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**Report of the
Pattaya, Thailand
-
Savannah, Georgia
City Twinning Project
for Urban Environmental Infrastructure**

**Savannah, Georgia
August 7-21, 1993**

A Program of:
The United States Agency for International Development (USAID) / Thailand

With Logistical and Technical Support from:

The World Environment Center
419 Park Avenue South, Suite 1800, New York, NY 10016
1600 Wilson Boulevard, Suite 500, Arlington, VA 22209
Silom Plaza, Second Level, 491/43-47 Silom Road, Bangkok, Thailand

I. Executive Summary

As Thailand's economy continues to grow rapidly, many municipal governments are facing new challenges and problems associated with wastewater and municipal solid waste (MSW) management. In an effort to help city officials in the process of choosing environmentally sound and effective treatment methods, the Thailand Mission of the United States Agency for International Development (USAID) is bringing together Thai cities and U.S. cities of comparable size, climate and geographic features. The program is designed so that Thai government officials will have an opportunity to have an objective overview of the solutions to waste problems implemented in the U.S. city. The World Environment Center (WEC) is coordinating this program in the United States.

From August 7 - 21, 1993, Dr. Preeda Wirojpan, Director, Department of Health and Environment, Ms. Kusuma Wongjantara, Assistant Director, Department of Health and Environment, and Mr. Montri Chalittaporn, Environmental Engineer, Sanitary Engineering Division, from the City of Pattaya, Thailand visited their "twin," Savannah, Georgia. The mission was designed to allow the delegation from Pattaya to get an objective view of Savannah's initiatives in wastewater treatment and solid waste management and in an effort to find solutions applicable to Pattaya. The delegation found the visit extremely helpful in understanding the options available to meet the growing demands on their current environmental infrastructure.

Pattaya and Savannah are both cities of approximately 150,000 with much larger populations of close to 300,000 each if the surrounding area dependent on the respective cities are included. In addition, both cities are major tourist destinations with over 2 million visitors annually. Both cities are situated in low lying areas, bordered by rivers and oceans and have a high average rainfall of approximately 1,300 millimeters annually.

The City of Pattaya grew out of a small fishing village in the 1960's and grew as a resort town largely serving the American military during the Vietnam War. The city is beginning to experience a second growth spurt in conjunction with the developing Eastern Seaboard Region for research, commercial and business activities as well as for residential development. However, due to the lack of proper regulation and guidance for land development and environmental infrastructure, Pattaya is experiencing serious problems with water supply, wastewater pollution, traffic congestion and excessive land development.

As a result of the initial visit to Savannah, the Pattaya delegates have a better sense of the options before them and the benefits and problems associated with each. In addition, the delegation has a renewed appreciation of public education and outreach programs as an essential element to the success of any solid waste or wastewater treatment system. Upon return, delegates from the City of Pattaya will continue efforts to effectively meet the challenges before them.

II. USAID/Thailand's City Twinning Initiative and Savannah's Role

The Regional Housing and Urban Development Office (RHUDO) of the United States Agency for International Development in Bangkok, Thailand conceived of the "twinning" model as a way to bring U.S. expertise to bear on development problems at a local level. In Thailand's urban areas, problems related to environmental infrastructure and services are among the most pressing. The concept of "twinning" allows delegates to learn about environmental issues, technologies and approaches in the "twin" city, as well as about how cities in the U.S. do business. This approach takes into account all the technical, political, social and economic aspects of providing services and infrastructure at the municipal level.

USAID identified priority environmental issues in Pattaya and identified the City of Savannah, Georgia as an appropriate "twin". Savannah and the surrounding Chatham County recently completed the lengthy and complicated process of evaluating their wastewater treatment needs and solid waste management plans for the county. The Metropolitan Planning Commission oversees these processes and coordinates task forces which include representatives from each of the nine municipal governments in the county, the private collection and disposal companies operating in the area, the Chamber of Commerce, and a number of concerned citizens and private sector representatives.

III. Background: Current Environmental Services in Pattaya

A. Wastewater Treatment

Current Services

Currently most households in Pattaya are serviced by a septic tank and cesspool unit for latrine wastewater. Other wastewater is discharged through a combined storm and wastewater system consisting of natural ditches or sewer pipe drains. All wastewater collected receives secondary treatment before discharge into the Gulf of Thailand or nearby canals. A small area of approximately 100 residences and businesses in South Pattaya, does not receive any treatment and is resistant to the city's efforts to provide sewer connections. The impact of this discharge is readily evident as the only beach area deemed unfit for bathing is around this section.

At the present time, an area of 4 square kilometers of the 53 square kilometers in the city are connected to a primary wastewater treatment facility. There are two plants serving this area: a plant with an 2.1 million gallons per day (MGD) (8,000 cubic meter) capacity (roughly one-half size of Savannah's Wilshire Plant) and a 1.3 MGD (5,000 cubic meter) facility. These two facilities treat approximately 20 percent of wastewater generated in Pattaya.

The major portion of the treatment at both facilities is provided by rotating biological contactor (RBC) technology. In addition, these plants utilize one-inch bar screens to filter large foreign matter from the stream; however, these screens are too wide and allows relatively large material into the plant. In addition, sludge pumps are too small (approximately 4 inch diameter) and often clog. The systems are high maintenance and require the use of de-clogging pumps and pipes on a daily basis. Currently the only additive to the wastewater stream is a 60% concentrated powder chlorine to remove coliform bacteria.

Rates for the water/sewer service are 3.6 Baht (approximately \$.15) per square meter (approx 9 square feet) per year in residential, 6 Baht (\$.25) per square meter for commercial areas, and 672 baht (\$26.90) per room per year for hotels. The municipal government sets these rates in accordance with federal guidelines and in line with operating and maintenance costs. The city does not recover capital costs from user fees.

Proposed Services

In an effort to enforce a recently enacted Pollution Control Law, the Pollution Control Department (PCD) of the Ministry of Science Technology and Environment (MOSTE) is currently finalizing a plan for a new 13 MGD (50,000 cubic meter) aerated sludge

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treatment facility to serve North Pattaya (Na-Klua). City officials estimate that this plan has a 80% chance of implementation. The facility is controversial, because it is slated to be located outside of Pattaya's city limits and requires that the city purchase the 140 acres (56 rai) of land required to house it. In addition, the location of the plant is relatively high (30 meters above Pattaya) and 2 miles away which will require costly pumping estimated at \$80,000 (2 million baht) annually. The plant will also discharge into a river that is already heavily polluted.

The Public Works Department (PWD) of the Ministry of Interior also has a plan for a new plant in a low lying area on the coast of North Pattaya to treat the same area. This project which was included in a 1990 survey of Pattaya by the Japanese International Cooperation Agency (JICA) would entail reclaiming land on the coast and discharging treated effluent into the Gulf. Only one of the plans will be implemented, and municipal engineers prefer the PWD plan, but realize that the PCD plan has a better chance of approval.

The Public Works Department has also approved a 5.3 MGD (20,000 cubic meter) plant for the Jomtien area of South Pattaya. This plant will utilize a combined fixed film and activated sludge technology for primary treatment. This plan is currently being contested by the Pollution Control Department (PCD) of MOSTE. The PCD would like to design the plant with a different activated sludge technology.

The city also plans to expand the existing 2.1 MGD facility in Central Pattaya to a 5.3 MGD facility.

Issues

Officials in Pattaya acknowledged that the process of coordinating between the Pollution Control Department of MOSTE and the Public Works Department of the Ministry of Interior often results in ineffective communication. In addition, federal government studies to determine the actual impacts of new wastewater management programs are often incomplete. On average, impact assessments last approximately six months to one year, and are not long enough for long term or comprehensive impacts to be evaluated.

The City of Pattaya also suffers from a lack of skilled technicians, operators, mechanics and engineers. For a number of reasons, it is very difficult for the city to hire and keep good operators and mechanics. First, there is no established certification process or training procedure, and second, the municipal pay structure prevents departments from providing incentive pay to qualified and skilled workers. This compensation structure creates a situation of high turnover, especially among qualified workers.

In addition, municipal engineers have experienced difficulties due to the lack of attention to training costs by decision makers when evaluating the total cost of a technology. The delegates felt that the city will often buy a new process/technology without providing adequate opportunities for employees to be trained for proper operation and maintenance. Without proper operation and maintenance many environmental technologies are often ineffective.

The City of Pattaya also has experienced difficulty in securing parts and service for damaged equipment. Often the government will purchase foreign equipment without thoroughly investigating domestic vendors, availability of parts and service, and warranties on operation. The engineering department is then forced to repair and maintain equipment on a somewhat makeshift basis which does not allow for maximum efficiency.

B. Solid Waste

Collection

A subsidiary of a major Thai conglomerate has a contract with the city of Pattaya for collection. Residential areas are serviced by large community containers which are conveniently located on the roadside. Most households are aware of the timing of the pick-ups, and place their waste accordingly. Due to the high percentage of food waste in the residential stream, the city has implemented a twice daily collection schedule. This frequency helps reduce the amount of odor and litter which occurs from overflowing collection containers.

The company operates 20 trucks in the city with approximately 300 employees to operate the collection service and four employees at the landfill.

Pattaya handles billing for solid waste which currently averages approximately 10 Baht monthly/household (\$0.50) for a maximum of 20 liters/day. The fee structure is graduated for levels above 20 liters/day. The rate for commercial and industrial customers is 1,000 baht (\$40.00) per 1 cubic meter/day.

Waste Stream Composition and Volume

The most significant materials in the waste stream in Pattaya include approximately 33.1% food waste, 19.1% paper, 10.7% wood waste, 9.6% plastics, 7.7% glass, metal and construction, and 19.8% other.

The average daily volume is 130 tons/day.

Landfill

The city operates a 350 acre (140 rai) landfill which was difficult to site due to public opposition. The landfill has been operating for approximately one year, and has an estimated five years life expectancy until it reaches capacity. The city has already purchased land for a new landfill. Currently the landfill is essentially uncontrolled. Employees of the collection company operate compacting and bulldozer equipment on the site, but there is no monitoring of vehicles or volume entering into the landfill nor inspection of the waste disposed.

