MWMC Eugene-Springfield WPCF Facility Plan – Biosolids and Effluent Reuse Alternatives Analysis

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Executive Summary

An alternatives analysis has been conducted for Metropolitan Wastewater Management Commission's (MWMC) biosolids management program and effluent reuse. The analysis reviewed solids treatment processes, operations, and overall facilities located at the Eugene-Springfield Water Pollution Control Facility (E-S WPCF), Biosolids Management Facility (BMF), Biocycle Farm (BF), and Seasonal Industrial Waste Facility (SIWF). Using the design criteria identified in Technical Memorandum No. 13, *Projected Flowstreams for Solids Processes and Capacity Analysis of Biosolids Treatment Processes and Facilities,* future unit process needs have been identified for solids treatment processes at upper limit flow and load projections. The following additional unit processes are needed through the design period (2025):

- Gravity Belt Thickener – 1 unit (3 total) online in 2006
- Anaerobic Digestion – 1 unit (4 total) online in 2011

To provide long-term flexibility in the MWMC's biosolids management program, an evaluation of advanced digestion processes was conducted and the following two technologies/processes were considered for future evaluation: pre-pasteurization and temperature-phased anaerobic digestion (TPAD). Elements of program flexibility, as related to MWMC's biosolids program, include the potential to produce Class A biosolids with fewer testing requirements, reduce volatile solids loading on downstream lagoons, adapt to regulatory changes, and establish and maintain favorable public perception. At this time the technologies should continue to be monitored for process improvements and a conservative footprint allocated on the future site layout.

In addition to the unit processes identified above, other improvements to existing solids treatment processes and land application sites have been identified:

- Improved digester mixing
- Relining of the facultative sludge lagoons
- Development of Phases 2 and 3 of the BF (additional hose reels and site preparation)

- Expansion of the existing composting process at the BMF to approximately 5 to 10 percent capacity of the biosolids capacity.

No additional unit processes are needed at the BMF; however, operational changes are recommended to reduce the overloaded facultative sludge lagoons (FSLs). To reduce the solids inventory in the lagoons from the current solids depth of approximately 10 to 11 feet to 6 feet, the BF and the belt filter presses (BFPs) should be operated at or close to capacity. Beginning in the summer of 2004, liquid and dewatered biosolids should be applied to the BF at 1600 and 600 dry tons/year, respectively. The application rate will increase as the grass and poplars at the BF mature. The BFPs should be operated 12 hours/day, 5 days/week, 7 months/year (March–September), with all units on approximately 85 percent of the time. Dewatered cake will continue to be hauled to local cooperative farms, as well as being applied at the BF. Based on solids projections and the above harvesting schedule, it is estimated that the lagoons will be at an optimal solids depth between 2006 and 2007.

The capacity of the 8.5-inch biosolids force main that conveys digested sludge from the WPCF to the BMF is being reduced because of the buildup of struvite in various locations along the line. If the current acid cleaning strategy does not reduce the struvite buildup, operating and/or process modifications within the WPCF to reduce struvite precipitation should be evaluated. Reduced capacity of the line is causing the digested sludge pumps to pump at higher pressures and lower efficiencies. If scaling in the line continues to occur, a fourth set of new digester pumps may be needed to convey the projected sludge flows. Under the worst-case scenario, sections of the biosolids force main, where scaling appears to be the most severe, will need to be replaced. Continued monitoring of pumping pressures is also recommended.

Up to 10 million gallons per day (mgd) of Level II and Level IV effluent reuse produced at the WPCF will be planned for the design period. To maximize the existing 3.5-mgd conveyance capacity of the reclaimed water main, which conveys Level II effluent from the WPCF to the SIWF and BMF, it is recommended that effluent be applied at the SIWF and the BF. Minor modifications are required at the SIWF and the existing land lease agreement will remain in place. A dedicated effluent irrigation system is recommended at the BF. This will include a new pipeline and two new irrigation pumps. It is recommended that Level II effluent be applied first at the SIWF (up to 1.0 mgd) and then at the BF (up to 1.5 mgd). It is recommended that Level IV effluent be achieved through three phases of development. The first phase provides small, local (to the WPCF) reuse on public green spaces. The intent of this phase is to provide public outreach with regards to effluent reuse and will provide 0.5- to 1.0 mgd of reuse. The next two phases will provide an additional 1.5 to 2.0 mgd and 2.5 to 5.0 mgd, respectively, of Level IV reuse. Filtration, disinfection, conveyance and distribution equipment will be required, as well as identification of the land area required to apply the desired amount of reuse. To account for all reuse activities, MWMC should develop an effluent reuse plan.

Introduction

This technical memorandum has been prepared as part of the 2003/2004 Metropolitan Wastewater Management Commission (MWMC) Eugene-Springfield Water Pollution

Control Facility (E-S WPCF) Facilities Plan Update (MWMC Project No. 80010). The purpose of this memorandum is to document analyses conducted on solids treatment processes and effluent reuse at the WPCF, Biosolids Management Facility (BMF), Biocycle Farm (BF), and Seasonal Industrial Waste Facility (SIWF).

Topics discussed in this document include evaluation of future phasing of solids treatment processes, existing issues and future operational strategies related to MWMC's solids management program, and evaluation of effluent reuse options. Solids management as discussed in this document refers to treatment and disposal.

The solids treatment components associated with MWMC's solids management program are highlighted below:

- Solids thickening – accomplished through gravity belt thickeners (GBTs)
- Solids stabilization of pathogens and volatile suspended solids (VSS) – accomplished through anaerobic digestion and facultative sludge lagoons (FSLs)
- Solids dewatering – accomplished through mechanical dewatering and air drying beds
- Solids storage – accomplished primarily through FSLs and air drying beds
- Solids land application – accomplished through application of dewatered biosolids on cooperative farms and the BF, and through application of liquid biosolids on the BF

MWMC does not currently have an established effluent reuse program. However, effluent (WPCF W2 water) piping is under construction to convey effluent to the BMF and SIWF.

Process Phasing

The design criteria identified in Technical Memorandum No. 13, *Projected Flowstreams for Solids Processes and Capacity Analysis of Biosolids Treatment Processes and Facilities,* was used for evaluating unit process capacity. Based on unit process capacities, phasing charts have been developed for the major unit processes associated with the solids facilities at the WPCF, BMF, BF, and SIWF. Based on the assigned design criteria, the phasing charts, which are provided in this section, show when (approximately) a unit process will exceed capacity.

