Section 5
Water Pollution Control Facilities Evaluation

5.1 Introduction

This section documents the evaluations of the existing water pollution control facilities (WPCFs). These evaluations consist of a summary of the history of each plant, a description of the current facilities and the unit processes at each facility, a summary of plant operating data, and a unit process capacity analysis. Section 5.2 presents a review of the Mystic WPCF, Section 5.3 presents the Borough WPCF evaluation, and Section 5.4 presents a review of the Pawcatuck WPCF. Section 5.5 presents process flow and mass balances for each of the existing WPCFs, as they are currently operated.

This evaluation was initially completed in July 2002. Since that time:

- Odor control improvements have been made at each of the three WPCFs,
- CTDEP implemented a *General Permit for Nitrogen Discharges*, which includes nitrogen load limits for each WPCF, and
- The Symbio™ process has been in operation at the Stonington Borough WPCF since January 2002.
- A second inspection of the Mystic WPCF site was conducted in 2006 to evaluate the condition of the facilities.

Descriptions and flow and load summaries are largely based on data available at that time with some updated information. Review of updated plant data from June 2002 to present would not impact the conclusions of this planning evaluation. It is recommended, however, that subsequent phases of this project, starting with conceptual design, re-visit pertinent aspects of this evaluation.

5.2 Mystic Water Pollution Control Facility

The Mystic WPCF provides wastewater treatment services for the villages of Mystic and Old Mystic, in addition to adjacent commercial districts. The plant was built in 1971-1972.

5.2.1 Plant History

Prior to construction of the Mystic WPCF, local residences and businesses were serviced by on-site septic systems, and it was known that many of these systems were not operating correctly due to soil conditions. In addition, some untreated wastewater was directly discharged to the Mystic River. In a study published in 1959

by Charles A. MaGuire and Associates, it was recommended that Stonington construct the three existing wastewater treatment facilities (the Mystic, Borough and Pawcatuck plants). In 1970, the Town of Stonington was granted approval to construct the Mystic WPCF as a 0.88-mgd conventional, secondary treatment plant, utilizing the activated sludge process, and chlorination for disinfection. Construction of the plant was completed in 1972, and the plant was placed into operation.

In 1987, flows to the Mystic plant began to exceed 90 percent of its design capacity. In January 1988, the Connecticut Department of Environmental Protection (CTDEP) issued an Order which required Stonington to: 1) evaluate the capacity of the Mystic WPCF; 2) prepare 20-year flow projections for the service area; and 3) institute a sewer connection moratorium on the plant's service area. In 1988, the firm of Cummings & Lafayette developed a modified facilities plan for the Mystic WPCF. Among the recommendations contained in the plan was to expand the Mystic WPCF to a design flow of 1.3 mgd to accommodate anticipated flows.

In 1990, in response to a request from Stonington to increase the plant's permitted flow from 0.88 mgd to 1.3 mgd, CTDEP issued a report entitled "*Water Quality Analysis of Mystic Harbor - A Water Quality Model and Waste Load Allocation*". In the report, CTDEP indicated that the pristine quality of water in the Mystic Harbor cannot be allowed to degrade, and thus increases in flow will necessarily be accompanied by tighter restrictions on effluent quality. In addition, CTDEP indicated that nutrient removal would likely be required in the future.

In 1993 and 1994, Wright-Pierce conducted a study for improving the operation and performance of the Mystic WPCF. Wright-Pierce conducted the study in phases, and likewise recommended that improvements to the Mystic WPCF, as well as needed improvements to other WPCA facilities, be implemented in phases. Phase 1 of the planned approach included an upgrade program comprised of either operational or minor equipment or structural changes that would immediately improve treatment at the Mystic WPCF. Phase 2 recommendations were for longer-term improvements (within five years of report acceptance), key among them being construction of a new double-barrel forcemain between the Mystic and Borough WPCFs, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. This, together with other improvements at both the Mystic and Borough WPCFs, allowed for removal of the new connection moratorium in the Mystic WPCF service area. It was recognized at the conclusion of the Wright-Pierce study that a long-term facilities plan would be required to put a plan in place to handle WPCA's sewage treatment needs. Plant improvements and the forcemain construction work were completed in 1999.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Mystic WPCF, along with the other two treatment facilities and their respective collection systems. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Mystic WPCF included improved ventilation of the influent wet

well, and treatment of the ventilated air with a package carbon system. These improvements were completed in 2003.

5.2.2 Plant Description

The Mystic WPCF was designed to treat an average flow of 0.80 million gallons per day (mgd), and a peak flow of 2.35 mgd. It appears that the permitted average flow of 0.88 mgd, rather than 0.80 mgd, resulted from a clerical error when the permit was originally issued. The original design of the plant was to handle biochemical oxygen demand (BOD) and total suspended solids (TSS) influent loads of 1,400 and 1,700 pounds per day (ppd), respectively. The plant is permitted to discharge an average flow of 0.88 mgd, and discharges to the Mystic River. **Figure 5–1** presents a site plan of the existing Mystic WPCF.

Flow and load to the Mystic WPCF vary seasonally due to the tourism industry in Mystic. Loading in the summer months is higher than average for a sustained period, due to the higher contributing population. Flow variation is not as extreme, because the increase in sanitary flow during the tourism season is offset somewhat by a decrease in infiltration flow during the summer months. Section 5.2.3 describes existing flows and loads in detail.

The Mystic WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Primary underflow (co-settled sludge) de-gritting
- Diversion pumping of de-gritted primary clarifier underflow (to Borough WPCF)
- Odor control
- Digesters (abandoned)

Raw sewage enters the plant through a 30-inch diameter gravity sewer. Flow normally passes through a comminutor before entering the influent wet well. If the comminutor is out-of-service, flow is directed to a manually-cleaned coarse bar rack for screenings removal. The comminutor currently in place was installed in 1997/1998.

