ANGLE and LINE

A Quarterly Newsletter by COWAN ASSOCIATES, INC.
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MAUI'S AGRICULTURAL ACHILLES' HEEL

By: J. Cheryleen Strothers, Senior Project Manager

During a recent vacation trip I had the pleasure of traveling the historic road to Hana, a barely two-lane road along the north shoreline of East Maui. The lush green vegetation along this scenic road is a result of the rain forest climate on the windward side of the Haleakala mountain range. Not only does this area provide impressive beauty for the tourist trade, it also provides the life blood – water – for the sugar industry on Maui.

Although the sugar industry started in 1849 on Maui, it was not until 1869 that the largest sugar production company was launched by two sons of missionaries, Samuel T. Alexander and Henry P. Baldwin. It was in 1869 that the two young men started their own business by purchasing 12 acres of land followed by the purchase of an additional 559 acres. The following year they planted their first sugar cane crop in Haiku. With the success of this first crop imminent, the two men officially started Alexander and Baldwin, Inc. and purchased 5,000 acres in the arid lands of the central plains of Maui. The two men quickly discovered that without copious amounts of water similar to the quantities available in Haiku, their crop would fail.

With the help of only his partner and a carpenter, Samuel Alexander devised a plan to provide an irrigation system which would gather water from the mountain streams of East Maui and convey it to the central plains. Alexander's proposal involved construction of a 17 mile long aqueduct consisting of ditches, tunnels, flumes and piping which would transport water from the rain forest area to the sugar fields. After successfully securing a license from the Hawaiian government to take water from East Maui, construction of the Hamakua ditch began in 1876 with a 2 year deadline for completion. Simultaneous with the construction of the Hamakua ditch, a second water use lease agreement was reached between the government and Claus Spreckels, a wealthy California sugar refiner who started operations on Maui. Spreckels' lease provided him with rights to all the unused waters from the watershed that fed the Hamakua ditch. In essence, this meant that if Alexander and Baldwin (A & B) could not complete construction on time, Spreckels would take over their ditch and get all the water for his own fields. With this added incentive to finish the ditch on time or risk losing their investment, construction of the Hamakua ditch was completed in the fall of 1878, one month prior to the deadline, thereby guaranteeing a 20 year lease to gather and convey a maximum 60 million gallons of water per day to the A & B fields.

In 1879 and 1880, Spreckels constructed a second ditch, the Spreckels' ditch, along the north coast of East Maui. Realizing the ever-increasing need for more water to continue to build the sugar industry, Spreckels negotiated another 30 year lease to build the most elaborate system to date, the 30 mile long Haiku ditch system, with the capacity of transporting 50 million gallons of water per day.

The late 1800's and early 1900's saw continued growth of the sugar industry, which included Spreckels' Hawaiian Commercial and Sugar Company being absorbed into Alexander & Baldwin, Inc. Throughout these years several other irrigation ditches were constructed. The last major project, the Wailoa ditch, was completed in 1923.

Currently, the collective East Maui Irrigation System consists of 74 miles of ditches, tunnels, pipes, and flumes with the capacity to transport 450 million gallons a day. The system also includes 7 reservoirs with a total of 274 million gallons of storage. Cultivated sugar cane fields now occupy 35,000

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MAUI'S ACHILLES' HEEL

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acres in the central plains and use approximately 126 billion gallons of water per year, of which more than half is supplied by the East Maui Irrigation System.

Although the East Maul Irrigation System has been operating for over 100 years, it is not without controversy. With every water lease renewal, more local residents are questioning the effect the system is having on the rain forests of East Maui. Removal of so much water, along with a recent drought, has caused streams, ponds, and waterfalls to dry up. One thing is certain, however - without the East Maui Irrigation System, there would be no sugar cane crop in the central plains.