For planning purposes, it is assumed that unit processes must have enough capacity to treat the upper limit flow conditions. In general, the needs for additional future processes are based on all units operating to meet capacity at design criteria conditions rather than adding enough units to meet capacity with one unit offline. Exceptions to this assumption are noted where appropriate. Additional units are assumed to be the same size as existing units. Spreadsheet tables associated with the phasing charts are included in Attachment A. Solids management occurs at three separate sites: WPCF, BMF, and BF. Table 1 summarizes the additional solids processes needed by year 2025. Unless stated otherwise, upper limit flow and load projections have been used in the development of the phasing charts. Phasing is described below for gravity belt thickening, anaerobic digestion, FSLs, belt filter presses (BFPs), and biosolids storage. Future improvements related to the solids management conveyance system are also discussed.

TABLE 1
Solids Unit Process Phasing—Upper Limit Flow and Load Projections
MWMC Facility Plan, Eugene-Springfield

Unit Process	Additional Units Needed in 2025	Comments
Gravity Belt Thickening	1	Further evaluation to be conducted as part of pre-design effort
Anaerobic Digestion	1	Recommend construction of advanced treatment process
Facultative sludge Lagoons	0	No additional volume required based on (1) expected process performance of digester improvements and (2) operation of the Biocycle Farm
Belt Filter Press	0	
Biosolids Storage	0	

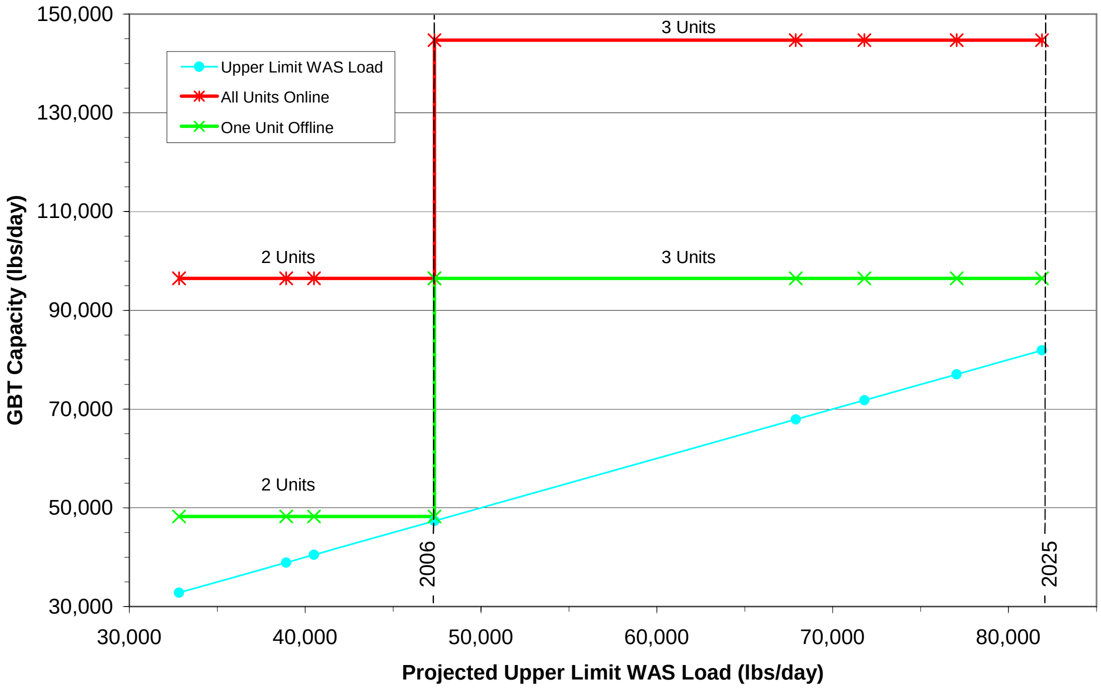
Gravity Belt Thickening

Two GBTs are used at the WPCF to thicken waste activated sludge (WAS) prior to solids stabilization in the anaerobic digesters. Under typical operation, one unit is offline. Figure 1 illustrates the phasing chart for the GBTs. Development of future GBT phasing is based on the design criteria loading rates of 2,010 dry pounds of solids/hour (solids loading rate) and 720 gallons per minute (gpm) (hydraulic loading rate), and the operating criteria of one unit offline during normal conditions. Based on the previous operating criteria and the limiting load criteria (solids loading rate), a third GBT is needed in 2006. As shown in Figure 1, if both existing units are online, a new unit is not required through the study period.

FIGURE 1

GBT Phasing

WWMW Conditions (24 hr/day operation)