See Figure 5-1

Raw influent is pumped from the wet well by two influent pumps. The pumps are vertical, centrifugal, non-clog type, and are driven by variable frequency drives (VFDs). Each pump was installed in the late 1980s, and has a design capacity of 2,100 gpm at 34 feet total dynamic head (TDH).

The influent pumps discharge to a flow channel that precedes the plant's liquid-treatment tankage. WAS removed from the activated sludge process is also pumped to this channel. The channel feeds flow to two rectangular primary clarifiers. The primary clarifiers are equipped with chain-and-flight mechanisms for conveying settled sludge toward the front end of each tank. The chains and flights also are used for conveying primary scum and grease toward rotating scum troughs located toward the effluent end. Primary scum is conveyed to a pit equipped with a mixer and pump, and is pumped to tanker trucks for transport off site. Primary effluent flows over v-notch weirs and enters a channel that directs flow southward toward the plant's two aeration basins.

The aeration basins are typically operated in conventional, plug-flow mode, and are equipped with coarse-bubble diffusers that impart a spiral-roll pattern in the tanks. The aeration system is currently operated to provide BOD removal, and for nitrification, as a step to remove as much nitrogen as possible with the existing facilities. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins.

The mixture of wastewater and microorganisms (the mixed liquor) from the aeration basins flows to two rectangular secondary clarifiers. The secondary clarifiers have the same length and width as the primary clarifiers, but have a shallow side water depth (SWD) of 8.25 feet. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which operators control the amount of sludge withdrawn. RAS is pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is routed to a wet well for the diversion pumping system.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. Dosage is based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Mystic River outfall through a 24-inch pipe. A 3,000-gpm effluent lift pump is installed to allow the plant to continually discharge to the outfall even during high backwater conditions, such as might occur during a hurricane. This pump is rarely used.

Primary sludge is removed from the bottom of the primary clarifiers at an estimated concentration of less than 0.1 percent solids. The sludge is pumped to a new grit removal system located in the old Dewatering Room in the Control Building. The grit system was installed in 1999, and consists of one cyclone and one grit classifier. Removed grit is deposited into a bin for transport off-site. Degritted sludge flows by

gravity to a wet well that feeds a diversion pumping system. An odor-control system is installed to ventilate and treat the air from above the grit classifier.

Two diversion pumps remove the degritted sludge from the wet well and pump it to the Borough WPCF for treatment. A double-barrel forcemain connects the Mystic WPCF to the Borough WPCF's gravity collection system. Currently, the smaller, 6-inch diameter forcemain is used to protect against solids deposition in the pipe. The second, 12-inch diameter forcemain was installed to handle a possible increase in the diversion flow rate. The 12-inch diameter forcemain has not yet been connected to the diversion wet well, so in order to use it, approximately 100 feet of forcemain would have to be installed.

The diversion pumps are each sized to pump approximately 230 gpm to the Borough WPCF. This entire flow is from the primary clarifier underflow, after de-gritting. This pumping process is designed to reduce loading to the secondary treatment process at the Mystic WPCF by utilizing "excess" capacity at the Borough WPCF, and was implemented in September 1999. Up to 300,000 gallons per day can be diverted to the Borough WPCF. To provide control of hydrogen sulfide generation in the diversion forcemain (for odor-control purposes at the air-release valves along the force main, at the transition to gravity flow, and at the Borough WPCF), a bioxide agent is pumped into the forcemain at a rate of about 33 gallons per day.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Two centrifugal RAS pumps (including one spare) are used to return sludge from the secondary clarifiers to the aeration basins. The RAS pumps are provided with VFDs, although the operators cannot vary the speed too much because of solids deposition problems in the pipelines at low speeds. One pump is used to pump WAS from the secondary clarifier underflow to the channel that feeds the primary clarifiers. The WAS pump is operated on a timed basis (i.e., a certain number of minutes per hour). Two primary sludge pumps (including one spare) are used to withdraw sludge from the primary clarifiers and pump it to the grit classification system, prior to the diversion pumping system.

Three blowers provide air for the activated sludge system. The blowers are positive-displacement type, and each has a capacity of 825 icfm at 20.7 psia discharge pressure. A VFD drives one of the units, and two-speed motors drive the other two. The blowers have been operating since the plant went on-line in 1972.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank, and three chemical feed pumps. One chemical feed pump is dedicated to each of the following: disinfection; odor control; and RAS chlorination. The pumps are connected by a manifold, which allows backup service to each application should one of the pumps fail.

A new supervisory control and data acquisition (SCADA) system has been installed at the Mystic WPCF by U.S. Water, as part of a system-wide control system.

The Mystic WPCF originally included a two-stage digestion process to stabilize the sludge removed from the liquid-side treatment processes. This system was taken out-of-service in 1993, and the gas-handling, mixing and other equipment necessary to operate the process was removed. The two digester tanks are still on-site, though they are currently not in use.

A summary table of the existing design and operating criteria for the Mystic WPCF is included in Appendix A.

5.2.3 Plant Inspection

CDM has conducted site visits to the Mystic WPCF to compliment our understanding of the plant operation based on previous reports, and to ascertain operational, structural or other deficiencies that will be considered as the alternatives evaluation process proceeds. Many of our observations are incorporated into Section 5.2.2. Additional observations are noted in the following sections, and are broken down into the following categories:

- Process/Mechanical/Equipment
- Site
- Structural/Architectural
- Electrical
- Miscellaneous (if applicable)

Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The plant has a problem in handling the grease load. It was estimated by plant operators that about 30 restaurants contribute to the plant loading.
- Operators report that care must be taken to make sure that the non-metallic chain and flight collectors on the primary clarifiers do not experience accelerated wear due to grit loads.
- There is an uneven flow-distribution problem to the aeration basins.
- It is difficult to maintain proper dissolved oxygen (DO) concentrations in the aeration basins. Operators report that the two basins are rarely balanced (i.e., when one basin has a proper DO concentration, the second basin is usually too

high or too low). There is no automatic control of DO concentration. The imbalance problem is likely a result of the poor influent flow split to the tanks.

