.59 + (2902 EP)(150 GPD)/0.75 = 3.48 MGD

The total rated capacity of the eight production wells is 5600 GPM, or 8.06 MGD at continuous operation. Assuming a worst case scenario of two wells down for maintenance the capacity of the system is 4000 GPM or 5.76 MGD. Thus, the ratio of capacity to demand, or capacity factor, would be 1.62. Additionally, in regard to the peak daily demand, estimated to be 7.2 MGD (6.0 MGD (3.48 MGD/2.90 MGD)), the total capacity of the wells exceeds this demand. These figures indicates that the wells have adequate capacity to meet the design demands.

3.2.3 OTHER WATER SOURCES

The Fort also has an existing system for collecting water from the Garden Canyon Spring and Huachuca Canyon Springs. At the present time, the Springs are not being utilized as a potable water source. Due to concerns regarding water quality and the preservation of the local eco-system. The Garden Canyon Spring is being utilized to supply wild life watering devices, the golf course pond, and the gravel pit pond, while the Huachuca Canyon Spring is currently being utilized to feed the officers' club pond.

The Fort's wastewater treatment plant supplies treated effluent for use on the golf course and parade grounds. While the assessment of the reclaimed water system was not included in the scope of work, it could be possible that through efficient use of this system, the demand for groundwater could be reduced.

3.2.4 WATER RIGHTS

The Fort has been named in a major law suit brought by the Gila River Indian Nation over water rights. This suit is about to be settled and is currently in the public comment process. Claims made by the Fort for establishing its historical water rights of 10,082 acre feet of water per year are contained in the settlement. It is not likely that the courts would rule that the Fort would be entitled to only a lesser water right.

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3.3 ALTERNATIVE AND RECOMMENDATIONS OF SYSTEM UPGRADE

The aquifer, the well field, and the water distribution system are not being fully monitored or managed at the present time. The lack of detailed well performance data, coupled with questionable pumpage collection procedures, and the absence of total distribution system performance reporting classify the present water distribution system as a manually operated system without a formal operating and/or long term management plan. A strongly recommended alternative to the manually operated and loosely monitored system is an automated data collection and computer monitored water management system. More efficient water system management practices could be implemented if improved data collection and compilation procedures were implemented.

Some wells have only totalizing meters, others have no meters at all. Therefore, meter readers are collecting all the information possible and necessary to properly manage the wells, without the wells being equipped with accurate flow meters. The overall pumping wire-to-water efficiencies are not being calculated and evaluated on a regular basis. Wells are not being pumped according to a plan from lowest cost water to highest cost water. A central filing system with detailed well files containing all the relevant data for each well is not being kept. Maintenance files, replacement costs and operational failures are not being closely tracked at the present time. Reduced operational and repair costs could be realized by implementing an operational and pumping plan based on data collected directly from the system.

As the demands on the system increase, proper monitoring and management becomes more critical. With better information about the performance of the system gathered and properly compiled, the system can be managed to minimize the cost of energy required. When the system operators can readily determine the wire-to-water efficiency of each of the wells and booster pumps, they can begin to manage the system on a cost-to-produce basis. When the operators can visually observe deterioration in the pumping capacity of a given well or booster plant, they can call for inspections or preventative maintenance procedures to prevent total failure of the component. The combined system management improvements could lead to better system management and reductions in overall operating and maintenance costs.

To implement the recommended improvements to the system, each well should be equipped with its own dedicated flow meter capable of measuring the instantaneous flow rate and recording the well's cumulative pumpage. If the distribution system continues to be manually monitored, this meter should be read every day at the same time to determine changes in the well's pumping capacity. A drop off in pumpage rate at the same time interval would give early warning of pending well or pump maintenance problems. If the system were to be automated and monitored electronically, each well should

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be equipped with electronic measuring and encoding devices to automatically read and report the well pumpage to a central facility.

System operators would monitor the complete system from this central facility. While each well and booster is being operated, an encoding device would be collecting and recording information about the changing demands placed on the system. A small computer system would be used to store and manipulate the data received. Pre established programs are available, to store and manage this information, that run on personal-size computers. These systems collect, store and display the pertinent information about individual wells, pumps, and storage systems. This information can also be used to manage the distribution system, reduce operational costs, and avoid water outages during the peak demand periods.

Well and pump record management should be improved to where a computer based data system can compile important information about the long term trends of the aquifer, wells and pumps, and daily system demands. Water management plans can be implemented to insure that the Fort has an adequate water supply to meet the proposed expansion and future growth.

3.4 COST ESTIMATE

Estimated costs for the recommended improvements have been prepared. The estimated cost for providing and installing an indicating flow meter on each well in order to actively monitor pumpage rates is estimated at $8,000 per well including modifications to the piping system that are necessary at some wells to properly install the meter. The estimated cost to acquire a small computer based system management plan, software is approximately $1,200.

Metering at Well Head	8 each @ $8,000	=	$64,000
Monitoring Software	1 each @ $1,200	=	$1,200
Subtotal			$65,200
Design Engineering (10%)			$ 6,520
Contingency (10%)			$ 7,172
TOTAL			$78,892

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SECTION 4 - WATER DISTRIBUTION SYSTEM

4.1 SUMMARY OF EXISTING SYSTEM

The existing water distribution system at the Fort consists of a well established network of mains, reservoirs and pumping facilities. In establishing the basis for the existing system, the assumption was made that the utility improvements that will be constructed under the utility/road upgrades (FY 90) would be considered as existing. In presenting our assessment of the system, we will address each of the major aspects of the system.