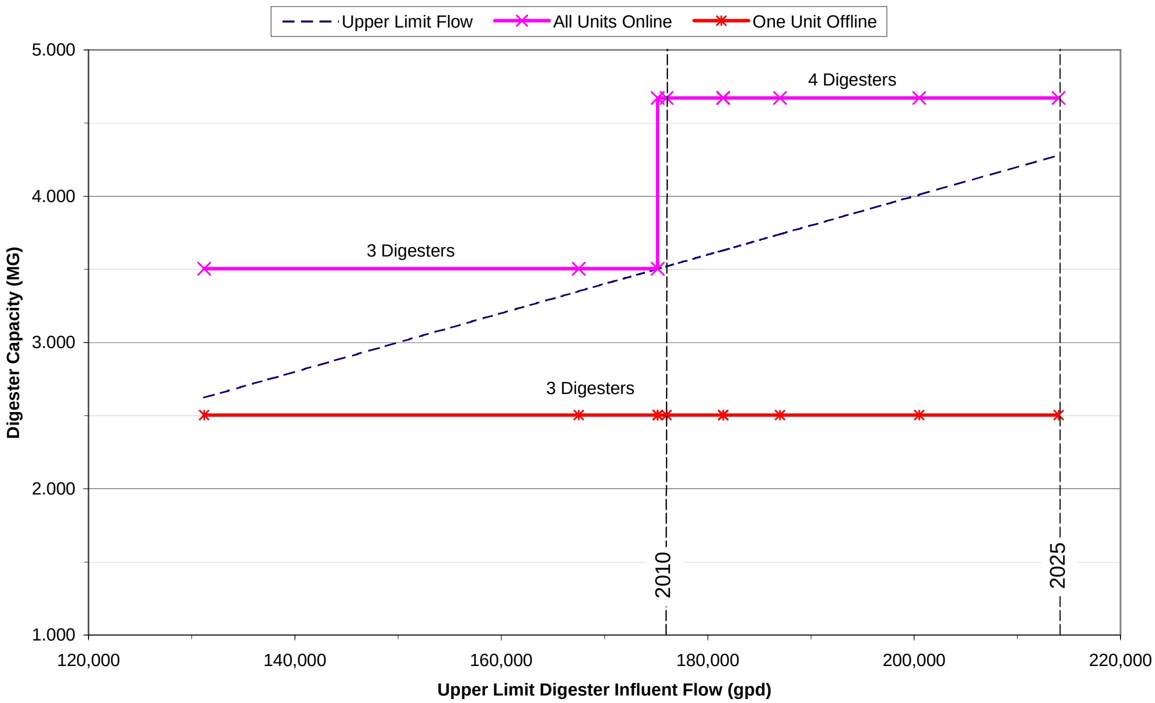


Anaerobic Digestion

Figure 2 illustrates the phasing chart for anaerobic digestion. Solids and hydraulic loading rates were evaluated and the hydraulic loading annual average condition, with a 20-day solids retention time (SRT), was determined to be the limiting criteria. It is assumed that future digester phasing will be based on all units operating to meet the design criteria. As shown in Figure 2, a fourth digester is needed in year 2010.

FIGURE 2

Digester Phasing
(*Annual Average Conditions, 20 day SRT, 0.15 lb VSS/day)*



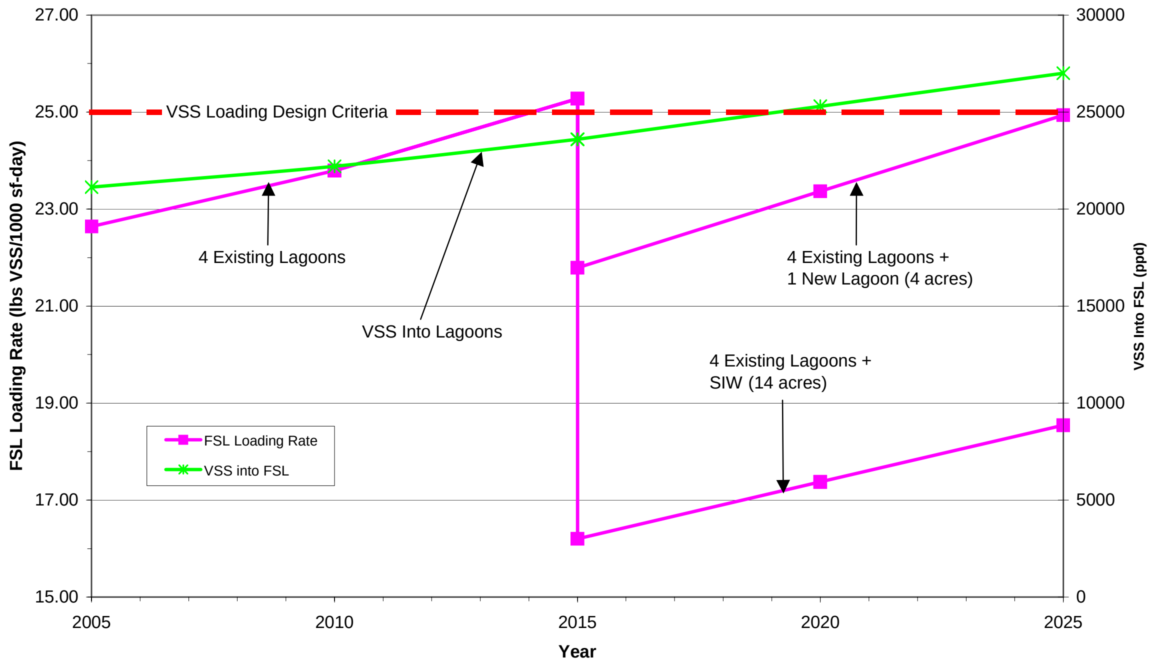
Facultative Sludge Lagoons

Figure 3 illustrates the phasing chart for the FSLs based on the design criteria of 25 pounds (lb) VSS/1,000 sf-day. As seen in Figure 3, the future increase in FSL VSS loading is related to the increase in volatile solids within the increased digested sludge flows. Based on annual average upper limit flow projections and 63 percent VSS in the digested sludge, additional lagoon surface area is needed in year 2015. This is also based on the current operational procedures of taking one lagoon offline for approximately 6 to 7 months (February-July) during the lagoon harvesting season. Figure 3 shows additional lagoon volume being added in 2015. Two alternatives were used in providing the additional lagoon surface area: construct a new lagoon, or use the existing lagoon at the SIWF. To achieve a VSS loading rate in the year 2025 that is 25 lb VSS/1000 sf-day, or less, an additional 4-acre lagoon is required. Figure 3 also shows that using the SIWF lagoon for a future FSL would provide excess loading capacity. Analysis of the FSL loading, future conditions, and reducing the current solids inventory in the FSLs are discussed in more detail in the analysis section of this document.

FIGURE 3

Facultative Sludge Lagoon Phasing

(Annual Average Conditions, 25 lbs VSS/1000 sf-day loading)



Belt Filter Presses

The BFPs at the BMF are operated seasonally and do not have to process digested sludge on a daily basis, as is typical for other treatment facilities. On average, the BFPs currently operate 12 hours/day, 5 days/week, 7 months/year (March through September). The FSLs receive digested sludge and provide storage for the sludge when the dewatering facility is not operating. No additional BFPs are required through the year 2025. Operational analysis of the processes at the BMF is discussed in the Process Analysis section of this document.

Biosolids Storage

Biosolids storage is accomplished in the air drying beds as a dewatered product and in the FSLs as sludge. Additional biosolids storage volume is not needed within the design period based on implementation of operating strategies at the BMF and presence of the BF. These issues are discussed in the Process Analysis section of this memorandum.

Process Analysis

The phasing charts described above use given design criteria and projected flows and loads to determine when additional capacity for a particular unit process would be needed. However, the interrelationships between certain treatment processes may allow construction of additional capacity to treat the solids produced at the WPCF to be delayed.

The primary focus of the Process Analysis section is to present alternatives for process optimization. Conclusions are developed and alternatives recommended. Analysis of solids processes, conveyance systems between the WPCF and the BMF, land application of solids, and effluent reuse are discussed. Attachment B contains associated analysis data presented in this section.