- A significant scum layer was noted on the top of the chlorine contact tanks. This can lead to maintenance problems and potential effluent quality problems if not routinely handled.

Site

- The Mystic WPCF site is confined by the Mystic River water line to the west and south, and a tidal swale and wetlands to the east.
- Neighboring properties include a Bed and Breakfast inn and other residences.

Structural/Architectural

- The structures are not exhibiting major structural deterioration, but are showing local signs of deterioration not uncommon for concrete structures of this age and service.
- The noted deterioration, primarily surface cracking, delineation, and spalling, will require repair.
- There are several code non-compliance areas to be addressed, including egress from basement areas, fire protection, and thermal insulation.
- The main building roof system is in need of replacement.
- The main building doors and several other architectural features are in need of replacement.
- The layout of the main building should be renovated as part of any upgrade project at the site.

Electrical

- The Mystic WPCF has a new electrical service, rated at 600 V, 800 amps.
- A new 300-amp emergency generator is installed in the plant. The generator is not provided with an adequate means of dispelling radiator heat, and when operational, the generator quickly heats up the pump room in which it is located. Its current location also may render it vulnerable to flooding, and relocating the generator to above the flood level would improve plant reliability.

5.2.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. Daily data from the entire period was used for flow. BOD and TSS loads are based on weekly data from July 2001 through June 2002, and NH_3-N and TN loads are based on monthly data from July 2001 through June 2002. The loading data are based

only on one calendar year because in March 2001, WPCA modified its sampling protocol to 24-hour composites, and the data collected from this protocol is considered to be more accurate than the previous data, which was collected using 4-hour composites from 7:00 am to 11:00 am. This change in sampling protocol has led to the discovery that the Mystic WPCF influent loads are much higher than previously believed. For example, the average influent BOD concentration measured in the three years prior to the sampling protocol change was 219 mg/L (which is within the typical range of domestic influent wastewater), and the average BOD concentration measured since the sampling protocol change is 380 mg/L, a 74 percent increase. This corrected influent data in part explains the performance difficulty the plant has had, even at less than its rated flow capacity.

Influent Flows and Loads

Table 5-1 summarizes the existing influent flow —in million gallons per day (mgd) — and mass loadings — in pounds per day (ppd) — to the Mystic WPCF. The data show that the influent to the Mystic WPCF is more highly concentrated than is typical for domestic wastewater. The full reason for this variance is not known, although factors contributing to the highly concentrated influent may include the many restaurants within the collection system, and extensive water conservation efforts at the hotels within the system.

Table 5-1
Mystic WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual[(1)]	0.570	1,806	1,462	142	202
Maximum Month[(2)]	0.772	3,024	3,055	192	273
Peak Day[(2)]	1.176	4,448	3,627	292	416
Peak Instantaneous	2.0				

Notes:
[(1)] Annual average values based entirely on plant records.
[(2)] Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at the Mystic WPCF. BOD_5 removal averaged 30 percent, and decreased to close to 20 percent during higher flow periods. TSS removal ranges between 60 and 65 percent over the range of flows experienced. Total nitrogen (TN) and total Kjeldahl nitrogen (TKN) removal was about 17 percent, and ammonia-

nitrogen (NH_3-N) removal was about 11 percent. Note that these percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment
The following are noted upon review of the plant's operating data.

- Monthly average mixed liquor suspended solids (MLSS) concentration averages 1,417 mg/L and typically varies between 960 mg/L and 1,820 mg/L.
- Average monthly wastewater temperature averages 61 degrees F, and varies between 52 deg. F and 71 deg. F.
- Secondary clarifier underflow concentration averages 5,200 mg/L, and varies between 7,600 mg/L and 2,800 mg/L.
- The mean pH of the influent wastewater is 7.2. Influent pH is very consistent, and ranges only from 7.0 to 7.3.

Disinfection
- The average chlorine dosage for disinfection is 12.3 mg/L.
- The typical total residual chlorine concentration is about 1.0 mg/L.

Solids Handling
Before the diversion of primary underflow to the Borough WPCF was implemented, the Mystic WPCF thickened the co-settled primary sludge and WAS for hauling and off-site disposal. Records from the period prior to the diversion indicate that the thickened sludge was typically 2.25 percent solids. An average of 7,700 dry pounds per month was hauled. Once the diversion started, solids-handling processes at the Mystic WPCF were suspended, because the primary sludge and WAS are now pumped to the Borough WPCF as part of the diversion.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Mystic WPCF with respect to its current discharge permit (see Section 1.5.2 and Appendix D). Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit requirements. It was noted that the Mystic WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS and slightly more violations for settleable solids concentrations and coliform violations. It was noted that most of the intermittent violations occurred in 1997 and 1998.

With regard to nitrogen load, the Mystic WPCF has discharged less than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows prior to the diversion to the Borough WPCF. However, as time passes, the discharge requirements become more strict. It is

expected that nitrogen discharges from the Mystic WPCF will be close to the 2004 limit of 46 ppd.

5.2.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Mystic WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. **Table 5-2** summarizes this evaluation for the Mystic WPCF.

As shown in Table 5-2, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), disinfection, and outfall.

For each unit process, typical design parameters and the related Mystic WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters. Table 5-2 indicates that the influent pumping process has a peak capacity of 3.02 mgd with one pump out of service (the "firm" capacity). The Mystic WPCF has no preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Mystic WPCF, limiting the nominal capacity of the process to 0.81 mgd for average flow conditions, and 1.62 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the mixed liquor suspended solids (MLSS) concentration is maintained at 1,420 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. Table 5-2 shows that the aeration basins' nominal capacity is 0.63 mgd (average), based on maintaining a maximum food-to-microorganism (F:M) ratio of 0.6, and that the secondary clarifiers limit the capacity of the secondary clarification process to an average of 0.76 mgd, based on the solids-loading rate limited allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf).

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 4,000 mg/L. This substantially increases the solids load to the secondary clarifiers, and assuming that the typical sludge volume index (SVI) is about

See Table 5-2

200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 0.50 mgd. The Mystic WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated. New tankage and/or equipment would be used to provide denitrification.