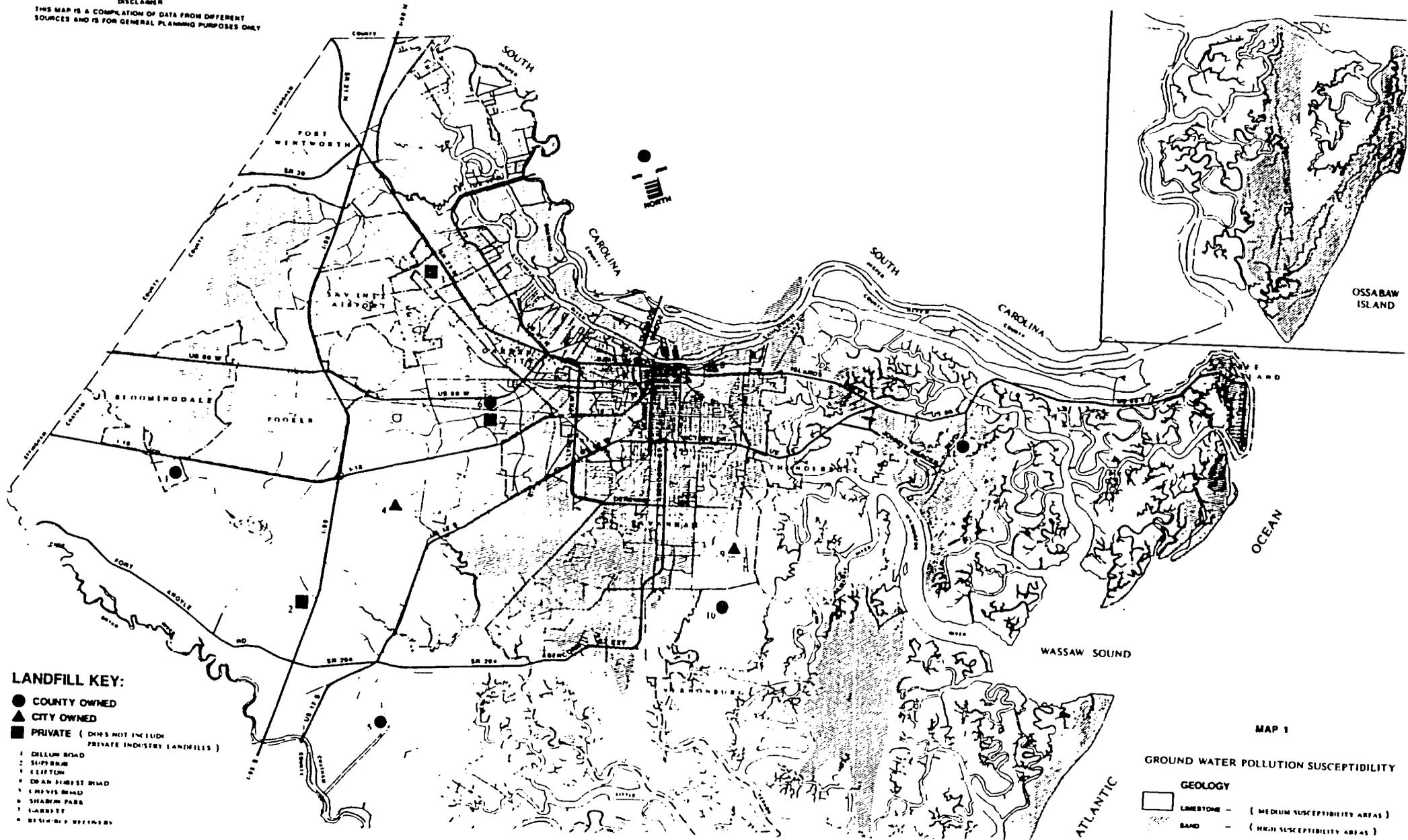
During the rainy season (May - November) Pattaya receives the majority of its annual rainfall (up to 1,630 mm). This moisture causes significant problems at the landfill. As the company is not in the habit of covering the active areas of the landfill daily, rainwater is allowed to filter through the waste and cause a serious leachate problem. To date, landfills in Pattaya are virtually unregulated and are operated essentially as dumping grounds.

Incinerator

The city currently has a small 3 ton per day incinerator for municipal solid waste on Ko Lan Island. There are currently no gas or particulate emissions controls. The City of Pattaya would like to incinerate more, but there is too much moisture in the waste stream to make it feasible.



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 SOURCES AND IS FOR GENERAL PLANNING PURPOSES ONLY



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III. Summary Notes from the Pattaya Delegation's Visit to Savannah

GENERAL BACKGROUND

Overview of Savannah and Comparison to Pattaya

Susan Weiner	Mayor
Don Mendonsa	City Manager
Milton Newton	Assistant Executive Director, Municipal Planning Commission (MPC)
David Rutherford	Senior Environmental Planner, Municipal Planning Commission (MPC)
Horace Magwood	Director, Bureau of Sanitation
Harry Jue	Director, Water and Sewer Bureau
Robert Bartolotta	Assistant City Manager for Management and Financial Services
Brian Gore	Assistant to the City Manager

Milton Newton	Assistant Executive Director, MPC
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The MPC is an agency jointly administered by the City of Savannah and Chatham County.

The most important similarity between Pattaya and Savannah is that tourism is the main industry in both cities. Pattaya hosts approximately 2 million tourists annually (90% from foreign countries). Savannah had approximately 5 million visitors in 1992 including conventions and business travellers (1.2 million actual tourists). To support the tourist industry both cities have a large number of hotels, restaurants, and tour companies.

Geographically, Thailand is 2.8 times more densely populated than Georgia (286 per square mile vs. 115 per square mile). In Savannah an area of 65 square miles supports a population of 142,184 and in Pattaya an area of 20 square miles supports a population of 161,550. In addition, both cities serve as the central business center for larger surrounding areas.

Savannah has an extensive environmental infrastructure, with 99.5% of all housing units having complete plumbing facilities. In addition 98.9% of all housing units get water from a public or private water system, and 97.1% are connected to public sewers; only 1,510 housing units utilize septic tanks or other means of sewage disposal.

Robert Bartolotta, Assistant City Manager for Management and Financial Services

The water and sewer services operate as enterprise funds; costs are recovered from user fees. The city operates the systems for Savannah and the unincorporated county areas, charging 50% higher rates outside of the city. The rationale behind this is that city residents paid for the treatment facilities out of property taxes originally.

Although operating costs are recovered from revenue, the city must finance improvements with revenue bonds. The city enjoys a very good rating for bond financing and was recently upgraded to a near double A rating.

The city bills residential customers twice monthly for sewer and water. The bill covers water, sewer, and solid waste collection, charging a base rate for service and an additional charge for volume. The city has a 98% compliance rate.

History of Current Regulatory Program in Georgia

Georgia Department of Natural Resources (DNR)

Larry Rogers Regional Manager, Environmental Protection Division (EPD)

Daryl Crosby Environmental Specialist, EPD

Gary Reynolds Environmental Specialist, EPD

Frank VanArdsdale Environmental Specialist, EPD

Talakshi V. Gala Director, Waster and Sewer Engineering, City of Savannah

Brian Gore Assistant to the City Manager, City of Savannah

The Environmental Protection Division (EPD) of the Georgia Department of Natural Resources is responsible for regulation and enforcement of industrial and municipal wastewater treatment, drinking water, solid waste disposal, air quality and erosion and sediment. Georgia established the EPD in 1972 following the establishment of the Federal Environmental Protection Agency in 1971.

Wastewater Treatment

In the early 1970's, most cities in Georgia had water treatment systems but no sewage treatment facilities. The federal government supported efforts to remedy this situation by funding 75% of total costs to develop sewage treatment plants, including engineering and construction costs. Municipalities were expected to cover the additional 25% through revenues of their own.

Soon after its establishment, the EPD created laws and measurable standards for wastewater treatment and later developed methods to monitor and measure stream quality. The state then began issuing 5 year discharge permits for discharge volume, BOD (biological

oxygen demand), total suspended solids (TSS), pH range, and bacteria. The permit levels are customized according to the receiving stream.

The EPD later implemented a widespread education campaign and an operator training course and certification process for wastewater treatment facility operators. The department also established laboratories for testing effluent from the plants and mechanisms to take action where plants are not meeting compliance levels. This process of developing safe and efficient wastewater treatment facilities took 10 years and has been in operation since 1980. Currently, there are very strict fines for any municipality or individual violating the discharge permit levels.

Solid Waste Management

Prior to the 1970's solid waste disposal in Georgia entailed dumping waste in an unpopulated area and burning waste in open fires. The federal Environmental Protection Agency (EPA) and the Georgia EPD recognized this practice as extremely detrimental to the environment and developed regulations for sanitary disposal as a result. The earliest regulations called for waste to be disposed in cells or trenches and prohibited open burning. However, these early regulations did not account for methane releases leachate problems or groundwater contamination; the laws did not cover gas releases, liquid waste, ground permeability, or stormwater infiltration.

The most recent regulation surrounding solid waste disposal will be in effect as of October 9, 1993. This legislation, known as Subtitle D of the 1976 Resource Recovery and Conservation Act, requires lining and leachate collection systems to prevent groundwater contamination. Most facilities will send the leachate collected from landfills to a wastewater treatment plant. The EPA is also requiring a 30% reduction in the amount of solid waste going to sanitary landfills by 1996.

In Georgia, sanitary landfills that comply with the latest regulations cost approximately \$150,000 - \$200,000 per acre to construct and maintain. The EPD performed an economic analysis which indicated that landfills are no longer economical unless they receive more than 200 tons of MSW per day. The study also found that incinerators are not economically feasible unless they burn between 500-1000 tons/day and they have customers for steam energy generated.

Laboratory

The EPD lab is equipped for quantitative measures for pollution, not necessarily what the qualities of specific pollutants.