Solids Treatment

Solids treatment is accomplished through mechanical and biological processes located at the WPCF, BMF, and BF. Processes located at the WPCF include two GBTs and three mesophilic anaerobic digesters. Processes located at the BMF include four FSLs, three BFPs, and thirteen air-drying beds.

Waste activated sludge produced in the secondary treatment process at the WPCF is thickened through the GBTs and is then pumped to the anaerobic digesters. Anaerobically digested sludge is then pumped from the sludge holding tanks at the WPCF through a 5.5-mile pipeline (biosolids forcemain) to the FSLs at the BMF. Sludge is discharged into the lagoons where it remains for approximately 3 years. Each year from March through September the solids in the lagoons are harvested. A dredge is used to pump solids, now termed biosolids (stabilized sludge), out of the lagoons, where it is then dewatered through three BFPs. Dewatered biosolids are then stored in static piles in the air-drying beds where they are periodically turned and windrowed using a Brown Bear windrower. The air-drying beds were used to dewater biosolids from the FSLs prior to the installation of the BFPs. A small portion of the annual biosolids production (less than 5 percent) is composted through aerated static piles. Beginning in July, the dewatered biosolids are trucked to local cooperative farms where they are land applied as a Class B biosolids product.

Waste Activated Sludge Thickening

Mechanical equipment in the form of two GBTs is used to thicken WAS produced in the secondary treatment process at the WPCF. The GBTs thicken WAS from approximately 0.5 percent solids to 4.0 percent solids prior to entering the anaerobic digesters. Current operational procedures have one unit on standby and one unit online during normal operating conditions. When online, the units operate 16 to 24 hours/day, 7 days/week. MWMC would like to maintain the current practice of thickening WAS with one unit on standby at design flow conditions. Unless alternative methods in the secondary process are implemented to reduce the amount of WAS produced, a third GBT will be needed in 2006. At this time, it appears the existing secondary treatment process will remain the same and, as such, an additional GBT is required. Future improvements to the primary treatment system include installation of primary thickeners. It may be possible to use the gravity thickener as a backup for WAS thickening during those times when a GBT is offline. Under this operating scheme the gravity thickeners would be operated in a co-thickening mode.

Recommendations

Expand the existing thickening building and install a third GBT the same size at the two existing units. Predesign evaluations of primary thickening may determine that co-thickening using the GBTs for short durations may be acceptable, and that installation of a third GBT can be deferred.

Install a third Polyblend unit in the basement of the thickening building regardless of whether the third GBT is constructed in an early phase.

Solids Stabilization

MWMC achieves biosolids stabilization through anaerobic digestion, FSLs, and dewatering (primarily mechanical). Anaerobic digestion and the FSLs are interrelated in functioning to stabilize solids through the reduction of pathogens and VSS. Further pathogen destruction occurs following the dewatering process when the dewatered cake is windrowed to a dry solids content of 40 to 50 percent. The capacities of these processes are sufficient to treat the current flows and loads seen at the WPCF. However, projected flows and loads indicate that additional digestion and FSL capacity may be needed during this study period. Similarly, solids production from the WPCF has become greater than the capacity for processing biosolids from the FSLs at the BMF. As a result, the lagoons have a solids inventory above optimal levels.

The primary purpose of sludge stabilization is to reduce pathogens and vector attractions (VSS destruction) in the use and disposal of treated sewage sludge (biosolids). Both pathogen and vector attraction reduction are regulated primarily by federal requirements set forth in U.S. Code of Federal Regulations Title 40 Part 503 (40 CFR 503). Subpart D of Part 503 includes criteria to classify biosolids as Class A or Class B with respect to pathogens. These classifications are based on the level of pathogens present in biosolids that are used or disposed. Biosolids produced by MWMC’s solids treatment processes are classified as Class B. This document focuses only on Class B products and requirements.

The 1999 Class A Biosolids/Compost Evaluation has been reviewed as part of evaluating and developing solids stabilization alternatives as part of this Facilities Plan. The 1999 evaluation was a result of a June 1997 Citizens Advisory Committee (CAC) recommendation to consider Class A pathogen reduction technologies, including composting. The recommendations from the 1999 evaluation were to continue using the air-drying beds following mechanical dewatering at the BMF, develop composting capacity for approximately 10 percent of the total biosolids produced but start with 5 percent production, further investigate temperature-phased anaerobic digestion (TPAD), and evaluate digester mixing improvements.

Pathogen Reduction

Pathogen reduction alternatives are identified in 40 CFR 503 and are intended to ensure that pathogen levels in biosolids are reduced to levels considered safe for biosolids to be land-applied or surface-disposed. To meet Class B biosolids pathogen requirements, one of the following three alternatives can be used:

- Alternative 1: Monitor indicator organisms. A test of fecal coliform density is required as an indicator for all pathogens. The geometric mean of seven samples shall be less than 2 million MPN (Mean Probable Number) per gram of total solids.
- Alternative 2: Treat biosolids in a process to significantly reduce pathogens (PSRP). PSRPs include aerobic digestion, air drying, anaerobic digestion, composting, and lime stabilization.
- Alternative 3: Treat biosolids in a process equivalent to a PSRP.

Anaerobic digestion is a PSRP, as defined in 40 CFR 503.32(b)(3), if the solids are retained in the digesters for at least 15 days at a minimum temperature of 35 °C. Currently, MWMC's anaerobic digesters meet these criteria and produce Class B biosolids. The liquid biosolids are further processed in the FSLs, where additional solids stabilization occurs.

Vector Attraction Reduction

It is critical to reduce the potential for exposing humans or other susceptible hosts (plants or animals) to pathogens contained in biosolids. Exposure may be initiated through vectors (flies, mosquitoes, fleas, rodents, and birds) that can potentially transmit pathogens to humans and other hosts through physical contact, or by playing a specific role in the life cycle of pathogens. Reducing the attractiveness of biosolids to vectors is regulated through twelve options identified in the Part 503 rule. The first of the twelve options is to achieve 38 percent reduction in volatile solids content.

MWMC biosolids have consistently met vector attraction reduction (VAR) requirements by achieving greater than 38 percent volatile solids reduction through both anaerobic digestion and additional treatment in the FSLs. Anaerobic digestion alone achieves greater than 38 percent volatile solids reduction. With the combination of anaerobic digestion and treatment in the lagoons, it is anticipated that VSS reduction in projected solids production through the design period will continue to exceed the 38 percent reduction requirement.