The existing chlorine contact tanks have a nominal capacity of 0.70 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. WPCA has reported that this has been allowed by CTDEP in the past, because the additional contact time provided by the outfall pipe. The outfall's hydraulic discharge capacity is approximately 8.7 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before triggering the effluent lift pump. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 0.70 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the F:M ratio in the secondary clarifiers limits the nominal capacity of the WPCF to an average of 0.63 mgd. If year-round nitrification is desired, as it will be in the future to obtain nitrogen removal, the nominal capacity of the existing WPCF is limited to a *maximum day* of 0.50 mgd.

5.3 Stonington Borough WPCF

The Stonington Borough WPCF (Borough WPCF) provides wastewater treatment services primarily for the Village of Stonington. A small area extending northward from the Village, and an area of Lord's Point are also served, and the plant now also treats up to 300,000 gallons per day of primary clarifier underflow from the Mystic WPCF, as described earlier. The plant was placed into service in 1975.

5.3.1 Plant History

In the 1959 MaGuire study, it was recommended that Stonington construct the three-wastewater treatment facilities (Mystic, Borough and Pawcatuck). It was also recommended that all three plants utilize similar layouts, processes and equipment to the extent possible. Construction of the Borough WPCF was completed in 1975, and the plant was placed into operation.

As described earlier, in 1993 and 1994, Wright-Pierce conducted a study for improving the operation and performance of the Mystic WPCF. A key recommendation from the study was construction of a new double-barrel forcemain between the Mystic and Borough plants, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. Implementation of this diversion required that upgrade work be conducted at the Borough WPCF. The work at the Borough WPCF included installation of a fine-bubble aeration system, retrofit of the plant's existing digesters into new primary clarifiers, and conversion of one of the plant's existing primary clarifiers into a secondary clarifier. The diversion from the Mystic WPCF began in September 1999.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Borough WPCF, along with the other two treatment facilities and their respective collection systems. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Borough WPCF included improved ventilation of the influent wet well, covers over all of the treatment tankage, and treatment of the ventilated air with a biofilter. These improvements were completed in 2003.

5.3.2 Plant Description

The Borough WPCF was designed to treat an average flow of 0.66 million gallons per day (mgd). The plant discharges to Stonington Harbor. **Figure 5-2** presents a site plan of the existing Borough WPCF. The site plan includes a conceptual footprint of the biofilter to be constructed in 2003

The Borough WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, primarily due to the diversion from the Mystic WPCF, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor Control

Raw sewage, including up to 300,000 gpd of primary clarifier underflow diversion from the Mystic WPCF, enters the plant through a 24-inch diameter gravity sewer. Flow normally passes through a comminutor before entering the influent wet well. The comminutor currently in place was installed in 1999, and replaced a unit that was installed during the original plant construction.

Raw influent is pumped from the wet well by two influent pumps. The pumps are vertical, centrifugal, non-clog type, and are driven by variable frequency drives (VFDs). These pumps are the original pumps, but were modified with new impellers, motors and drives to enable them to pump to the higher elevation of the new primary clarifiers. Each pump has a design capacity of 970 gpm at 37 feet total dynamic head (TDH).

The influent pumps discharge to two new primary clarifiers, which were constructed in 1999 by modifying the abandoned sludge digesters. The 30-foot diameter primary

See Figure 5-2

clarifiers are equipped with center-feed scraper mechanisms for conveying settled sludge toward a well at the center of the tanks. Scum and grease collected on the surface of the primary clarifiers is drained to a scum pit for later mixing with the primary sludge. Primary effluent flows over inboard, v-notch weirs around the circumference of the tanks and towards the plant's two aeration basins. The primary clarifiers are covered with domes to allow capture of the headspace air for odor control.

The aeration basins are operated in conventional, plug-flow mode. The basins are equipped with fine-bubble membrane diffusers. Operators are currently utilizing the Symbio™ process in the aeration basins, attempting to achieve simultaneous nitrification and denitrification. The Symbio™ process has been in operation since January 2002. The process has shown only occasional success in providing simultaneous nitrification and denitrification, and the goal of achieving consistent success has not been achieved. Since startup of the process, the effluent total nitrogen concentration has been lees than 10 mg/L lass than 15 percent of the time, which indicates that the process is not reliably removing nitrogen to the levels needed. However, the Symbio™ process has resulted in some "side" benefit for the plant, in terms of operational stability and settling. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins.

The mixed liquor effluent from the aeration basins flows to three rectangular secondary clarifiers. Two of the secondary clarifiers are from the original plant construction, and the third secondary clarifier was constructed and installed by modifying one of the plant's original rectangular primary clarifiers, before the digester conversion. The third secondary clarifier is identical in dimensions to the original two tanks. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which operators control the amount of sludge withdrawn from the clarifiers by varying the RAS pumping rate. RAS is then pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is pumped to the influent wet well, for subsequent co-settling in the primary clarifiers.

Secondary scum is skimmed from the secondary clarifiers manually, and flows to the thickened sludge storage tank, for mixing with the thickened sludge prior to hauling.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. The sodium hypochlorite is added in a mixing chamber at the influent end of the chlorine contact tanks, and is dosed based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Stonington Harbor outfall. An effluent lift pump is installed to allow the plant to continually discharge to the outfall even during high backwater conditions. Plant staff report that this pump is currently in inoperable condition, and is scheduled for repair or replacement in the near future.

Co-settled primary sludge and WAS is removed as the underflow from the primary clarifiers at a typical concentration of about 2 percent solids. The sludge is pumped by two plunger pumps to a rotary-drum sludge thickener. The on-line thickener is used about 45 to 50 hours per week, and thickens the sludge to about 6 to 7 percent solids. A liquid polymer system, consisting of a holding tank, mixer and two chemical feed pumps, is used to aid coagulation.