4.1.1. PRESSURE ZONES

The variation in elevation of the topography of the base ranges from 4400 feet in the northeastern portion of the campus, to over 5200 feet in the southwestern portion of the campus. To account for this variation in elevation, three pressure zones have been established in the distribution system. The boundaries of the pressure zones are shown on Figure 4.1 The high zone, Zone "A", has a high water elevation of 5293 feet and generally services the Old Fort and west range portions of the campus, from approximately the 5200-foot contour to the 5000-foot contour. Zone "B", which has a high water elevation of 5110 feet, services the central portion of the campus, from the boundary of Zone "A" to approximately the 4800-foot contour. The lowest pressure zone, Zone "C", has a high water elevation of 4887 feet and supplies the balance of the campus.

Isolation between zones is accomplished either by termination of the distribution system at the zone boundary, or by in-line gate valves. Under normal operating mode, pressure reducing valves are not utilized between the three primary zones. However, due to the elevation differences within Zone "A" and "B", sub-zones have been established at their lower ends. The sub-zoning is accomplished by in-line pressure reducing valves (PRV) which modulate the pressure downstream of the device and protect the facilities within the sub-zones from excessive pressures. Each pressure zone contains one or more storage reservoirs which are located at the upper end of the zone and which ride on the system, providing the hydraulic head for the distribution system.

Generally, the pressure zoning of the distribution system is adequate. There are locations within the system where the pressure dictates that PRV's be installed on the service lines, which is not uncommon in systems that are subject to large variations in the topography. However, it is our recommendation that an additional PRV be installed in zone "A" in the 6-inch line near Facility 41421 to provide a second point of supply to the northern sub-zone of this zone. Additionally, some of the existing PRV's are leaking, have defective gauges, and have poor-quality vaults. From a rough sampling of field inspections, we would estimate that seven additional PRV's will require upgrading to insure continued efficient operations.

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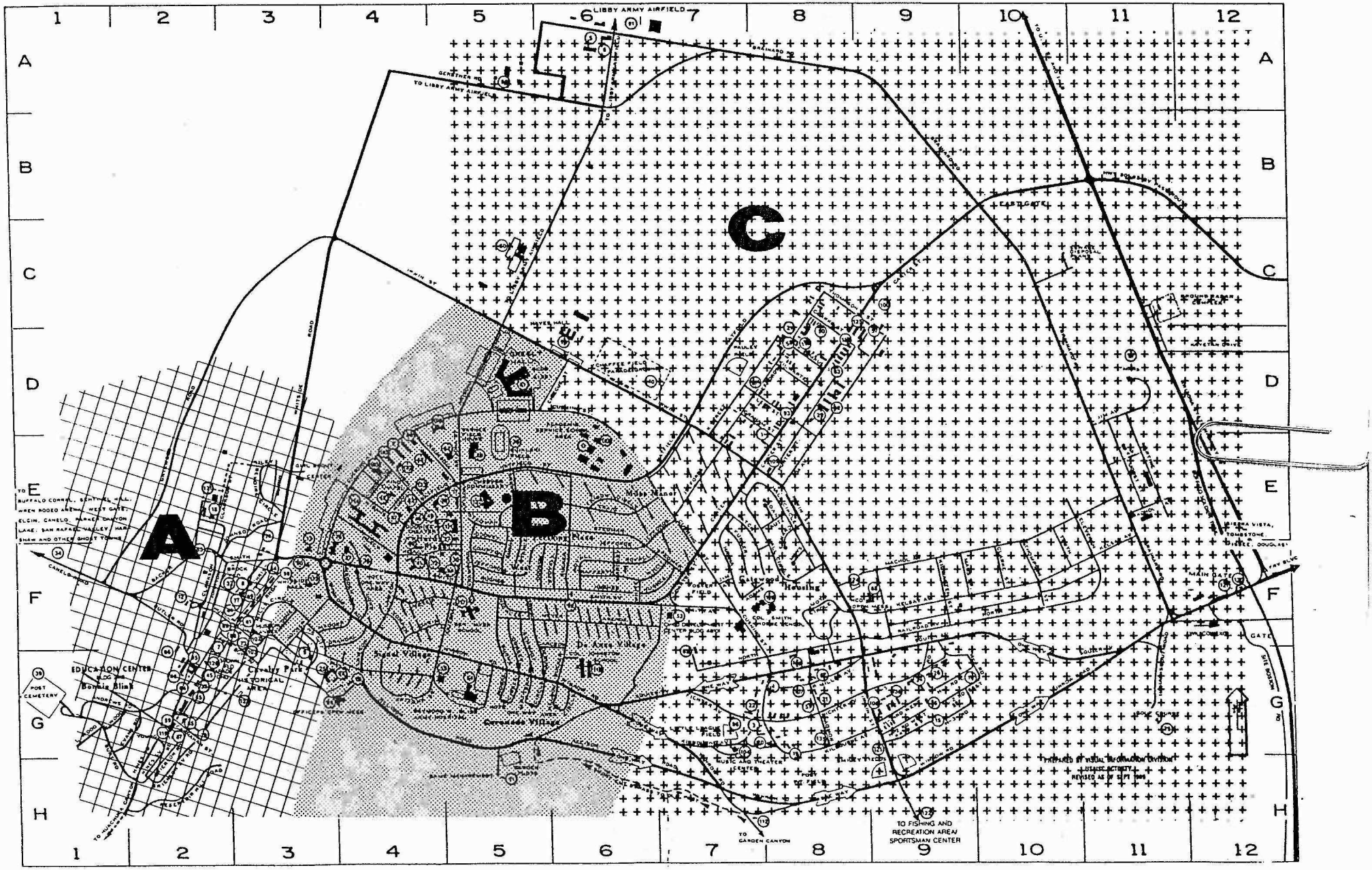
FIGURE 4.1

PRESSURE ZONE MAP



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