Anaerobic Digestion

As shown previously in Figure 2, the digestion capacity will be exceeded in approximately 2010. Near- and long-term capacity issues should be addressed.

A lithium chloride analysis to evaluate digester capacity was conducted approximately 10 years ago. Results from the test indicated that the active volume of the digesters was 63 percent. Since that analysis, no major modifications have been made to the digesters to increase the active volume. As flows and loads continue to increase, the SRT in the digesters decreases. This may affect MWMC's potential to meet effluent biosolids pathogen and VSS reduction requirements. Modification of the existing digester gas mixing system with a pump mixing system would increase the active volume of the digesters to above 90 percent, and is recommended.

Long-term capacity must be provided through the addition of digester volume. The phasing chart shown in Figure 2 assumes that the near-term digester mixing improvements have been implemented. The fourth digester shown in Figure 2 assumes a traditional mesophilic digester of the same size as the existing units. However, to be consistent with the 1997 Biosolids Management Plan recommendations to move toward a Class A program over the long term to provide for future biosolids flexibility, advanced digestion treatment processes have been evaluated.

Alternatives were evaluated on monetary and non-monetary issues. Non-monetary issues include siting, constructibility, performance, affect on downstream equipment, operational flexibility, and maintenance. Processes selected for preliminary consideration were:

- Conventional, mesophilic digester
- Pre-pasteurization
- TPAD

The advanced digestion alternatives evaluated in this document expand, in part, on some of the ideas and recommendations made in the 1999 Class A Biosolids/Compost Evaluation report. The 1999 evaluation was a result of a 1997 CAC recommendation to further evaluate Class A technologies prior to developing a long-term plan for the BMF. The 1999 report evaluated composting, TPAD, lime pasteurization, and air-drying beds, plus biosolids storage. The report recommended adding composting to the overall biosolids management program and to maintain air-drying as the primary biosolids treatment technology. The report recommended further study of advanced digestion processes. As such, this evaluation focuses more on the advanced digestion technologies. Table 2 provides a process comparison summary of the three alternatives evaluated as part of this document.

TABLE 2
Comparison of Digestion Treatment Processes
MWMC Facility Plan, Eugene-Springfield

Process	SRT at Max Month (days)	Operating Temperature	Max VSS Loading at Max Month (lb/ft^3-day)	Pathogen Level Produced	Modifications Required / New Equipment
Conventional (Mesophilic)	15	Mesophilic (35 °C)	0.15	Class B	N/A
Pre-Pasteurization	30 min / 15	~70°C / Mesophilic	0.20	Class A	Medium
TPAD	5 / 10	Thermophilic / Mesophilic	0.30	Class A (when Thermophilic operated in Batch or Draw/Fill/Hold mode)	Moderate

Alternative 1 – Conventional, Mesophilic Digester

Alternative 1 consists of constructing a traditional mesophilic digester. It is likely that the anaerobic digestion process would be the typical high-rate, single-stage process. Advantages and disadvantages of this alternative are listed below.

Advantages:

- A conventional process recognized and familiar to WPCF staff
- Non-proprietary process
- Proven performance record in municipal wastewater treatment plants
- Operating schemes more in line with current digestion process
- Most widely implemented digestion process at publicly owned treatment works (POTWs) across the United States

Disadvantages:

- Potential foaming problems
- Low volatile solids reduction
- May require larger retention times to achieve required volatile solids reduction
- Good mixing system required to maintain active digester volume

The major equipment that would be necessary under this alternative includes sludge recirculation pump(s), heat exchanger(s), a digester mixing pump(s), a digested sludge transfer pump, and hot water recirculation pump(s).

Alternative 2 – Pasteurization

Pre-pasteurization of predigested sludge involves heating raw sludge to 70°C (160°F) before transferring it to a separate holding tank, in this case one of the existing digesters. The temperature of the solids in the holding tank is maintained at a minimum of 70°C for 30 minutes. Upon completion of the pasteurization process, the temperature of the solids is decreased to 40°C (100°F) in a spiral heat exchanger and transferred to the digester. By using a sludge/sludge spiral heat exchanger, it is possible to recover greater than 50 percent of the required thermal energy prior to entering the digester. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Requires minimal SRT and also provides Class A biosolids that satisfy regulatory requirements
- Although more heat is required and higher heating costs are incurred, this process has been reported to recover over 50 percent of the thermal energy
- May improve dewatering characteristics
- Greater flexibility in reverting to mesophilic operations because thermophilic organisms do not need to be developed
- Ability to meet VAR requirements, when combined with anaerobic digestion
- Public recognizes the "pasteurization" term and, therefore, public education and acceptance may be easier

Disadvantages:

- There are few pasteurization treatment systems operating in the U.S. Pre-pasteurization systems have been installed in Perris, CA; Franklin Township, PA; and Carmel, IA; and one is under construction in Alexandria, VA.
- Fouling tendencies in sludge-sludge heat exchangers
- Production of odorous air
- Cooling of pre-pasteurized sludge is required prior to entering the mesophilic stage
- Does not provide additional VSS destruction or volume reduction

- If heat is not recovered, then energy requirements are high

The major components associated with pre-pasteurization include sludge/sludge heat exchangers for pre-heating undigested sludge and for recovering heated digested sludge, hot water heat exchangers for primary sludge heating, pasteurization tank(s) (three small tanks are commonly used to maintain a batch process: fill, hold, and draw pasteurization cycles), mesophilic digester, and recycle and transfer pump.

Site-specific issues associated with the implementation of pre-pasteurization at the WPCF are as follows:

- New pasteurization tank(s) would be needed prior to sludge entering the digester(s). The tank(s) would need volume for 30 minutes of theoretical SRT. This detention time is equivalent to 6,000 gallons of storage (based on 2025 wet weather maximum month [WWMM] flows), or 1,500 gallons per mesophilic digester. Typical pasteurization processes use three pasteurization tanks (fill, hold, and draw cycles).
- New hot water heat exchangers will most likely be needed. Undigested sludge must be heated to 70°C (160°F) prior to entering the pasteurization tank(s). Further evaluation of the heat exchangers is needed.
- New boilers may be needed to supply the necessary hot water to the existing heat exchangers. Further evaluation of the boilers is needed to determine if they can supply enough hot water to heat undigested sludge to pasteurization temperatures.
- New sludge/sludge heat exchangers are needed. These will serve as pre-heat treatment to the hot water heat exchangers and in recovering heat from the heated sludge after the pasteurization process.
- A fourth mesophilic digester, similar in size to the existing three units, would be installed.
- The existing digestion system would remain unchanged. Mesophilic digestion would still occur.
- New instrumentation and controls (I&C) would be needed for the pasteurization tanks and heat exchangers. Longer-term, new I&C would be needed with the construction of the third digester. If the pasteurization process were immediately implemented, it could be fully automated. Plant staff would be able to monitor and operate the process in one shift per day. With future facility modifications, the process would remain automated.