Work in the lab has been greatly simplified by using prepackaged kits for wastewater testing. This lab and most others in Georgia use kits produced by Hach, a company in Loveland, Colorado that designs and manufactures a wide range of products from simple test kits to on-line analyzers for automated process monitoring. (Hach Company World Headquarters, PO Box 389 Loveland, CO 80539 USA TEL: 1-800-227-4224 FAX:303-669-2932)

WATER AND WASTEWATER TREATMENT

Jekyll Island Wastewater Treatment Facility: Bobby Palmer, Director

Wastewater Treatment

The Jekyll Island facility services approximately 6,000 people including residents and tourists. Wastewater is primarily from residences, restaurants, and hotels. The facility has a 1 mgd capacity and uses an activated sludge system for treatment with a primary settling system and a trickling filter for additional treatment (Photo 1). Drinking water is also treated at the facility through a separate treatment system at the site.

Photo 1: The trickling filter system at the Jekyll Island Wastewater Treatment Facility. Mr. Bobby Palmer (right) explains that the force of the water through the pipes forces the arms to rotate, making it a very cost effective technology. Algae on the filter rocks serve as a clarifying agent. Also pictured: Montri Chalittaporn, Preeda Wirojpan, (Pattaya) T.V. Gala and Brian Gore (Savannah), and Larry Rogers (Georgia EPD).

Currently the plant receives approximately 800,000 gallons of influent daily containing a BOD level of 112 parts per million (ppm) and is permitted to discharge at a rate of 30 ppm. The biggest pollutant is grease from restaurants. Chlorine is the only element added for treatment at a rate of approximately 60 pounds per day, leaving a residual of 0.1 - 0.2 ppm in the effluent.

The plant pays its operators approximately \$6.00 an hour, and lab technicians \$8.00 an hour. This pay is competitive and the plant has only lost one employee in seven years.

Certified Laboratory

The facility houses a certified lab for drinking and wastewater analysis. The three lab operators test pH, mixed liquor, return sludge, total suspended solids and total and free chlorine on residuals. They also test for BOD twice weekly and COD once weekly. In total, the lab performs 40,000 tests annually.

Lab technicians are required to have a high school diploma, 27 hours of supervised lab work and six months of experience to work in the lab. The state of Georgia also requires a written test and a routine lab test. Technicians are licensed and must renew the license every two years by taking 12 hours of continuing education courses sponsored by the Pollution Control Department at the Georgia Water and Wastewater Institute in Carleton, GA.

Wilshire and Georgetown Wastewater Treatment Facilities

Mark Vanagel

Director, Wastewater Treatment Bureau

Laboratory and Office

The Wilshire and Georgetown wastewater facilities each plant has a small on site laboratory to test for solids, dissolved oxygen, and other analysis necessary for operation. Additional analysis not essential for daily operation are performed at the main lab located at the President Street facility.

The offices keep operation and maintenance manuals for all of the equipment in the plant and emergency equipment for chlorine leaks.

Wilshire

This Wilshire plant opened in 1989 with a maximum capacity of 4.5 million gallons per day (MGD) (17,000 cubic meters) and an average flow of 3 mgd. The plant serves an area of approximately 8 square miles and a residential population of 30,000 with some commercial and restaurant customers. The plant is manned by three people for 40 hours a week with staff on call during the off hours. The plant and pump stations cost approximately \$6.8 million to construct in 1989.

The plant uses an activated sludge technology. Raw sludge is first pumped through a 24 hour composite sampler which can be programmed to take samples according to flow or time (Photo 2). From the sampler, electric pumps force the influent to the initial screen where gravity takes over to control flow through the rest of the plant (Photo 3). The plant has a total energy cost of approximately \$7,000 - \$8,000 monthly. The plant also has a back-up generator in case of a power outage. The generator is diesel fueled and turns on automatically if there is a loss of power at the plant.

Photo 2: Kusuma Wongjantara observes the composite sampler at Savannah's Georgetown Wastewater Facility with Mark Vanagel. The sampler can be programmed to take samples of the influent according to time or volume.



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The plant has been operating smoothly during its 4 year life; however, there have been some problems with corrosion from hydrogen sulfide which collects in the sludge. The hydrogen sulfide is currently not treated before entering the plant and is causing corrosion on stainless steel screens and is staining the plant walls.

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Photo 3: Mark Vanagel, Director, Wastewater Treatment Facilities, Savannah explains to Montri Chalittaporn, Sanitary Engineer, Pattaya that gravity pulls water through the plant to the clarifying tanks pictured.

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Georgetown

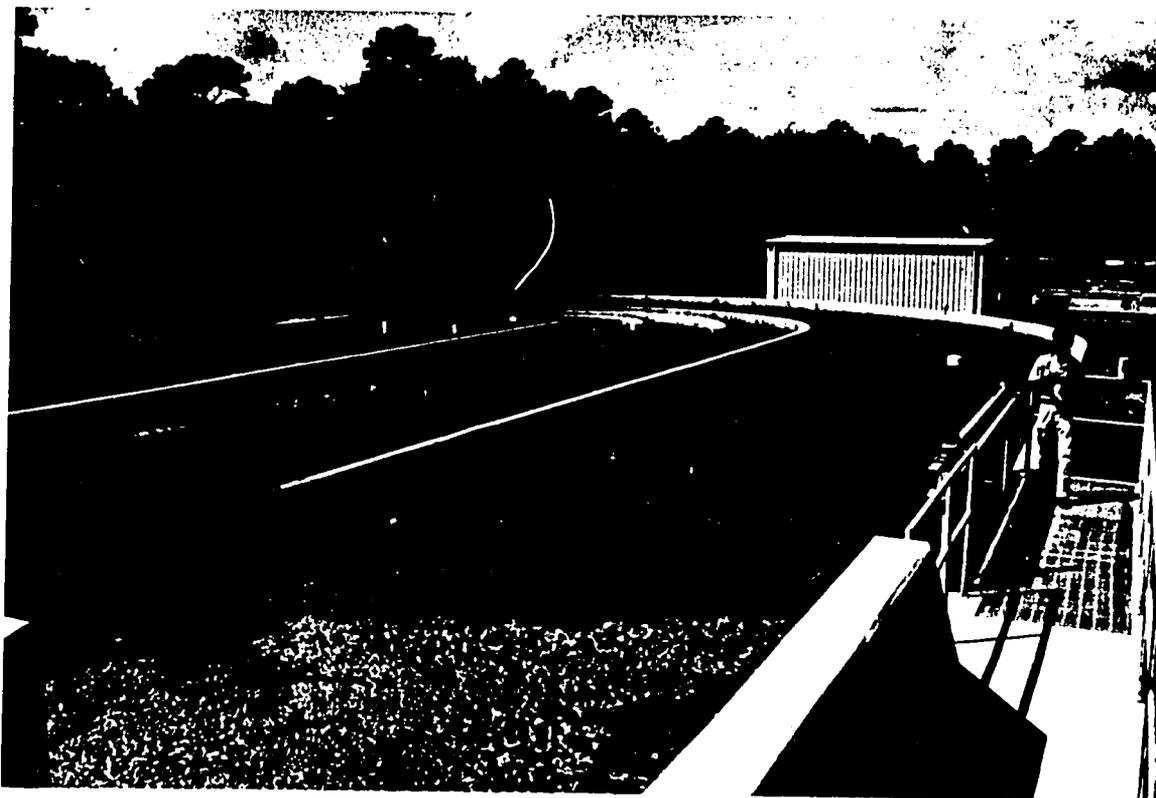
The Georgetown plant was built in 1991 and is the newest in Savannah. The plant has a maximum capacity of 2.5 mgd and average daily flow of 800,000 gallons per day. The plant uses an extended air detention system which creates a situation where sludge has an approximately 24 hour contact period with air (Photo 4).

This plant is unique in its use of UV light tubes instead of chlorine to control coliform bacteria. The effluent is passed through trenches where UV rays from the tubes effect the genetic structure of the bacteria to prevent reproduction. This method leaves no residual; however, it is very expensive and energy intensive. The tubes must be replaced annually and the ballasts are changed every two years.

Supervisory Control and Data Acquisition System

The city is planning to implement a Supervisory Control and Data Acquisition (SCADA) system for all of the wastewater and drinking water plants in the city and county. This system will allow remote monitoring of critical equipment on a 24 hour basis without requiring 24 hour staff at each facility. This system will cover the Wilshire and Georgetown plants as well as all of the pump and lift stations.

Photo 4: Montri Chalittaporn examines the extended air detention system at the Georgetown Wastewater Treatment Facility. the system allows for sludge to have an approximately 24 hour contact period with air.



Industrial and Domestic Water Treatment

Harry Joyner
Willy Weil

Water Operations Administrator
Water Operations Superintendent

Savannah has two water supply sources. First, a series of artesian wells located in throughout the city and county serve as the major source of water for residential customers. A system of cast iron pipes and pumps connect homes to these wells, and pressure is maintained at 50-55 pounds per square inch (psi). The water from the wells is only treated with chlorine to provide sterilization for the water lines.

Second, industrial customers generally receive water from the Industrial and Domestic Water Treatment Plant which treats water from Abercorn Creek (which feeds off of the Savannah River). The plant was built in 1947 as part of a program to attract industry to the Savannah area. It was initially built to provide soft water for five pulp and paper mills, all of whom are still customers. The plant now has 24 customers including the city. Average flow is 42 mgd.

Large pumps at the creek pump water through 4 foot diameter pipes into a filter plant (approximately 15 miles away) where it is treated, purified and pumped to customers.

The plant has six major steps: pre-chlorination for purification, coagulation (addition of alum), settling of mud and foreign material, filtration through sand filters to remove mud and floc, pH adjustment using lime to raise the level to 8.3, and post chlorination with a goal of maintaining a constant residual of 1 ppm.

Wastewater Pump Stations

Elaine S. Campbell
Malcolm Cail

Administrator, Wastewater Collections
Electronic Control Technician

Maintenance

The city of Savannah operates 146 submersed and canned pump stations throughout the city and county (Photo 5). The system is in a continuous state of rehabilitation; each pump must be completely replaced every twenty years and major functioning parts must be changed every ten years. The Wastewater Bureau replaces approximately five stations annually.

A staff of 12 to 15 people control and maintain the entire pumping system. Designated "checkers" are responsible for inspecting each station every other day. However, it is anticipated that after the Supervisory Control and Data Acquisition (SCADA) system is on line, the pump stations will only have to be checked manually every 2 weeks.