Maui is considering specializing in biotechnical research to foster agricultural crops less dependent on huge amounts of water. Maui's most sophisticated sugar cane growers are keenly aware that surface runoff is a limited resource, so they have begun improvements in irrigation efficiency by using drip irrigation. In addition, 45% of the irrigation water supply comes from deep wells using brackish groundwater. Nevertheless, it appears that water supply may be Maui's agricultural Achilles' Heel for a long time to come.

EMPLOYEE SPOTLIGHT

By: Charles R. Tomko, P.E.

Cowan Associates, Inc. is proud to announce the addition of Nicole A. Schantz to our staff. Ms. Schantz is a graduate of The University of Virginia with a Bachelor's Degree in Civil Engineering from the School of Engineering and Applied Science. She is originally from the Coopersburg area and graduated from Southern Lehigh High School.

Ms. Schantz will be assisting us in the Structural Engineering department. Ms. Schantz has received her Engineer-in-Training certification from the Commonwealth of Virginia.

Welcome Nicole A. Schantz, EIT

DEVELOPMENT OF A MUNICIPAL WATER SYSTEM MASTER PLAN

By: Carl H. Wischner, Senior Project Manager

The Borough of East Greenville, Montgomery County, recently asked Cowan Associates, Inc. to prepare a Water System Master Plan of the Borough's entire existing water system.

The request was unique in that not many municipalities decide to take on evaluations of entire infrastructure systems. The study was also a challenging request because the original system was installed in 1894 and very little documentation existed. The reality came very quickly that in order to complete an evaluation of the entire system and prepare a Master Plan, close partnering with the Borough would be essential.

Initial meetings were held and plan goals were established that included:

Evaluation of the existing water source and entire distribution system to determine the overall system's ability to meet existing and future water needs of the Borough into the new century.

Determination of system deficiencies.

Development of solutions to correct deficiencies.

Development of recommendations for system upgrading and improvements.

Development of an upgrade program and initial project.

Through the initial meetings with Borough personnel and subsequent field inspections, a system inventory and base plans were developed. Each component was evaluated as to condition and age. Some of the more interesting findings included:

(a) The existing distribution system consists of approximately 39,500 feet of 8", 6", and 4" mains, and 54 fire hydrants. Of this pipe footage, it was also established that approximately 30% of the distribution system consisted of the original 1894 piping, and approximately 76% of the distribution system piping was between 45 and 105 years old.

(b) Water storage was limited and consisted of a 300,000 gallon elevated storage tank built in 1934. While it could have been renovated, repairs were extensive.

(c) The Borough had two (2) water sources – a surface water supply from the Perkiomen Creek which has been utilized since 1894 and a groundwater supply from a well that has been utilized since 1958. In an emergency, the Borough has an interconnect with an adjacent municipal water system.

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(d) The surface water is treated at a Borough filtration plant located on the Perkiomen Creek. The original filtration plant was built in 1894 and was replaced in 1939. It was upgraded and modified to its present condition in 1988 and now requires some remedial work.

(e) Raw water is drawn from an impoundment on a side branch of the Perkiomen Creek. The impoundment is severely silted in and impacting water quality. The impoundment is created by a low profile dam constructed in 1932, that is in an advanced state of deterioration.

After this initial assessment, we found that the Borough does have an established customer base, an adequate supply of water, and a distribution system that can be upgraded in a systematic manner. However, it was obvious that the old age of the system and progressive deterioration associated with age would be the most critical factor in prohibiting the system from meeting existing and future water needs of the Borough.

The next challenge was to determine the condition and severity of the deterioration of flow capacity in the distribution system, including the several areas of the Borough with severe low flow and low pressure problems. To evaluate the entire distribution system, a computer modeling and analysis of the system was conducted.