Alternative 3 – Temperature-Phased Anaerobic Digestion

TPAD is a two-step process in which a small thermophilic digester is followed by a large mesophilic digester. Typical retention time requirements are 5-day thermophilic and 10-day mesophilic. The majority of pathogen destruction and solids treatment occurs in the first digester, including volatile solids destruction reported to be 80 to 90 percent, and greater methane gas production. Additional polishing, deodorizing, and sludge conditioning for subsequent dewatering occurs in the second digester. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Digester volume reduction can be achieved through higher loading (higher concentration and lower retention time).
- Less capital expense (lower digestion capacity required) than other advanced digestion processes.
- Currently being used in the U.S. Four operating plants that have converted to TPAD from conventional digesters include Newton, IA; Sturgeon Bay, WI; Omaha, NE; and Mobile, AL. Additional plants in Waterloo, IA; Mason Farm, NC; Neenah-Menasha, WI; and Independence, IA, have recently been constructed.
- Relatively simple to modify an existing mesophilic digestion process.
- Increased volatile solids reduction and greater methane gas production.

Disadvantages:

- The main disadvantage of the TPAD process is that it is not a Process to Further Reduce Pathogens (PFRP) and will require Class A verification by the U.S. Environmental Protection Agency (EPA)
- Process is patented (patent held by Iowa State University)
- Sludge-sludge heat exchangers are required
- Increased production of ammonia in sidestream (from higher VSS destruction)
- Holding tank for undigested sludge requires odor control

The major components associated with the TPAD process include thermophilic (5-day minimum SRT, typical) and mesophilic (10-day minimum SRT, typical.) digesters, sludge-sludge heat exchangers for pre-heating undigested sludge and for recovering thermophilically heated digested sludge, hot water heat exchangers for primary sludge heating, and recycle and transfer pumps.

To convert TPAD to a Class A process, the draw/fill cycles need to be discontinuous for the thermophilic reactor (between ½ - and 1-day gap in feed and withdrawal cycles). A holding tank (1-day retention time) prior to digestion is required to achieve batch feeding. To improve destruction of pathogens, Infilco Degremont, Inc. (IDI), has developed and pilot-tested a variation of the TPAD process at the Belmont Wastewater Treatment Plant (WWTP) in Indianapolis, IN. This variation is in the operation of a thermophilic first-phase reactor in a draw/fill mode with four feedings per day.

Site-specific issues associated with the implementation of TPAD as a Class A treatment option at the WPCF are as follows:

- New hot water heat exchangers will be needed. A typical TPAD process requires undigested sludge to be heated to 54°C (130°F) prior to entering the thermophilic digester. Further evaluation of the heat exchangers is needed.

- New boilers may be needed to supply the necessary hot water to the existing heat exchangers. Further evaluation of the boilers is needed to determine if they can supply enough hot water to increase undigested sludge to thermophilic temperatures.
- New sludge/sludge heat exchangers are needed. These will serve as pre-heat treatment to the hot water heat exchangers and in recovering heat from the heated sludge after the thermophilic retention time.
- Four new 5-day SRT thermophilic tanks and one mesophilic tank would be constructed. The existing digesters could be used in the TPAD process (they would serve as the mesophilic tank). Volume required for thermophilic digestion would need to be 1.4 million gallons (MG) (based on 2025 WWMM flows), or 354,000 gallons per tank (based on four tanks). The new mesophilic digester would be the same size as the existing digesters.
- I&C modifications would be required.

Discussion and Recommendations

Table 3 presents a preliminary comparison of the alternatives. Non-monetary ratings are based on factors such as siting, constructability, process performance, effects on downstream equipment, operational flexibility, and maintenance. Higher ratings are more favorable.

TABLE 3
Digestion Alternatives Cost Comparison
MWMC Facility Plan, Eugene-Springfield

Process	Project Cost (millions of dollars)	Non-Monetary Rating*
Mesophilic Digestion	$5-$6M	21
Pre-Pasteurization	$13.5-$16M	16
TPAD	$11-$13.5M	21

*Maximum possible score of 30 points

As can be seen from Table 3, construction of a conventional mesophilic digester is tied with TPAD for the highest non-monetary rating. The primary reason for the high non-monetary rating is that the process is well-known and MWMC staff is accustomed to operating and maintaining digesters of this type. Pre-pasteurization has the lowest non-monetary rating. However, the thermophilic pasteurization tanks are much smaller (6,000 gallons versus 354,000 gallons) than those required for TPAD operation and siting may be easier. TPAD, as previously mentioned, is tied with mesophilic digestion for the highest non-monetary rating. The benefits that TPAD provides, when considering the issues associated with downstream processes (VSS loading on the FSLs), makes this alternative attractive for achieving long-term goals of meeting solids stabilization requirements with the potential of not having to construct a fifth lagoon.

To provide for future flexibility of solids management at the WPCF, the following actions regarding anaerobic digestion are recommended:

- Modify the existing digester gas mixing system to improve the active digester volume. The evaluation and selection of a new digester mixing system should account for the potential impacts to struvite formation. This project should be considered near-term (0-5 years).
- Construct a fourth digester, to be online between 2010 and 2012. Both advanced digestion processes, TPAD and pre-pasteurization, should be considered for providing future digestion capacity. A further detailed evaluation of these processes is also recommended.

Facultative Sludge Lagoons

There are two main issues associated with the FSLs:

- Exceedance of the VSS loading design criteria of 25 lb VSS/1000 sf-day in the year 2010.
- The solids inventory in the FSLs, which is currently above recommended operating levels.