Currently, the Wastewater Bureau contracts out a great deal of maintenance work. The city contracts with outside mechanics based on an estimate of the number of hours of service they will need in a year. When the work load on the checkers is reduced the city would like to use the time saved to do more of this work in house.

Odor Control

The delegation observed the biggest station which provides one-third of the flow to the President Street Plant. The station is located directly behind a hotel and the wastewater stream is open to the air to allow gas to escape. The department occasionally gets complaints about odors, but not enough to justify a change. Some of the lift stations in heavily residential areas have odor control systems to neutralize gases. One system utilizes Sodium Hypochlorite, which is a fairly expensive system as the feeder heads must be replaced annually at a cost of approximately \$4,000. Another system the delegation viewed uses rock salt to increase the conductivity of the effluent, allowing it to hold electric charge which helps control odors.

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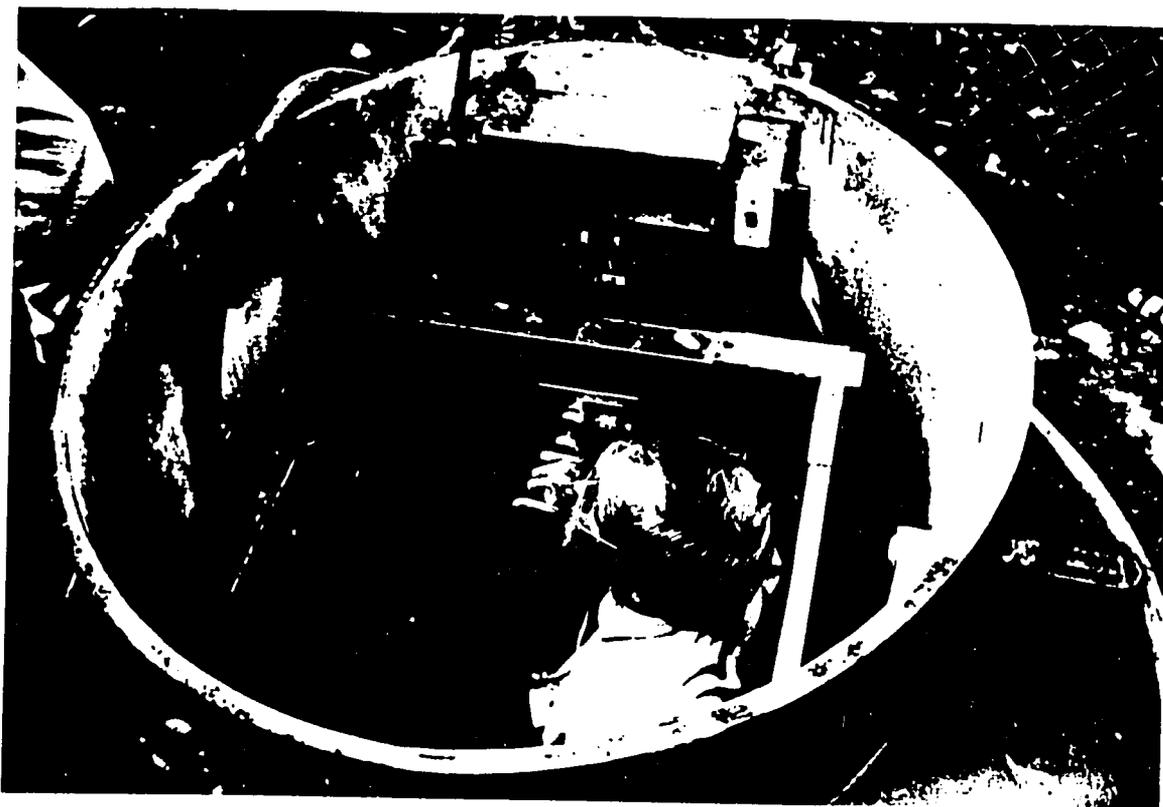


Photo 5: Malcolm Cail uses an automated lift to lower into one of Savannah's cased pump control stations under Savannah's main tourist street.

President Street Wastewater Treatment Plant

Mark Vanagel

Director, Wastewater Treatment Bureau

Lab

The on site lab handles all process monitoring requirements by the state and federal governments for the three plants in Savannah. At least two of the operators have four year bachelor's degrees in chemistry and have an extensive training and certification process which must be continuously updated.

Treatment Process

The President Street Plant was built in 1974 to handle an average flow of 22 mgd and a maximum flow of 55 mgd. Raw sewage is pumped to the plant through a sixty inch diameter line and is divided into two 48 inch lines to flow through two bar screens. Four pumps bring the influent to two aerated grit chambers which handle 25 mgd each. The influent then flows by gravity into the aeration basins where aerobic bacteria ingest the organic material in the stream. Six large aerators keep oxygen dissolved in the water to supply the bacteria, and mix the incoming wastewater with the activated sludge. Each

basin holds 2.5 million gallons, with a detention time of six hours at average flow. The "mixed liquor" product then flows to one of four final clarifiers where the dirt settles out. The settled dirt is removed continuously through flow control valves and returned to the aeration basins by variable speed sludge return pumps.

Each of the clarifiers are 95 square feet and provide a surface loading rate of 550 gallons per day per square foot and a retention time of 3.6 hours at average flow (Photo 6). The treated water finally flows over weirs to the chlorine contact chamber and after more than 30 minutes detention time is discharged into the Savannah River. (The chlorine residual is permitted at a level of 1.75 ppm) (Photo 7).

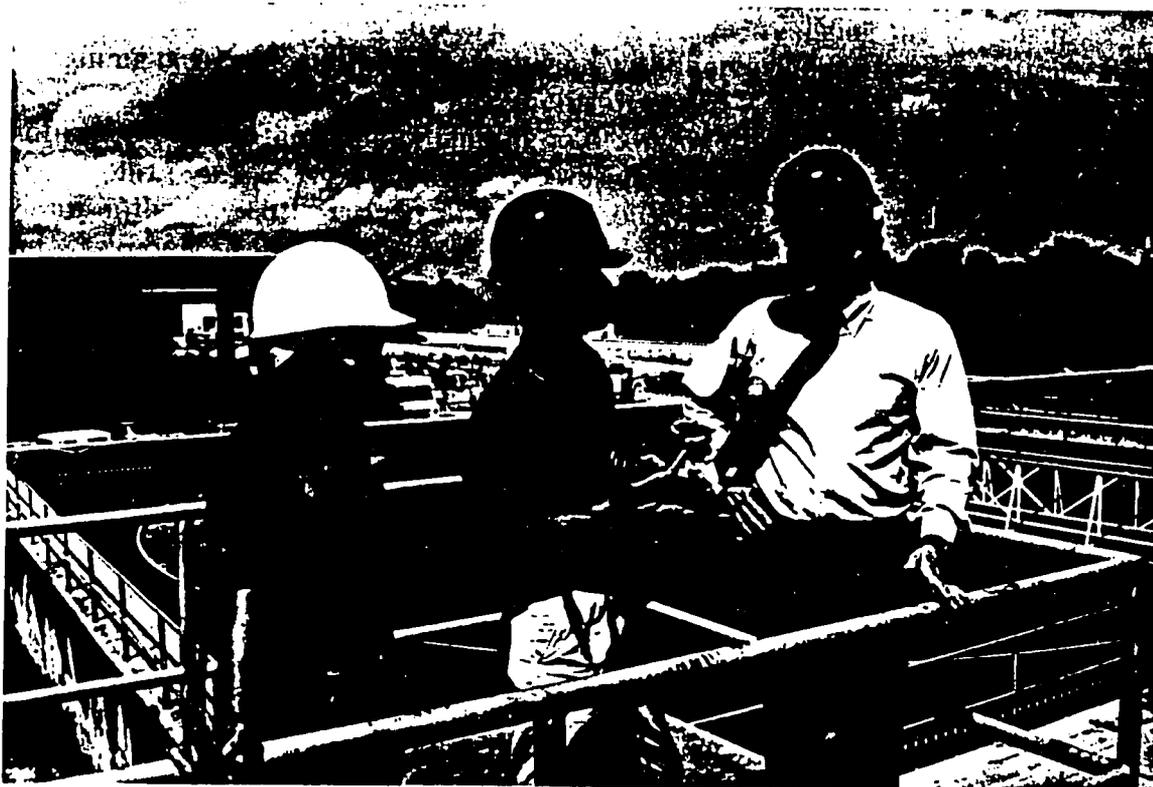
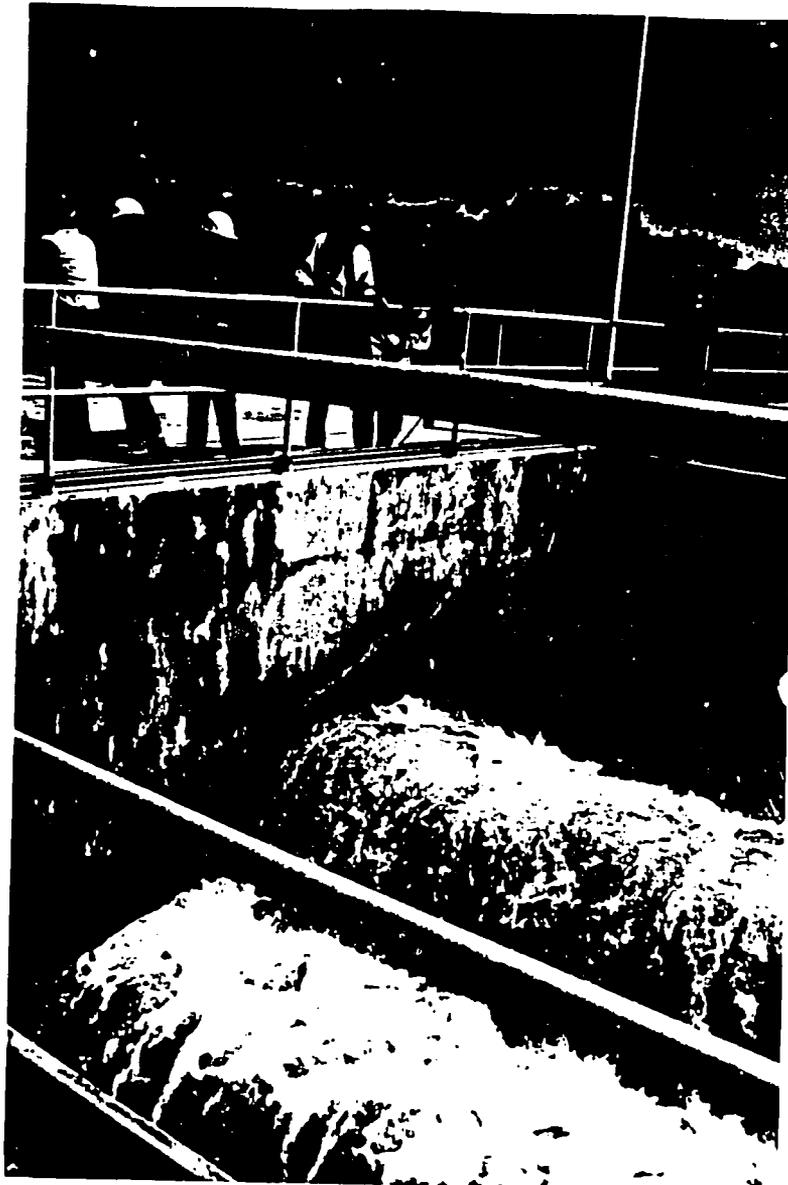