Thickened sludge is deposited into a small holding tank, and then is pumped to a larger sludge holding tank that was constructed by modifying the second original rectangular primary clarifier. The existing thickened sludge transfer pump is a double-disk type pump.

The new odor-control process installed in 2003 consists of a system of tank covers, improved ventilation, and treatment of captured odors through a biofilter. Odor Control is provided for all of the plant's process tankage and the influent wet well. The biofilter was built into the plant's previously-existing landscape features to minimize visual impact to the site.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Three centrifugal RAS pumps are used to return sludge from the secondary clarifiers to the aeration basins. Two of the RAS pumps are driven by VFDs, and the third is a constant-speed pump. One WAS pump, with a capacity of 200 gpm, is used to pump WAS from the secondary clarifier underflow to the influent wet well. The WAS pump operates automatically on timer. Two primary sludge pumps are used to withdraw sludge from the primary clarifiers and pump it to the thickener.

Three blowers provide air for the activated sludge system. The blowers are positive-displacement type, and each has a capacity of 800 icfm at 7.2 psig discharge pressure. All three of the units are driven by VFDs. The blowers were all installed in 1999, and operators generally run two units in the summer and one in the winter to maintain adequate air to the aeration basins.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank, and two chemical feed pumps. Plant staff is also able to dose sodium hypochlorite to the RAS line for nocardia control.

A 230-kW emergency generator set is also housed in the Control Building.

A new supervisory control and data acquisition (SCADA) system has been installed at the Borough WPCF by U.S. Water, as part of a system-wide control system.

A summary table of the design and operating criteria for the Borough WPCF is included in Appendix A.

5.3.3 Plant Inspection

CDM has conducted site visits to the Borough WPCF to compliment our understanding of the plant operation based on previous reports, and to ascertain operational, structural or other deficiencies that will be considered as the alternative evaluation process proceeds. Many of our observations are incorporated into Section 5.3.2. Additional observations are noted in the following sections. Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The thickened sludge pump, which is designed to pump sludge from the rotary-drum thickener to the sludge storage tank, is problematic in this application. The pump is a double-disk type, installed in 1999, and it appears that the thickened sludge is too thick for the pump to operate as planned.

- The effluent lift pump is in poor condition and is currently inoperable, according to plant staff.

Site

- The existing site is constrained by Stonington Harbor to the west. Residential housing is located in close proximity to the north and east.

- WPCA had noted an increase in the number of odor complaints at the Borough WPCF when the diversion from the Mystic WPCF was implemented in August 1999, and again during the public participation aspect of the wastewater planning effort. However, since the recent odor control improvements were completed in 2003, no complaints have been received.

Structural/Architectural

- The Borough WPCF is in generally good, structurally sound condition.

Electrical

- No recorded field observations.

5.3.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. For flow, daily Borough influent data from the entire period was used, and from August 2000 through June 2002, the daily diversion flow from Mystic was subtracted from the daily Borough influent flow to obtain the flow from the Borough collection system. BOD and TSS loads are based on weekly concentration data from the pre-diversion period, and applied to the flows. NH_3-N and TN loads are based on monthly concentration data from the pre-diversion period, and applied to the flows. Plant operating data used includes the influent wastewater temperature, the mixed liquor suspended solids (MLSS), the sludge volume index (SVI), and sludge removal records. The Borough WPCF samples are 24-hour composites.

Influent Flows and Loads

Table 5-3 summarizes the influent flow and mass loadings to the Borough WPCF from the Borough collection system only. The loading from the Mystic diversion is not included in Table 5-3.

Table 5-3
Stonington Borough WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual[(1)]	0.216	374	304	48	70
Maximum Month[(2)]	0.346	804	591	94	136
Peak Day[(2)]	0.486	944	737	114	167
Peak Instantaneous	1.52				

Notes:
(1) Annual average values based entirely on plant records.
(2) Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at the Borough WPCF. Prior to the Mystic diversion, BOD_5 removal averaged 39 percent. TSS removal ranges between 60 and 70 percent. TN, TKN and ammonia-nitrogen removals were about 17, 14 and 13 percent, respectively. After the Mystic diversion, BOD_5 removal has decreased to an average of about 30 percent. TSS removal has continued to be between 60 and 70 percent over the range of flows experienced. TN, TKN and ammonia-nitrogen removals were about 17, 14 and 13 percent, respectively. These percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment

The following are noted upon review of the plant's operating data. This data does not include (pre-dates) the impacts from the pilot Symbio™ process.

- Monthly average MLSS concentration averaged about 1,200 mg/L and varied between 1,100 mg/L and 1,500 mg/L prior to the Mystic diversion. Since the diversion started, the monthly average MLSS concentration has been about 3,000 mg/L.

- Average monthly wastewater temperature averages 61 degrees F, and varies between 52 deg. F and 71 deg. F.

- The mean pH of the influent wastewater is 7.0. Influent pH is very consistent, and ranges from 6.7 to 7.4.

Disinfection

- The average chlorine dosage for disinfection is 6.2 mg/L.

- The typical total residual chlorine concentration is about 0.7 mg/L.

Solids Handling

The Borough WPCF thickens and stores co-mingled WAS and primary sludge. The thickened sludge, which is also mixed with primary and secondary scum, is then pumped to trucks for hauling. Since the diversion from the Mystic WPCF began, the Borough WPCF has produced approximately 1,500 pounds (dry weight) per day of solids.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Borough WPCF with respect to its current discharge permit. Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit requirements. The Borough WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS. These violations constitute the largest percentage of violations at the Borough plant over the period of study. The BOD violations at the Borough plant occurred in 1997 and 1998. No BOD violations were noted after 1998.

With regard to nitrogen load, the Borough WPCF discharged more than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows prior to the diversion from the Mystic WPCF. As time passes, the discharge requirements become more strict, thus, requiring additional nitrogen trading at a cost.

5.3.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Borough WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. Table 5-4 summarizes this evaluation for the Borough WPCF. As shown in Table 5-4, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), disinfection, and outfall. For each unit process, typical design parameters and the related Borough WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and

CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters.