VSS Loading

As shown previously in Figure 3, the VSS loading design criteria for the FSLs is exceeded in approximately 2015, which would indicate that additional lagoon surface area is needed. However, the interrelationship between the upstream digesters and the FSLs may make an additional lagoon unnecessary.

Increased VSS loading to the lagoons may result in increased odors and may also affect the lagoons' ability to achieve the regulatory requirement of an overall plant VSS reduction of 38 percent. However, MWMC has consistently exceeded the 38 percent VSS reduction requirement in the anaerobic digesters alone. Providing additional volume through either construction of a new lagoon or using the SIWF lagoon is based on meeting the VSS loading design criteria at the current projected flows and VSS loads to the existing lagoons. If the fourth digester uses an advanced digestion process, the VSS loading to the lagoons will be less than the current projections.

At this time it appears most likely that a fifth lagoon will not be needed within the design period. There are several reasons for this assumption. The first is that overall plant VSS reduction requirements are likely to be achieved even if VSS loading to the existing lagoons exceeds design criteria. The second is that digester mixing improvements will increase active digester volume and further improve VSS destruction. The third is that the fourth digester (constructed between 2010 and 2012) may use an advanced digestion process that will improve reduction in VSS loads to the lagoons. Based on the phasing shown in Figure 2, there will be 3 to 5 years between construction of the fourth digester and when a fifth lagoon is required to evaluate the affects of digester performance on the downstream lagoons.

Solids Inventory

Currently, the solids in the FSLs are processed through mechanical and passive dewatering processes. Mechanical dewatering is accomplished through three 2-meter BFPs. Passive dewatering is accomplished using thirteen air-drying beds. Mechanical dewatering is the primary processing method. The lagoons are harvested seasonally, typically from March through September. Beginning in February, one lagoon is taken offline and allowed to settle for 1 month. Beginning in March, a dredge is used to pump solids from the lagoons into two 370,000-gallon mix tanks that then feed the BFPs. Dewatered cake is then placed in windrow piles in the air drying beds where it is further dewatered to approximately 40 to 50 percent solids. In mid-summer, the windrowed piles are trucked to local cooperative farms for land application. Solids (digested sludge) sent to the lagoons year-round exceed the seasonal capacity of the dewatering processes (based on current operation), thus leading to increased inventory.

As the solids inventory in the lagoons has increased to levels above typical operating conditions, the increase in the lagoon solids blanket has decreased the water cap on the lagoons. An optimal solids depth in the FSLs is approximately 6 feet. The water cap helps to control odors in the lagoons by decreasing the potential for turn over of the solids blanket. “Turn over” occurs when the upper layers of the solids blanket become warmer than the bottom layer and the organic material in the bottom layer flips with the warmer upper layer. This flip (turn over) brings anaerobic organic material from the bottom to the top and results in the release of odorous fumes. Maintaining a water cap depth greater than the solids depth helps to control the temperature of the solids layer beneath and, therefore, odors. Staff members have recognized the increased solids inventory and they have anticipated that the solids inventory would be reduced once the BF Phase 1 came online in the summer of 2004. Recommendations for future operating strategies to reduce the solids inventory in the lagoons are discussed below.

Recommendations

At this time, construction of a fifth lagoon by a specific year is not recommended, nor is it expected that a fifth lagoon will be needed within the design period. It is recommended that lagoon VSS loading rates be closely monitored as upstream process improvements and additions are implemented. Groundwater monitoring has suggested that the southwest lagoon may be leaking. For regulatory and maintenance purposes, it is recommended that the lagoon be relined. Following the relining, if groundwater monitoring still shows evidence of leaking, the additional lagoons should be relined. Relining of all lagoons, if needed, would be conducted in phases, with one lagoon being taken offline at a time, completely drained, and then relined. It is estimated that one lagoon can be relined in 1 year.

With Phase 1 of the BF becoming operational in the summer of 2004, the future recommended operating strategy for processing solids in the FSLs should be as follows:

- Apply liquid biosolids from the lagoons to the BF at the maximum non-irrigated capacity of the BF
- Dewater biosolids in the BFPs on a regular operating schedule, from March through September

Key elements of this operating strategy are listed below:

Biocycle Farm

- 165 acres will be available in Phase 1, to be online in the summer of 2004

- 130 acres will be available in Phases 2 and 3, to be online in 2006 and 2008, respectively

The BF is assumed to be non-irrigated

Belt Filter Presses

- Operation: March through September, 12 hours/day, 5 days/week, all units online approximately 85 percent of the time
- BFP pressate recycle is 42.5 MG/year to the lagoons, with 300 gpm of washwater

Facultative Sludge Lagoons

- Solids are harvested at approximately 3 percent dry solids
- The current solids depth is approximately 10 feet (72 MG)
- The optimal depth of the solids blanket is 6 feet
- Normal total operating depth is 13.5 feet (102 MG)
- Annual precipitation is 44 inches (29.9 MG/year)
- Annual liquids evaporation is 35 inches (23.8 MG/year)
- A maximum of 206 MG of supernatant can be pumped from the lagoons; however, typical operation is most likely to be 100 MG/year