Photo 6: Kusuma Wongjantara and Montri Chalittaporn discuss the clarifier technology with Mark Vanagel at the President Street Facility.

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Photo 7: Kusuma Wongjantara, Mark Vanagel and Brian Gore observe the discharge point into the Savannah River from the President Street Wastewater Treatment Facility. Here water flows from the chlorine contact chamber (residual of 1.75 ppm) and cascades for further aeration before discharge.

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Sludge De-watering Technologies

A portion of the sludge removed from the clarifiers is wasted into the sludge thickeners and run through one of two de-watering systems. Both systems use a polymer to help coagulate the solids before entering the dewatering process. The 20 year old plate and frame system is currently under construction but is the preferred system for its ability to achieve 25 -30% dry solid content. In this system, filter screens trap the solids and allow the water to return to the aeration basins. The plant has had lots of problems with the equipment due to manufacturing defects and operation and maintenance problems. Filter cloths need to be changed every six months and if operated and maintained properly the system operates efficiently. There is now a plastic version of this cast iron technique which removes many of the problems. However, the system requires a steep capital investment of approximately \$1 million.

The second de-watering system, a belt press system, consists of a series of belts and rollers that squeeze water from the solid sludge. At best this system delivers a product that is 16-18% solid at a rate of 30,000 lbs/day. This system is 10 years old and was originally purchased as a back-up system.

Sludge Incineration

The sludge is finally burned in an on site incinerator. A computer system indicates draft to incinerator, oxygen content, water content, inlet temperature, outlet temperature etc. for the operator. Under new regulations, the plant must begin monitoring hydrocarbon emissions in addition to the currently monitored particulate. The incinerator is currently fueled with natural gas, and would ideally be "autogenous" which is possible with a sludge that is at least 26% dry solids.

Maintenance

Maintenance is the key to a successful plant. There are 3 mechanics and 2 assistants at the plant 40 hours/week. The plant offers in-house training programs and have begun to rely on the new computer system to schedule maintenance and insure parts are on hand.

The plant recently invested in a computer system to control inventory for parts and equipment as well as monitor work orders, purchase orders, maintenance schedules, repairs, cost centers broken down by process and vendors etc. They use a computer software system called MP2 by Data Stream which is suitable for any manufacturing operation.

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Union Camp Corporation, Kraft Paper and Board Division

Charles Beacham
Bernie Cleary

Process Engineer
Public Relations

The Complex and The Manufacturing Process

Union Camp's Savannah Complex, the largest paper mill facility of its kind in the world, has been in operation since 1936. The complex has four manufacturing facilities: chemical manufacturing, liner board for corrugated boxes, paper bags, and kraft paper. All of these manufacturing operations are water and energy intensive. It is located on the edge of the Savannah River which is classified as an industrial river.

Union Camp is experimenting with using more post consumer waste in their process and currently use up to 35% recycled corrugated boxes and are experimenting with 2-3% newspaper content. These changes are largely customer driven; for example, McDonalds, a very large customer, requires that their bags be made from 100% post consumer paper. In fact, the company has found that some of their machines run better with a mix of recycled fiber with virgin material.

Union Camp has recently been striving for conservation of all resources including water, and see this activity as essential to the company's profitability. In addition, the company is putting more emphasis on process changes to prevent chemical and organic losses from reaching the treatment system. Waste minimization practices are important to all processes; for decreasing the volume of waste reduces the wear and tear on the pumps and mechanical parts in the treatment facility and enhances the efficiency of the manufacturing process in general.

Wastewater Treatment

The primary system (a 310 foot diameter clarifier) is on the main plant facility and the secondary system (an over 100 acre aerated lagoon) is on Hutchinson Island approximately 0.75 miles (1.2 km) across the Savannah River. The primary system was built in 1968 and the secondary system in 1972. A fifty foot deep channel housed the original pipe (built in the 1970's) and a 70 foot deep channel houses the recently added 48 inch diameter ductile iron pipe.

The wastewater treatment system handles approximately 18-20,000 gallons/minute from the pulp and paper process. The wastewater has approximately a ten day retention time in the system while going through a system of 52 high speed aerators and a series of baffles before discharge to the bottom of the Savannah River. In this process, an influent of BOD levels of 500 ppm are reduced to 50 ppm, claiming a 90% efficiency rate. Nitrogen and phosphorous are added to achieve the permit discharge levels for BOD, TSS, color and pH. Because the Savannah River is classified as an industrial river, the level of allowable pollutants in the wastewater stream is significantly more than allowable in a recreational stream flow.

A computer controls the wastewater treatment system including remote control of the aerators in the remote lagoon. In addition, the computer monitors the pulp and

paper process and can provide the wastewater system operators with a rough prediction of the influent before it hits the system.

Weather presents the biggest challenge to the efficient operation of the wastewater treatment system. During the hurricane season, the plant maintains a level 3-3.5 feet below normal to allow for sudden rains. Cold weather is also a challenge because of the drastic reduction in temperature in the lagoon.

Stormwater Drainage System: Billy Jones, Facilities Maintenance Director

In the late 1980's, the city of Savannah levied \$2.4 million from property taxes designated for drainage improvements. Severe widespread flooding continued and in 1990, the City Council approved a plan to secure a \$26 million in revenue bonds with additional property taxes for four projects to lessen structural and street flooding throughout the city. The system relies on gravity to bring water to the discharge point where 4 float activated pumps and three bar screens at the main drain control solids and provide flow to the Savannah River.

The city is using an engineering firm to complete the system. However, the city has arranged to purchase all of their own equipment for the system to avoid costly markups by the engineering firm. In this purchasing method the manufacturers deliver equipment to a bonded warehouse where they complete service necessary. It is then turned over to the consultants whose responsibility it is to get the system functioning and deal with any problems. Only after close inspection of the completed system does the city take over the system for operation and maintenance. All of the equipment comes with a five year warranty. In addition, the Water Department has a full time electrician who is responsible for routine repairs and maintenance.

Northwest Chatham County Sewerage Study Overview

David Rutherford

Metropolitan Planning Commission

The Northwest Quadrant, a 45,000 acre area, is the last section of the county to undergo a survey to project water and wastewater sewer needs for the next fifteen years. This area is close to the airport and port and is thus projected to expand as a distribution and manufacturing area. The area is currently 65% wetlands, and is thus under a separate study by the EPA to determine the environmental impact of developing parts of the area.

The plan estimates that it may need a new 10 to 15 mgd wastewater treatment plant to service the area. The county is considering funding this facility with impact fees which are based on the additional load to the existing system and the cost of new extensions necessary to service a new development. In the past, the county has spread the tax around the entire community through property taxes, but now proposes to make the users of the new system carry the brunt of any additions.

SOLID WASTE MANAGEMENT

Metropolitan Planning Commission, Solid Waste Program

David Rutherford

Senior Environmental Planner

Georgia Comprehensive Solid Waste Management Act of 1990

In 1990, the U.S. Federal Government and State of Georgia issued a new regulation requiring each community in the country to decrease their solid waste stream by at least 25% by 1996 and design a ten year plan for handling solid waste. The State of Georgia offered some suggestions but allowed each community to identify their own methods to achieve reduction.

In response, the Metropolitan Planning Commission established a 38 member Solid Waste Task Force of representatives from the public, private, and non-governmental sectors, as well as interested community members to study options. Starting in July 1991, the task force met monthly for 10 months and issued the final report in December 1992. The task force was divided into five sub-committees: recycling/composting and reduction; collection; disposal; public education; and finance. The meetings enjoyed an 80% attendance rate and allowed city officials to get an accurate feel for community interest and sentiment.

In the decision making process, the city also held more than twenty public hearings, providing a forum for public input and information.

Waste Stream Volume

In 1993, a population of 220,000 in Chatham County produces municipal solid waste (MSW) at a rate of 1,100 tons /day. This is the equivalent of 10 pounds/person/day. This per person rate is a great deal above the average for the United States; however, this figure includes waste generated by the 5 million visitors to the county annually and waste from the port and industries in the county. Residential and commercial customers generate approximately 214,600 tons/year, or 600 tons/ day which equals approximately 5 pounds/person/day.

To create a plan for 25% reduction for each of the 9 towns in Chatham county, collection routes were changed in order to determine the current level of MSW generated by each specific community. This has reduced the efficiency of the collection process, but has provided a baseline information from which to build a reduction program.

Waste Stream Composition (by weight)

42% of Chatham County's MSW is paper; 25% is construction and demolition waste; 18% is from yard waste; 8% is from food; 6% from plastics and 1% other.