Table 5-4 indicates that the influent pumping process has a peak capacity of 1.40 mgd with one pump out of service (the "firm" capacity). The Borough WPCF has no preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Borough WPCF, limiting the nominal capacity of the process to 0.85 mgd for average flow conditions, and 1.70 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the MLSS concentration is maintained at 1,200 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. Table 5-4 shows that the aeration basins' nominal capacity is 0.86 mgd, based on maintaining a maximum F:M ratio of 0.6. Under this operating scenario, this limits the secondary treatment capacity, because the secondary clarifiers' limiting flow rate is an average of 1.05 mgd, based on the allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf).

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 3,750 mg/L. This substantially increases the solids load to the secondary clarifiers, and assuming that the typical SVI is about 200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 0.80 mgd. Except for the possible capabilities of the Symbio™ process, the Borough WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated.

The existing chlorine contact tanks have a nominal capacity of 0.64 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. The outfall's hydraulic discharge capacity is approximately 7.5 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before triggering the effluent lift pump. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 0.64 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the nominal capacity of the existing WPCF is limited to a peak 0.86 mgd by the allowable maximum F:M ratio in the aeration basins, assuming a

See Table 5-4

MLSS concentration of 1,200 mg/L to meet conventional treatment standards. If year-round nitrification is desired, the nominal capacity of the WPCF is limited to a *maximum day* of 0.80 mgd, because the solids loading rate to the secondary clarifiers increases and becomes the limiting criterion.

5.4 Pawcatuck WPCF

The Pawcatuck WPCF provides wastewater treatment services for all of the sewered areas of Pawcatuck. The plant was placed into service in 1980.

5.4.1 Plant History

The 1959 MaGuire study recommended construction of the Pawcatuck WPCF. The Pawcatuck WPCF utilizes the same unit processes as the other two plants, but is comprised of a different layout because of the available space.

In 1991, the Stonington WPCA was sued by a number of neighbors of the Pawcatuck WPCF, as a result of odors from the plant. Legal matters pertaining to the settlement of this suit, and ongoing additional action, have made odor control a vital consideration in the operation and maintenance of the plant. Modifications to the plant's processes are all made with odor control as a primary design consideration. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Pawcatuck WPCF included new covers over the primary clarifiers and aeration basins, improved ventilation of the solids processing and septage receiving areas, and treatment of the ventilated air with a biofilter. These improvements were completed in 2003.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Pawcatuck WPCF, along with the other two treatment facilities and the collection system.

5.4.2 Plant Description

The Pawcatuck WPCF was designed to treat an average flow of 1.3 million gallons per day (mgd). The plant discharges to the Pawcatuck River. The plant is currently treating flows well below its original design capacity. **Figure 5-3** presents a site plan of the Pawcatuck WPCF.

The Pawcatuck WPCF receives all of its influent flow from a discharge forcemain from the nearby Pump Station No. 3. There is no influent pumping or preliminary treatment (comminution, screening or grit removal) facilities at the Pawcatuck WPCF site.

The Pawcatuck WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, primarily due to replacement of aged equipment and currently employs the following treatment processes:

- Primary clarification, with waste activated sludge (WAS) co-settling

See Figure 5-3

- Septage receiving
- Activated-sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control
- Digesters (abandoned)

The influent flow from Pump Station No. 3 bypasses an abandoned aerated grit chamber, and discharges to the inlet channel to the two primary clarifiers. Only one primary clarifier is used under normal operation, because only one tank is typically needed to treat current flows. The inlet channel and both primary clarifiers are covered for odor control purposes, and the enclosed area is vented to the new biofilter system. The primary clarifiers are equipped with chain-and-flight sludge removal mechanisms. Scum and grease are manually skimmed from the surface of the clarifiers with rotating skimmers. The scum and grease flows to a pit, from which it is pumped to the thickened-sludge holding tank for eventual hauling. Primary effluent flows over v-notch weirs at the effluent end of the tanks and towards the plant's two aeration basins.

Septage is received in the garage area of the Pawcatuck WPCF, and is discharged into an underground, 10,000-gallon holding tank. The septage-receiving tank is not equipped with mixers or aeration, but does have a coarse bar rack at the inlet end. Septage is metered into the plant flow by pump. The septage storage tank is vented to a biofilter odor-control system. Septage is received intermittently, with between one and two 2,000-gallon trucks per week the typical range.

The aeration system is operated in conventional, plug-flow mode. Only one of the two basins is typically in operation. Both basins are equipped with fine-bubble membrane diffusers. The aeration system is currently operated to provide BOD removal, and as much nitrogen removal as possible. Operators currently create an anoxic zone at the front end of the aeration basins, by shutting off the air flow to that diffuser grid, and recycling a portion of the mixed liquor with a submersible pump from the effluent end of the basins to the front end. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins. The aeration basins were covered and the headspace ventilated to a biofilter as part of the 2003 odor control improvements.

The mixed liquor from the aeration basins flows to two rectangular secondary clarifiers. Both tanks are typically in service to provide efficient settling. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which RAS is pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is pumped to the channel that feeds the

primary clarifiers. Scum is removed from the surface of the secondary clarifiers similarly to the primary clarifiers, and the scum drains to the same pit as the primary scum and grease. Secondary effluent flows over straight-edge finger weirs at the effluent end of the tanks.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. The sodium hypochlorite is dosed based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Pawcatuck River outfall.

Co-settled primary sludge and WAS is removed as the underflow from the primary clarifiers. The sludge is pumped to one rotary-drum sludge thickener. A polymer system, consisting of three polymer mixing and aging tanks, and an in-line-mixing tank upstream of the thickener, is used to aid coagulation. Thickened sludge is deposited into a sludge holding tank, from which it is pumped to trucks for hauling offsite. A chopper pump is also used to pump the thickened sludge to the trucks. Odor control is provided for the thickener and for the truck when loading. The thickened sludge storage tank is covered, and all components are ventilated to the odor-control system.