To insure that the computer model matched the existing conditions of the piping system, Borough personnel performed flow testing of representative sections of the system. The data obtained from the flow testing were incorporated into the model and a computer analysis of the system was run. The analysis concluded that the majority of the distribution system had severely diminished flow carrying capacity, low pressures, and inadequate fire flow. Considering the magnitude and widespread deficiencies in the system, it was decided to develop an "Ultimate Future System" to which the Borough could ultimately upgrade and which would meet their future needs. A basis of design for the ultimate system was established [based upon criteria set forth by Insurance Services Office (ISO) and American Water Works Association (AWWA)]. Needed fire flow within the entire Borough, by block, was determined and, utilizing the computer model of the system, an ultimate future system consisting of large size trunk mains and smaller size distribution piping was developed.

A final list of system deficiencies was established; solutions were developed and prioritized into supply/treatment deficiencies and distribution/storage deficiencies. Deficiencies were further broken down into projects and prioritized into Immediate, Intermediate, and Long Term needs.

Preliminary cost estimates were prepared. After analyzing the costs, it became apparent that the total cost to completely upgrade the water system as one project would not be feasible. Options were reviewed, discussions were held with the Borough, and an "Initial Core Project" was developed that would meet the immediate minimum goals established and would provide a foundation to upgrade the remainder of the water system to meet future Borough water needs.

Initial core project would include the following improvements to the water supply:

Replacement of the raw water impoundment dam and dredging of the impoundment.

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FORENSIC CORNER

by: Johann Szautner PE, PLS, V.P.

Many of my clients and colleagues have asked me to share case histories from my practice of Forensic Engineering. Indeed, the knowledge gained from a forensic investigation is a lesson in preventative engineering and risk management. Properly and thoroughly practiced, preventative engineering examinations, including assessment of failure modes, may greatly reduce the need for forensic engineering.

As professionals and as a society, we need to foster an environment that encourages prompt acknowledgment of a problem and quick initiation of a thorough examination of what went wrong. The sooner the problem is identified, the narrower the range of affected parties and the fewer the economic consequences.

With this in mind, I will periodically share with you a case history, and I am asking you to email your feedback –

jfs@cowanassociates.com.

HUMOR

The chickens in a large hen house started to quarrel, wounded each other and many of them died every day. The upset farmer hurried to a consultant, and asked for a solution to his problem. "Add baking-powder to the chickens' food," said the consultant, "it will calm them down."

After a week the farmer came back to the consultant and said: "My chickens continue to die. What shall I do?" "Add strawberry juice to their drinking water, that will help for sure."

A week passed, and again the farmer came to the consultant: "My chickens are still quarrelling. Do you have some more advice?" "I can give you more and more advice," answered the consultant. "The real question is whether you have more chickens."

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Remedial work and improvements to the Filtration Plant.

to the distribution system:
Installation of large diameter trunk mains.
New water storage tank.

to system operations:
New maintenance building.

Initial core project was structured in such a manner that remaining long term improvements outlined in the Master Plan could easily be incorporated into future street projects or separate stand-alone phases as funding becomes available.

Prior to adopting the Master Plan, the Borough held public meetings and solicited comments from the residents.

Financing options were discussed and user fee projections were presented. Results of the meetings were positive. All involved realized the inadequacies of the existing system and need for the improvements to meet existing and future water needs of the Borough. Input from these meetings fine-tuned the plan, finalized sizing and siting for the water storage tank, brought forth the need to construct a new maintenance building, and combined the immediate and intermediate plans into one immediate project.

The Master Plan was adopted by the Borough and the immediate project is proceeding into the final design phase.

In conclusion, the foresight that the Borough of East Greenville had in development of a Master Plan has allowed the Borough to address the needs of their aged water system in a systematic planned manner with the minimal amount of impact to its residents before any acute problems developed in the system that would require costly, unplanned, emergency acting.

Cowan Associates, Inc. congratulates Borough officials and citizens of the Borough for their support, cooperation as partners, input, and hard work in performing research, field testing necessary, and the wisdom of helping to select an implementable plan.

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ANGLE and LINE is published quarterly by Cowan Associates, Inc. For additional information on articles contained within contact:
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