Current Disposal Facilities

Chatham County currently has 5 county owned and operated landfills for demolition, yard and other dry waste. The City of Savannah owns and operates the Dean Forest Sanitary landfill (approximately 400 acres) and Waste Management Inc., a private company, owns and operates another large sanitary landfill (approximately 700 acres total) in the county. The city operated sanitary landfill has an estimated life of 20 more years. (See Annex E)

The City of Savannah also operates the only Resource Recovery Waste to Energy (WTE) facility in Georgia. 100% of the waste from the city and from 2 other small towns in the county gets processed at this facility. In addition, a few cities outside of the county (up to a distance of 80 miles) send municipal solid waste to the facility.

Fees

In 1991 waste cost \$5 per truck load (approximately 5 tons) at the dry waste landfills and \$21/ton at the sanitary landfill. However, realizing the increasing costs of maintaining current facilities and complying with increasingly strict regulations, the tipping fees were raised in three increments over two years to \$31/ton at the dry landfills, \$38/ton at the sanitary landfill, and \$33/ton at the waste to energy facility.

Collection fees for twice weekly curbside pick up and once weekly "large object" pick up in the city costs \$13 per month per household. Once weekly pick up of normal solid waste only in the county costs \$18 per month.

Tipping fees are expected to rise to \$60/ton by 1996.

Commercial Customers

Commercial operations have the option of contracting with the city or with private collection operators. However, by law, all solid waste collected within the city limits must be taken to the resource recovery facility (WTE plant).

Waste Stream Reduction Options

Chatham county is considering three reduction options: composting, curbside recycling and commingled recycling. The county is currently ready to implement pilot programs in selected areas. The City of Savannah will have a small curbside recycling project starting in September which will include 3,200 households (9% of the total) which are statistically representative of the city for average income, population density etc.

For this project, the city has assumed they will not receive any revenue from the collected materials for planning purposes. In addition the city has assumed an 80% participation rate for a mandatory program and 40% participation rate for a voluntary program. A mandatory program would result in approximately 54,600 tons/year from commercial and residential customers. A voluntary program would result in approximately 30,000 tons/year. This is not a significant percent of the total waste stream by weight. The city currently collects 193,000 tons of construction and demolition material; thus, some believe it would be easier to manage construction and demolition

waste better to achieve the 30,000 ton reduction rate achievable through a voluntary recycling program.

Before choosing the recycling program, the city hired a private engineering consulting firm to assess the impact of a recycling program on the incinerator efficiency. The firm concluded that if the removed paper and plastic were replaced with wood waste and demolition waste, the operating efficiency would not be significantly affected. In addition, the WTE facility is exempt from decreasing the waste processed as the incinerator needs a great volume to operate efficiently.

County Recycling Efforts

The county operates a number of manned drop off centers in the area. These sites require a permit from the state to operate. Many private companies in the area accept recyclable material and generally pay a variable market rate per ton.

Sanitary Landfill

Gene Prevatt
Horace Magwood

Director, Refuse Disposal/Street Cleaning
Director, Solid Waste Bureau

The 130 acre (325 rai) Dean Forest Road sanitary landfill, designated on the entrance sign as, "The Solid Waste Reclamation and Disposal Facility," is part of the city's solid waste management program. The Solid Waste Bureau operates on an approximately \$4 million annual budget of which \$2.5 million is allocated to the WTE facility, \$1.5 million to the landfill and \$150,000 to the city's transfer station.

The city has three main objectives for solid waste management: to safely handle MSW to avoid health and environmental problems; to protect ground and surface water contamination; and maximize cost efficiency.

Landfill Design and Regulation

The currently permitted area, Phase I, covers a total area of 130 acres. Phase I is designed for thirty four, 7 to 10 foot trenches dug to within a depth of 2 feet above the water table. The trenches maintain a slope of at least 0.5% to allow proper runoff into the collection ditches. These trenches will be built up with cells above ground to a height of approximately 10 feet. The permit requires a closure plan that includes a 2 foot layer clay "cap" to prevent infiltration. The area must then be planted with bahia, bermuda or rye grasses. The landfill cannot allow trees to grow on closed landfill areas, as the roots would allow rain water to infiltrate the fill and cause leachate problems.

Design regulations also require that the landfill must be a controlled area (ie surrounded by fences), compacted daily, have a six inch daily cover of dirt and other survey controls. In addition, the landfill must have silt fences around any area of the landfill which is disturbed for more than 30 days to prevent sediment runoff into the stormwater system (Photo 8).

Photo 8: Gene Prevatt, Director, Refuse Disposal explains the environmental precautions taken at Savannah's sanitary landfill. The landfill receives approximately 320 tons of ash, sludge, and other solid waste per day.



This landfill is currently maintaining the minimum standards required by the state EPD, and is facing modifications as Subtitle D of the 1976 Resource Conservation and Recovery Act (RCRA) takes effect October 9, 1993. The city has already purchased six groundwater monitoring wells to install in the Phase I area, and will have to have an additional 26 wells in the upcoming expansion (due next year). The facility will also be adding nine methane monitoring points.

The city chose the current site for its remoteness and limited use as a pasture land and forest. At that time the state only required a solid assessment for the application. The city advertised the intent to locate a landfill and make plans available at the public library. In 1993, the state requires a hydrology study, and groundwater flow study, zoning regulations, natural wetlands surveys, and extensive public hearings in addition to the soil test. The permitting process takes 2 to 5 years. The city worked with an engineering consulting firm of Hussey, Gay and Bell for design and assessment.

Operation and Management

The landfill is managed using a computer system to track productivity, tonnage of measure MSW and ash received, monitor the origin of the waste, make long range projections for operating costs, and monitor site depletion.

The staff operates the actual landfill with one bulldozer, one compactor, one farm tractor, and one self loader. The city rents other equipment through a contract arrangement when necessary. The maintenance crew from the "city garage" handles routine maintenance on equipment.

The landfill operates with a staff of six people including a scale operator and a special projects crew. The landfill operates from 7:00AM to 3:15 PM.

Volume

The landfill accepts approximately 250 to 380 tons of waste daily including ash from the resource recovery facility and sludge from wastewater treatment facilities and dry waste per day. In 1992, the facility accepted 83,000 tons of ash and dry waste. Approximately 50% of this amount is ash from the WTE facility at a rate of 10-15 forty yard trucks per day.

The ash compacts to 1,600 pounds per cubic yard. Regular MSW compacts to approximately 1,000 pounds per cubic yard.

Municipal Solid Waste Collection

Horace Magwood

Director, Solid Waste Bureau

A fleet of 47 trucks and 132 employees service the entire city for curbside collection of municipal solid waste. An additional 40 employees collect litter, bulk items and provide special support services. The city is separated into six districts for collection with the largest at 20,000 units and an average size of 7,000 units. The crews collect at each unit twice weekly and work four, 10 hour days per week (Monday, Tuesday, Thursday, Friday)

The city is experimenting with city provided, automated waste containers. In a pilot project, the city provided households with a 95 gallon container with wheels and a metal handle which allows trucks to attach and automatically dump the waste into the truck. This system has greatly increased worker efficiency and has reduced the amount of loose trash in the neighborhoods due to improperly contained waste. The solid waste bureau would like to expand the program; however, it is estimated to cost \$3 million, and is thus not politically feasible at this time (Photo 9).

The districts outside of the pilot area receive backyard pickup which is very labor intensive and time consuming.

The Bureau has safety meetings every Thursday morning before the trucks depart for their routes. Each week an employee volunteers to gather information on a safety topic to present at the following weeks meeting. This keeps everyone looking for topics. Every six months the city compiles accident reports and evaluates driver safety. The best drivers are awarded certificates for their achievement.

Photo 9: Residential municipal solid waste collection vehicles are using automated systems in parts of Savannah. The city provides collection bins which fit onto levers on the trucks, reducing human contact with the waste.



Resource Recovery Facility (Waste-to-Energy WTE)

Ernest Bennett
Gene Prevatt

Plant Manger, Katy-Seghers (contractor)
Director, Refuse Disposal and Street Cleaning

In an effort to control the rate of MSW disposal in the city's landfill, the city decided to build an incinerator which has been in operation since 1987. The city included the public in the project from the initial conception and has had little opposition throughout. The city is extremely happy with the facility, and would, "rather have the WTE plant than two landfills." The Savannah facility was the 90th WTE facility built in the U.S.; now there are approximately 141 WTE facilities across the nation.

Cost

The project cost \$55 million to begin operation which was raised through general revenue bonds. By contract, the facility will be paid for in 20 years; it is estimated that the plant will have a life of 40 years.

The plant costs approximately \$200,000 per month to operate and maintain.

Kemira Chemical, a neighboring plant producing titanium oxide, purchases all of the energy generated by the WTE plant. The price of the energy is tied to natural gas and is thus susceptible to market price swings; the WTE facility offers its steam and electricity at a 10% discount from the natural gas price.

BEST AVAILABLE COPY

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Operation

The incinerator was designed as a 4,000 Btu facility and requires no auxiliary fuel to burn. The facility is equipped with two 250 ton per day boilers. The facility produces 120-130 pounds of steam and 4-6 megawatts of electricity per hour.

The plant operates 24 hours a day 7 days a week with a total staff of 38 employees. Four people are mandatory for each shift.

WTE facilities are highly regulated for stack emissions of: particulate, SO₂, NO_x, CO, lead, HF, and mercury. The Savannah facility is currently emitting less than one-third of their permitted levels. The EPA is in the process of revising the clean air act, and the permit levels will be decreasing for the facility.

Currently the facility uses electrostatic precipitators to clean stack emissions. They are also about to embark on a \$10 million improvement project to add a bag house to the operation to further lower emissions.

Local Recycling Pilot Projects and Collection Companies

David Rutherford

Metropolitan Planning Commission

Southeast Recycling Company

A paper company began operating newspaper recovery facilities in many areas of the Southeastern U.S. as a cost effective means of acquiring raw materials for production. The company started operation by giving the containers to schools, non-profit organizations and churches to handle collection and paid them for the amount they collected. Now the Savannah facility also places containers in local shopping areas for newspaper and will begin a magazine collection program in the near future.