Primary scum and grease, and secondary scum, are also hauled off site. A chopper pump moves the scum from the pit to the thickened sludge holding tank, where it mixes with the thickened sludge prior to hauling.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Two centrifugal RAS pumps (one in service at a time) are used to return sludge from the secondary clarifiers to the aeration basins. One WAS pump, with a capacity of 225 gpm and driven by a VFD, is used to pump WAS from the secondary clarifier underflow to the channel that feeds the primary clarifiers. Operators currently run the WAS pump on a timer. Two primary sludge pumps (one in service at a time) are used to withdraw sludge from the primary clarifiers and pump it to the thickener.

Three blowers provide air for the activated sludge system, two new units, installed in 1999 and 2001, and one older unit from the original plant construction. The older blower is in poor condition, and is not suitable for operation with a fine-bubble diffusers.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank for use in disinfection, one 50-gallon tank for use in chlorinating the RAS stream, and one spare 30-gallon tank. Three chemical feed pumps are used to feed sodium hypochlorite to these processes.

The Pawcatuck WPCF originally included a two-stage digestion process to stabilize the sludge removed from the liquid-side treatment processes. This system was taken

out-of-service in 1993, and the gas-handling, mixing and other equipment necessary to operate the process was removed.

The new odor control process installed in 2003 consists of a system of tank covers, improved ventilation, and treatment of the odors through a biofilter. Odor control is provided for the plant's primary clarifiers, aeration basins, and all sludge handling processes.

A backup power generator is housed in the Control Building. The generator was manufactured by Cummins-Onan, and is rated at 250 kW.

A new supervisory control and data acquisition (SCADA) system has been installed at the Pawcatuck WPCF by U.S. Water, as part of a system-wide control system.

A summary table of the design and operating criteria for the Pawcatuck WPCF is included in Appendix A.

5.4.3 Plant Inspection

CDM has conducted site visits to the Pawcatuck WPCF to compliment our understanding of the plant operation and to ascertain operational, structural or other deficiencies that will be considered as the alternatives evaluation process proceeds. Many of our observations are incorporated into Section 5.4.2. Additional observations are noted in the following sections. Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The plant is currently operating with an internal recycle flow in the aeration basins, and in shutting off air to the front end of the basins, in an attempt to create an anoxic zone. A significant amount of nitrogen removal occurs as a result of this process.

- WPCA has reported that there may be too long a delay time in the control loop for the sodium hypochlorite dosing system, and relocating the feed system is under consideration. The chlorine residual monitors have been problematic in terms of the amount of maintenance required.

Site

- The Pawcatuck WPCF sits on only a portion of WPCA's existing property. There is a significant amount of site footprint available for expansion, if required (see Figure 5-3).

Structural/Architectural

- The mixing tank inlet to the chlorine contact tanks is not provided with guardrail.

- The digester building back room has a leaking roof.

Electrical

- No recorded field observations.

Miscellaneous

- There is a mechanics shop located in the Control Building. This shop serves the needs of all three of WPCA's facilities.

- The Pawcatuck WPCF was originally designed and laid out with the consideration that the plant tankage could double at some point in the future (i.e., a "mirror" process footprint could be constructed to expand capacity).

5.4.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. Daily data from the entire period was used for flow. BOD and TSS loads are based on weekly data from July 2001 through June 2002, and NH_3-N and TN loads are based on monthly data from July 2001 through June 2002. The loading data are based only on one calendar year because in March 2001, WPCA modified its sampling protocol to 24-hour composites, and the data collected from this protocol is considered more accurate than the previous data, which was collected using 4-hour composites from 7:00 am to 11:00 am. Plant operating data used includes the influent wastewater temperature, the mixed liquor suspended solids (MLSS), the sludge volume index (SVI), and sludge removal records.

Influent Flows and Loads

Table 5-5 summarizes the existing influent flow and mass loadings to the Pawcatuck WPCF. The data show that the influent to the Pawcatuck WPCF is typical municipal wastewater, similar to the other two plants.

Table 5-5
Pawcatuck WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual[(1)]	0.473	782	1,108	94	148
Maximum Month[(2)]	0.696	974	1,651	138	217
Peak Day[(2)]	0.918	1,121	1,991	182	286
Peak Instantaneous	1.68				

Notes:
(1) Annual average values based entirely on plant records.
(2) Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at Pawcatuck. BOD_5 removal averaged about 40 percent. TSS removal ranges from about 70 percent at typical flow rates, to about 60 percent at high flows. TN and TKN removal were about 18 percent, and ammonia-nitrogen removal was about 12 percent. As with the other plants, these percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment

The following are noted upon review of the plant's operating data. These items will be considered during the alternatives evaluations that will be developed in a subsequent section:

- Monthly average MLSS concentration averages 1,575 mg/L and varies between 500 mg/L and 3,129 mg/L.
- Average monthly wastewater temperature averages 58 degrees F, and varies between 51 deg. F and 67 deg. F.
- The mean pH of the influent wastewater is 7.1. Influent pH is very consistent, and ranges only from 6.8 to 7.3.

Disinfection

- The average chlorine dosage for disinfection is 6.1 mg/L.
- The typical total residual chlorine concentration is about 0.7 mg/L.

Solids Handling

The Pawcatuck WPCF thickens and stores co-mingled WAS and primary sludge. The thickened sludge, which is also mixed with primary and secondary scum, is then pumped to trucks for hauling. The Pawcatuck WPCF has produced an average of approximately 1,060 pounds (dry weight) per day of solids.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Pawcatuck WPCF with respect to its current discharge permit. Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit

requirements. The Pawcatuck WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS. These violations constitute the largest percentage of violations at the Pawcatuck plant over the period of study. Most of the violations occurred in 1998 and 1999.

With regard to nitrogen load, the Pawcatuck WPCF has discharged less than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows, which were higher. However, as time passes, the discharge requirements become more strict. It is expected that nitrogen discharges from the Pawactuck WPCF will be close to the 2004 limit.