The City of Pooler

As part of the Chatham County comprehensive solid waste reduction program, the city of Pooler has started two drop off centers for newspaper, aluminum, clear glass, green glass, and brown glass (Photo 9). The city provided a booklet to each household in the community explaining the program, adds in the newspaper and an article in their quarterly newsletter. The program has only been in progress one month, but is not meeting projections yet. The city is considering moving the drop-off site to the local schools.

The city is planning to run the project for six months and make an initial assessment.

Photo 10: Dr. Preeda Wirojpan observes an un-manned recycling center in Pooler, Georgia provides separate bins for newspaper, green glass, brown glass, clear glass, aluminum cans and tin cans. Residents bring their recyclable goods to the site and sort them manually.

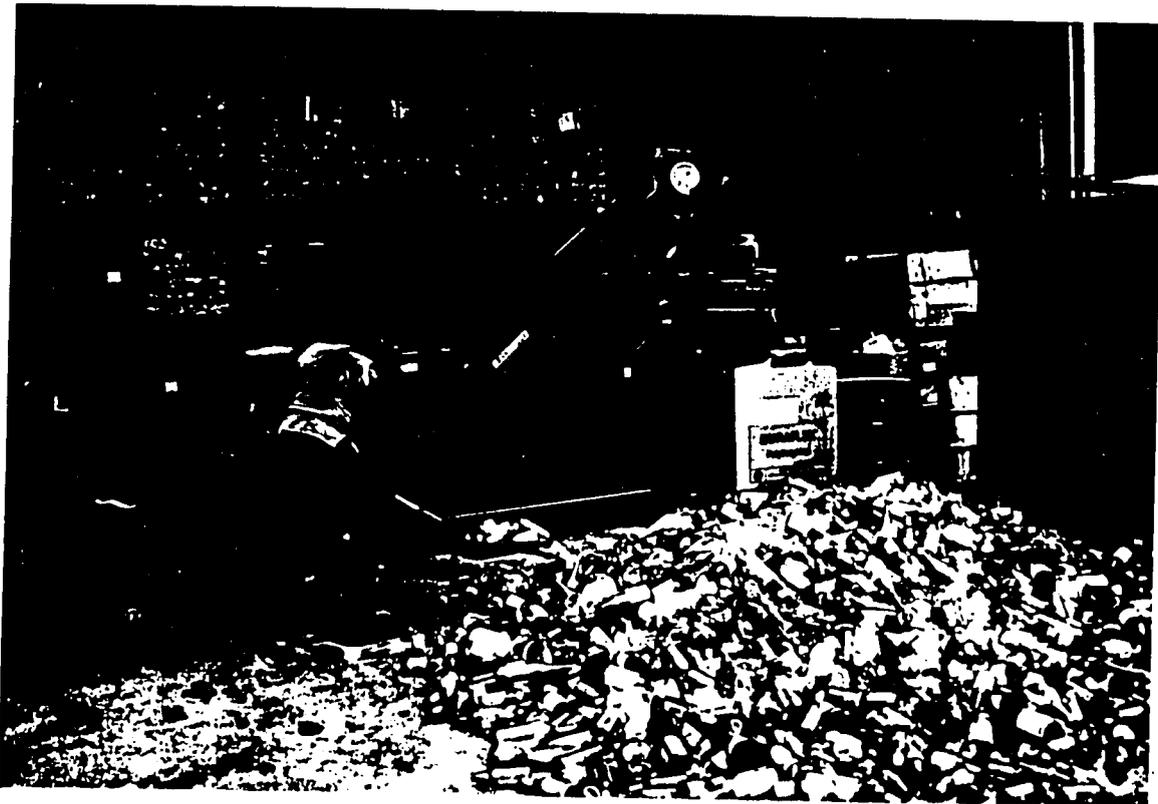


Photo 11: After collection recyclable goods are purchased by a local recycling company where glass is sorted by color and crushed by machine (foreground) and cans are compacted into bales

IV. Conclusions and Recommendations

Evaluation and Follow-up

The delegation from Pattaya was exposed to many issues concerning wastewater treatment and solid waste management in the City of Savannah and the surrounding areas. The City of Savannah appears able to maintain compliance levels with federal and state regulations. The city, however, is not attempting to implement more stringent regulatory requirements nor striving to be a model of environmental infrastructure and services. Solid Waste and Wastewater officials in Savannah are managing their bureaus with limited funds and in general are able to offer a level of services that meet the needs and demands of the community.

Officials in Savannah were candid in discussions of the political, economic, social, and technical factors affecting the decision for the solid waste and wastewater treatment facilities and programs now in operation. The schedule also included opportunities for the Pattaya delegation to meet the needs outlined in the scope of work. For these reasons, officials from both cities felt that the "twin city" partnership offers an unique opportunity to discuss problems related to urban environmental infrastructure and services objectively and constructively. However, due to perceived language and cultural barriers, serious dialogue regarding Pattaya's problems was very limited, and most of the meetings were monologues on conditions in Savannah.

Whereas the delegation from Pattaya was able to learn a great deal from their experience in Savannah, general consensus among the delegates from Thailand is that the majority of the problems in providing adequate environmental services stem from:

- 1) difficulty in attracting and maintaining skilled operators, technicians and mechanics
- 2) insufficient coordination among and consideration of costs by national and local governments regarding infrastructure improvements
- 3) insufficient funds to properly manage facilities
- 4) limited access to spare parts for equipment
- 5) lack of clear responsibility for a consolidated solid waste management program which covers collection and disposal
- 6) no access to computers to monitor wastewater and solid waste treatment facilities

These problems require close scrutiny of training programs for new employees and before the introduction of new technologies, evaluation of current employee compensation structures, assessment of the municipal organizational structure for solid waste management, and a review of environmental infrastructure planning and funding procedures.

The original idea behind the twinning program calls for a reverse visit by a delegation from the American host city. Although as stated above, the majority of Pattaya's problems cannot be alleviated by a short term visit from foreign experts there are some areas where Pattaya could benefit from a short visit by officials from Savannah. Proper wastewater treatment is extremely important to maintaining water quality at Pattaya's beaches, and engineers in Pattaya feel they could gain from a review of the wastewater treatment proposals which are currently under consideration by the Public Works Department and the Pollution Control Department.

In addition, solid waste management in Pattaya appears to be in a state of flux with the landfill management recently transferred to the Sanitary Engineering Division from the Environment and Health Department. However, collection remains under the responsibility of the Health and Environment Department. Pattaya would like to improve current collection systems and disposal techniques and could benefit from an assessment of their current operations.

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Proposed Scope of Work for Savannah Delegation to Pattaya

Tentatively: January 1994

City Delegation:

Mark Vanagel
Gene Prevatt

Director, Wastewater Treatment Bureau
Director, Refuse Disposal and Street Cleaning

Wastewater Treatment

- Observe current treatment facilities and make suggestions for operation and maintenance
- Review plans for the Pollution Control Department and for the Public Works Department wastewater treatment facilities and survey the proposed sites

Solid Waste Collection

- Observe current routes, trucks, and collection bins for residential and commercial customers, with special attention to the potential for separate collection of wet and dry waste etc.
- Identify modifications, enhancements and improvements to existing solid waste collection systems.
- Analyze and evaluate fee structures, billing arrangements and fee collection systems

Solid Waste Disposal

- Visit the solid waste disposal site. Perform an informal environmental assessment of the area, observing the surrounding environment and potential problems with run-off, odor, leachate etc.

Incinerator

- Review operation of the current 3 ton/day facility with attention to difficulties in process and emission controls.
-

V. Annexes

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Annex A
Statement of Work

Statement of Work Savannah Georgia:

City of Pattaya of City of Savannah Twinning Exchange

1. Background

Pattaya is located approximately 150 kilometers southeast of Bangkok on the Gulf of Thailand. The city and the region around it (frequently referred to as the Eastern Seaboard) is primarily known as a tourist destination. Pattaya had a registered population of 61,550 in 1992 and local officials estimate that another 100,000 unregistered citizens live in the city. The community also hosts about 2 million visitors annually. The city has an area of 53 square kilometers (20 square miles), fairly large by Thai standards. If only the registered population is considered, the city has a density of 1,160 individuals per square kilometer. If the unregistered population is added this number rises to 3,037, a figure which still a quite low of Thai cities. In reality, however, densities in Pattaya are quite high because development is concentrated along the beach, particularly in the area adjacent to the bay in the central part of the community.

The city has grown very little since 1990 and a drive through the city reveals a considerable amount of unoccupied commercial space particularly along the access routes that run between the main north-south highway and the central business district. City officials acknowledge that environmental degradation, especially pollution of the seawater, has been a major contributor to the slump. As a result, Pattaya's future as a center for tourism is uncertain and may be dependent not only on efforts to control pollution in Pattaya itself, but also upon efforts to protect the environment throughout the entire Eastern Seaboard region.

City officials feel that the proper disposal of wastewater was the most serious environmental problem facing the city. At the present time only 4 square kilometers out of 53 are served by a wastewater treatment facility. Two wastewater treatment plants are operating in this area, one with a capacity of 8,000 cubic meters of wastewater per day, the other with a capacity of 5,000 cubic meters. Nonetheless, they estimate that even within that 4 square kilometers only about 20% of the wastewater is collected. Furthermore, during the rainy season inflow into the plant substantially exceeds capacity and much of the effluent is diverted away from the system directly into the sea. The plants, which are of the rotating biological contactor type, have numerous technical deficiencies although they still continue to make an important treatment contribution. Current problems include excessive amounts of sand in the system which clog screens in the primary settling pond, deficiencies in the rotating drums which reduce the amount of BOD that can be extracted from the effluent and a breakdown of the sludge collection system. A shortage of personnel also significantly handicaps wastewater treatment efforts. Currently the Department of Sanitary Engineering consists of a chief engineer, a scientist and 15 laborers.

In an effort to minimize seasonal variations, wastewater treatment charges are linked to the building size (measured in square meters) rather than the volume of wastewater generated. The fees are set so that they cover slightly more than current O&M costs. The existing pricing systems probably subsidizes hotels and restaurants, relatively intensive users of water, at the expense of other building owners. Furthermore, the existing fee system may

also shift costs away from those occupying higher value land near the core to those occupying lower value land on the periphery (because higher land values encourage more intensive use of a given unit of building space).

Pattaya is about to expand the capacity of the existing 8,000 cubic meters per day treatment plant to 20,000 cubic meters per day. In addition, it has begun construction of a second 20,000 cubic meter per day treatment plant on the southern side of town. More distant plans also exist for the construction of a third treatment plant, on the north side of town on landfill in the ocean. City officials are also considering ways of providing additional training for wastewater treatment staff, particularly the general laborers. However, the policy of rotating personnel to a new municipality after 4-5 year tour of duty, reduces the city's incentive to engage in training.

II. Proposed Objective

To transfer technical knowledge and build management and institutional capabilities among key municipal officials from the City of Pattaya, specifically in the area of wastewater. Hosting city officials from Savannah will also be encouraged to supplement these efforts by exposing the Thai participants to city environmental programs in other areas, such as solid waste and noise and general issues in good city management.

III. Twinning Exchange Details

Individuals proposed for inclusion in the Pattaya delegation of city officials include:

1. Mr. Vittaya Khunanukornkul, City Manager
2. Mr. Montri Chalittaporn, Director of Sanitary Engineering
3. Ms. Kusuma Wongiantara, Chief of Public Health Administration

It is anticipated that the Pattaya delegation will spend approximately two weeks in Savannah. The visit will have three principal components: a) 1-2 days of sessions providing an overview of the operations and economic base of the City of Savannah; b) 6-7 days of sessions focus on various aspects of Savannah's wastewater treatment program and c) 2-3 days of sessions focusing on other environmental management issues including solid waste and noise management as well other areas where the City of Savannah feels it has special strengths. It is anticipated that the sessions will provide a balance of seminar presentations and actual exposures to the issues being discussed. Consideration might be given to breaking the delegation into two parts with the City Manager being given greater exposure to policy issues and the director of sanitary engineering and chief scientist being given more exposure to "hands-on" topics.

Possible topics that might be covered include the following:

1. Methods of increasing the city's general revenues as demonstrated by the various types of revenue enhancement schemes (e.g. development impact fees) that could be used to cover an additional share of wastewater treatment costs.

2. Methods to reduce wastewater management costs through improved efficiency.
3. Contractual arrangements employed to privatize wastewater collection, treatment or disposal services.
4. Public awareness campaigns to increase support for city environmental initiatives.
5. Regulatory mechanisms to increase compliance with local environmental regulations.
6. Relationships with higher government agencies which oversee the city's environmental management practices.
7. Steps that have undertaken to enhance the efficient management and operation of Savannah's wastewater treatment department.
8. Specific wastewater treatment topics to be determined by consultations between WEC, Savannah and Pattaya city officials.
9. Steps that have undertaken to enhance the efficient management and operation of Savannah's solid waste collection and disposal operations.

The first six items list above have a strong policy component while the last three are more hands on topics. It is presumed that it would be most appropriate to give Khun Vittaya and exposure to the first group of topics and Khun Montri and Khun Kusuma exposure to the second group. Some overlap is anticipated.

IV. Reports

It is anticipated that WEC will prepare a 5-10 page trip report (perhaps based upon material gathered from twinning exchange participants) for distribution to the City of Pattaya, the City of Savannah and USAID/Bangkok. It is also anticipated that WEC will prepare a separate 7-10 page report that outlines details of the proposed trip of Savannah city officials to the City of Pattaya.

V. Technical Direction

The project officer for this activity will be Julie Otterbein, RHUDO/Bangkok, with technical support being provided by Dr. Lawrence Dolan, RHUDO/Bangkok and Dr. Chalot Sripicharn, Bangkok WEC representative.

VI. Terms of Performance

The departure date of the Pattaya delegation is on or about August XX, 1993 and returning August XX, 1993. A five day work week is expected.

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Annex B
Itinerary for Savannah Visit

DATE	SITE/ORGANIZATION VISITED
Monday August 9	Savannah orientation Community tour
Tuesday August 10	State of Georgia, Environmental Protection Division Jekyll Island Wastewater Treatment Facility
Wednesday August 11	Wilshire and Georgetown Wastewater Treatment Facilities Industrial and Domestic Drinking Water Facility
Thursday August 12	Tour Pump Stations and President Street Water Pollution Control Facility
Friday August 13	President Street Water Pollution Control Facility
Monday August 16	Union Camp, Industrial Wastewater Treatment Facility Stormwater Management Program
Tuesday August 17	Metropolitan Planning Commission - Briefing on Solid Waste Reduction Plan
Wednesday August 18	Dean Forest Road Solid Waste Reclamation Facility tour Northwest Quadrant Water and Sewer Expansion Plan
Thursday August 19	Waste-to-Energy Resource Recovery Facility City Council Meeting
Friday August 20	Recycling programs in Chatham County Wrap up at City Hall

Annex C
Persons & Organizations Visited

NAME	AFFILIATION
Susan Weiner	Mayor, City of Savannah
Don Mendonsa	City Manager, City of Savannah
Harry Jue	Director, Wastewater Bureau
Horace Magwood	Director, Solid Waste Bureau
David Rutherford	Senior Environmental Planner, MPC
Bob Barglada	Asst. City Manager for Finance
Milton Newton	Asst. Executive Director, MPC
Brian Gore	Asst. to the City Manager, Savannah
Larry Rogers	Regional Manager, Environmental Protection Division
Daryl Crosby	Environmental Specialist
Gary Reynolds	Environmental Specialist
Frank VanArdsdale	Environmental Specialist
Talakshi Gala	Director, Water and Sewer Engineering, Savannah
Bobby Palmer	Director, Jekyll Island Wastewater Facility
Mark Vanagel	Director, Wastewater Treatment Division
Harry Joyner	Water Operations Administrator
Elaine Campbell	Administrator, Wastewater Collections
Malcolm Cail	Electronic Control Technician
Charles Beacham	Process Engineer, Union Camp
Billy Jones	Facilities Maintenance Director
Gene Prevatt	Director, Refuse Disposal/Street Cleaning
Ernest Bennett	Savannah WTE Plant Manager, Katy-Seghers

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Annex D
Business Cards of Persons Contacted



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Assistant to the City Manager

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SENIOR ENVIRONMENTAL PLANNER



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Annex E

List of Documents Received

<u>Author/Organization</u>	<u>Publication/Document</u>
Chatham Urban Transportation Study	<i>Annual Report 1992</i>
Hach Products for Analysis	<i>Catalogue</i>
Magazines	<i>Environmental Protection: July '93, March '93, Nov '91, June '91</i> <i>Garbage: March '91, Nov '90</i> <i>Waste Age: July '93, Feb '92, Dec '91, Nov '91, Aug '91, July '91</i> <i>World Wastes: July '93, March '93, March '92, Jan '92, Dec '91, Nov '91, Sept '90</i>
The Industrial and Domestic Water Treatment Facility (brochures):	<i>The Savannah Water System</i> <i>Using Water Wisely</i> <i>The ABC's of Water Conservation</i> <i>About Safe Drinking Water</i> <i>The Story of Drinking Water</i>
Union Camp	<i>Annual Report</i> <i>"Who Scores Best on the Environment?" Fortune, July 26, 1993. pp 114-122.</i>

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TABLE 23
ACTIVE DISPOSAL FACILITIES,* APRIL 1992

Site Location	Site Owner	Type of Facility	Years Remaining Capacity*
Chevis Road	Chatham County	Dry Trash Landfill	5
Clifton Landfill**	Clifton Equipment	Industrial Landfill	1
Dean Forest Road**	City of Savannah	Sanitary Landfill	4
Garrett-Kelly*** Road	Larry Garrett	Industrial Landfill	4
Dillon Road	Chatham County	Dry Trash Landfill	8
Sharon Park	Chatham County	Dry Trash Landfill	2
Superior/Waste Management**	Waste Management	Sanitary Landfill	1
Thomas Avenue	Chatham County	Dry Trash Landfill	10
Wilmington Island	Chatham County	Dry Trash Landfill	2
Resource Recovery	City of Savannah	Incineration	10

* None of the current disposal facilities meet the new federal Subtitle D regulations for disposal of municipal solid waste.

** Permit for expansion under review by State EPD.

*** Plans for expansion within five years.

**** With current solid waste management practices. However, capacities will increase with implementation of reduction measures.

The Superior/Waste Management site currently has permits for lateral (horizontal) and vertical expansion under review by the state. If the expansions are approved, the projected capacity of the new site will be approximately 30 years.

TABLE 26

1992 BUDGETS FOR SOLID WASTE MANAGEMENT SERVICE
JANUARY - DECEMBER, 1992

Local Governments	Budget
Bloomingtondale	*60,660
Garden City	218,678
Pooler	231,394
Port Wentworth	**209,877
Savannah	10,711,102
Thunderbolt	112,175
Tybee Island	223,809
Vernonburg	9,000
Unincorporated Chatham County	1,135,780

* Fiscal year July 1, 1991 - June 30, 1992

** Fiscal year ended June 30, 1991

The standard method of financing these services is with a user fee or fee for garbage pick up on a monthly or bimonthly basis. Table 27 reveals the monthly garbage pickup fee paid by the residents of the local governments.

TABLE 27

MONTHLY FEES FOR RESIDENTIAL GARBAGE PICKUP
MARCH 1992

Local Governments	Monthly Fees
Bloomingtondale	9.00
Garden City	9.00
Pooler	10.00
Port Wentworth	7.00
Savannah	*11.00
Thunderbolt	2.50
Tybee Island	**2.00
Vernonburg	12.00
Unincorporated Chatham County	***18.00

* Billed Bimonthly

** Fee collection to begin June 1, 1992

*** Citizens pay for service directly to private contractors.

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Annex F

List of Contacts

Pattaya Delegation

Mr. Preeda Wirojpan	Director, Department of Health and Environment
Ms. Kusuma Wongjantara	Assistant Director, Department of Health and Environment
Mr. Montri Chalittaporn	Sanitary Engineer, Sanitary Engineering Division

Savannah Delegation

Mr. Don Mendonsa	City Manager
Mr. Brian Gore	Assistant to the City Manager

World Environment Center Liaison

Natalie Kraft	Asia Program, WEC - Washington DC
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