5.4.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Pawcatuck WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. Table 5-6 summarizes this evaluation for the Pawcatuck WPCF.

As shown in Table 5-6, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), and disinfection. For each unit process, typical design parameters and the related Pawcatuck WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters.

Table 5-6 indicates that the Pawcatuck WPCF has no on-site influent pumping, or preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Pawcatuck WPCF, limiting the nominal capacity of the process to 1.01 mgd for average flow conditions, and 2.02 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the MLSS concentration is maintained at 1,575 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. **Table 5-6** shows that the aeration basins' nominal capacity is 2.05 mgd, based on maintaining a minimum detention time of 5 hours. However, the secondary clarifiers limit the capacity of the secondary treatment process to an

See Table 5-6

average of 1.93 mgd, based on the allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf). The return sludge pumping capacity further limits treatment capacity to 1.87 mgd, but this constraint could be readily eliminated.

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 3,100 mg/L. This increases the solids load to the secondary clarifiers, and assuming that the typical SVI is about 200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 2.10 mgd. The Pawcatuck WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated. It is assumed that new tankage and/or equipment would be used to provide denitrification.

The existing chlorine contact tanks have a nominal capacity of 1.64 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. The outfall's hydraulic discharge capacity is approximately 11.5 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before backflow interferes with the effluent weir flow meter. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 1.64 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the overflow rate from the secondary clarifiers limits the nominal capacity of the WPCF to an average of 1.93 mgd. If year-round nitrification is desired, the nominal capacity of the WPCF is limited to a *maximum day* of 2.10 mgd.

5.5 Mass Balances

Process flow and mass balances have been developed for each the three WPCFs, for the existing average annual day, maximum month average day, and peak day loading conditions. These mass balances are presented in **Figures 5-4, 5-5 and 5-6.**

5.5.1 Calculation Tool

The mass balances were developed using Plan-It STOAT, a computer program that incorporates the most up-to-date and proven wastewater process models to mimic and predict actual plant performance given a certain set of inlet and operating conditions and model performance parameters. Plan-It STOAT was developed by Water Research Center (WRC) with technical support by CDM, and is used by CDM in the facilities-planning stages of a project, as it allows for the efficient evaluation of different process options. 5.5.2 Assumptions

General

Mass balances for each of the three plants are described separately. The following assumptions apply to all three mass balances. Additional assumptions that apply only to a specific plant are as noted in the following sections.

See Figure 5-4

See Figure 5-5

See Figure 5-6

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1. Plant operating data as described earlier in this section were used to develop influent loadings to the plants, in terms of flow, BOD, TSS, ammonia-nitrogen, and TKN.

2. Wastewater temperature is equal to the annual average as indicated by plant records.

3. Aeration basin DO is always maintained at 2.0 mg/L. This assumption impacts the model's prediction regarding the ability of the plant to achieve nitrification, and the mass balance nitrogen component data reflect that nitrification occurs. It is understood that lack of aeration control can interfere with the ability to maintain a DO concentration of 2.0 mg/L at all times, and hence the degree of nitrification actually observed.

4. Mixed liquor concentration, RAS flow, RAS concentration, WAS removed and effluent quality were matched as closely as possible to average annual data. For maximum monthly and peak day conditions, RAS and WAS rates were adjusted to maintain similar mixed liquor concentrations as during the average annual conditions. This approach assumes that operators attempt to maintain relatively constant MLSS levels, except for when the target MLSS is modified for seasonal purposes.

5. The amount of material removed by the plants' current scum skimming operation has negligible impact on the plant mass balance, and is ignored. This applies to both the total gallons and the pounds of solids.

Mystic WPCF

The following assumptions were used in developing the mass balance for the Mystic WPCF:

1. Primary underflow was targeted at approximately 300,000 gallons per day.

2. All available process tankage is in service.

3. Grit removed from the primary clarifier underflow has negligible impact on the mass balance, and is ignored. Grit washwater recycle to the influent wet well is also ignored.

Borough WPCF

The following assumptions were used in developing the mass balance for the Borough WPCF:

1. All available process tankage is in service.

2. The diversion from the Mystic WPCF is in place.

3. Thickened sludge is approximately 6.5 percent solids when pumped to the trucks for hauling. The thickening process recovers 90 percent of the solids, and the remaining is recycled to the front of the plant.

Pawcatuck WPCF

The following assumptions were used in developing the mass balance for the Pawcatuck WPCF:

1. The total septage received at the Pawcatuck WPCF averages 2,500 gallons per day. Since no quality data was available for the septage received at the plant, typical septage data, as tabulated in the *EPA Handbook, Septage Treatment and Disposal*, 1984, was used.

2. It was assumed that the following number of tanks was in service: one primary clarifier, one aeration basin, two secondary clarifiers, and two chlorine contact tanks.

3. Thickened sludge is approximately 6.5 percent solids when pumped to the trucks for hauling. The thickening process recovers 90 percent of the solids, and the remaining is recycled to the front of the plant.

5.6 Conclusions

The data described in this section will be used in developing the alternatives evaluation presented in Section 7. General conclusions of the existing WPCF evaluations that have a significant impact on the direction of the alternatives evaluation are as follows:

- The Mystic WPCF is the oldest of the three existing plants, and is not currently capable of efficiently treating all of the flow to the plant from the collection system. For this reason, a significant portion of the plant's influent flow (up to 300,000 gpd) is currently diverted to the Borough WPCF.

- The Mystic WPCF site is constrained, and expansion of the Mystic WPCF would be very difficult.

- The Borough WPCF is capable of successfully treating flows and loads from its local collection system, as well as the diversion from the Mystic WPCF. The usable Borough WPCF site is constrained, and expansion of the Borough WPCF would be very difficult.

- The Pawcatuck WPCF is underloaded at current flows and loads to meet existing treatment goals. The plant site is large, with a significant amount of available space for expansion.

- The WPCA has placed a high priority on avoiding nuisance odors from the three plant sites, and recently completed a significant odor control improvements program at all three sites.

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