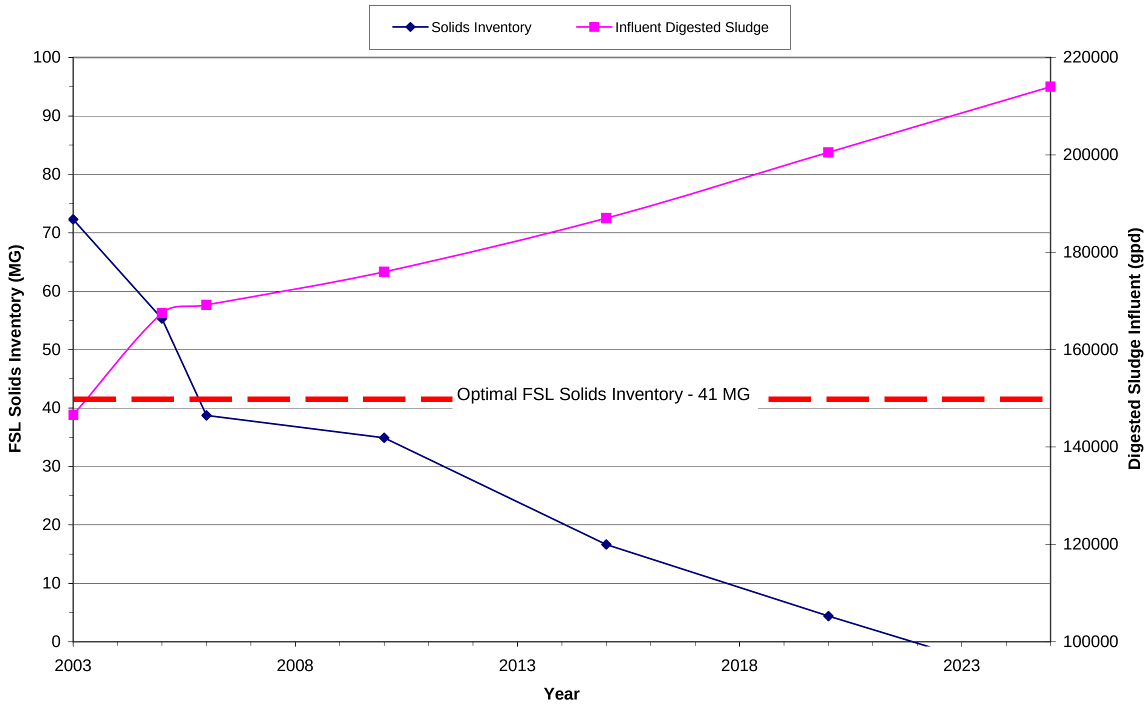
Graphical results of this operating strategy are shown in Figure 4. As can be seen from Figure 4, the solids inventory could be reduced to an optimal solids depth of 6 feet (41 MG) between year 2006 and 2007. This assumes that the operating conditions listed above are followed. Reducing the solids inventory in this time frame would require the dredge pump to operate at a maximum pumping rate of less than 600 gpm. The dredge has a capacity of 2000 gpm.

Conveyance

The conveyance system between the WPCF is comprised of three main lines: the biosolids force main (8.5-inch), the reclaimed water main (RWM; 16- to 24-inches), and the supernatant line (10-inch). Improvements are currently being made to the RWM to improve capacity. As a result, the RWM has not been further analyzed in this document. Similarly, no issues appear to be present with the supernatant line. The supernatant line has capacity to convey flows identified in the future operating strategies of the BMF facility and, as a result, has not been analyzed further. The capacity of the biosolids force main, however, has been reduced because of struvite buildup in the line and is discussed in more detail below.

FIGURE 4

Facultative Sludge Lagoon Solids Inventory
(Annual Average Conditions, BFP and BF Operation)



The biosolids force main (BFM) conveys digested sludge from the WPCF to the BMF through an 8.5-inch ductile iron pipe that was installed when the BMF was constructed in the mid-1980s. The pipeline is now almost 20 years old and is experiencing problems with localized struvite buildup. Struvite (magnesium ammonium sulfate) formation is common in facilities with anaerobic digestion as a result of the breaking down of activated sludge, which elevates ammonia and phosphate levels. The random struvite buildup is limiting conveyance because of an increase in the pipe roughness and a decrease of the inside diameter of the pipe. Acid cleaning loops are planned to begin soon, which is intended to remove the struvite formation. Plant water (W2) is also being added the BFM to change the saturation point of the digested sludge and therefore reduce the amount of additional struvite formation.

The BFM pipe was originally designed to convey a maximum design pressure of 200 pounds per square inch (psi) through the 8-inch pipe. Two digested sludge pumps have been replaced twice since their original installation. The pumps are currently 75 hp variable frequency drive (VFD) controlled, and are operated one pump at a time, conveying between 350 to 430 gpm at 110 psi. The daily batch of digester sludge is currently pumped in less than 8 hours.

The BFM was analyzed to assess the capacity of the pipe and pumps with respect to increasing daily future flow through the design period. Digested sludge projections through the design period are shown in Table B-1 of Technical Memorandum No. 13, *Projected Flowstreams for Solids Processes and Capacity Analysis of Biosolids Treatment Processes and Facilities.*

A spreadsheet model was used to determine pressures in the BFM. Based on current pumping conditions (~400 gpm at 110 psi), the model indicated that the average diameter of the pipe is approximately 7.4 inches. This correlates to 75 percent of the original capacity of the 8.5-inch line. This condition was assumed as the current normal operating condition. The model was also run for two other conditions: a clean pipe condition of 8.5-inch-diameter with no struvite buildup, and a degraded condition of 6.0-inch-diameter with further struvite buildup. The latter correlates to about 50 percent of the capacity of the original 8.5-inch pipe diameter.

Discussion

With current levels of struvite buildup, the pipe can accommodate predicted future flow volume over an 8-hour pumping duration up to approximately 2018. Beyond this date and associated flow rate, the pressure needed to convey the digested sludge will be in excess of the pipe maximum design pressure. However, the pumping duration could be increased to 10 hours, which reduces the flow rate and allows sludge to be conveyed below the maximum design pressure. If the pipe were cleaned completely of all struvite, the digester sludge produced through the design period could be conveyed in an 8-hour pumping duration. If the capacity of the BFM were reduced to 50 percent of original capacity, the present flow volume could not be conveyed in an 8-hour pumping duration. To convey digested sludge through year 2025 under the 50 percent scenario, the pumping duration would need to be increased to 16 hours.

Analysis of the digested sludge pumps has been based on one pump operating. As seen in Figure 5, with both digested sludge pumps operating in parallel there is little affect on the overall pumping capacity. Although the digested sludge pump has enough capacity to provide flow rates of up to 1,200 gpm, the total dynamic head (TDH) that can be provided at the flow rates of interest is in the 90 to 110 psi range. Consequently, with current levels of struvite buildup, the pump cannot provide enough head to convey the sludge at flow rates higher than those currently being supplied. As daily flow volumes increase in the future, the pumping duration will need to be increased to around 13 hours to bring the flow rate down to a point where it can be conveyed with the TDH provided by the pump. If the pipe were cleaned completely of all struvite, the pump would be able to provide enough TDH to convey the flow volume over an 8-hour pumping duration through 2025. If the pipe were to become degraded further to 50 percent of original capacity, the pumps could not provide enough head to convey the present volume of sludge over an 8-hour pumping duration. As daily flow volumes increase in the future, the pumping duration will need to be increased to around 22 hours to bring the flow rate down to a point where it can be conveyed with the TDH provided by the pump. Figure 5 illustrates flow and head relationships for varying effective diameters of the BFM. As seen from Figure 5, the existing pumps will no longer be able to convey digested sludge if the pipe area continues to decrease.

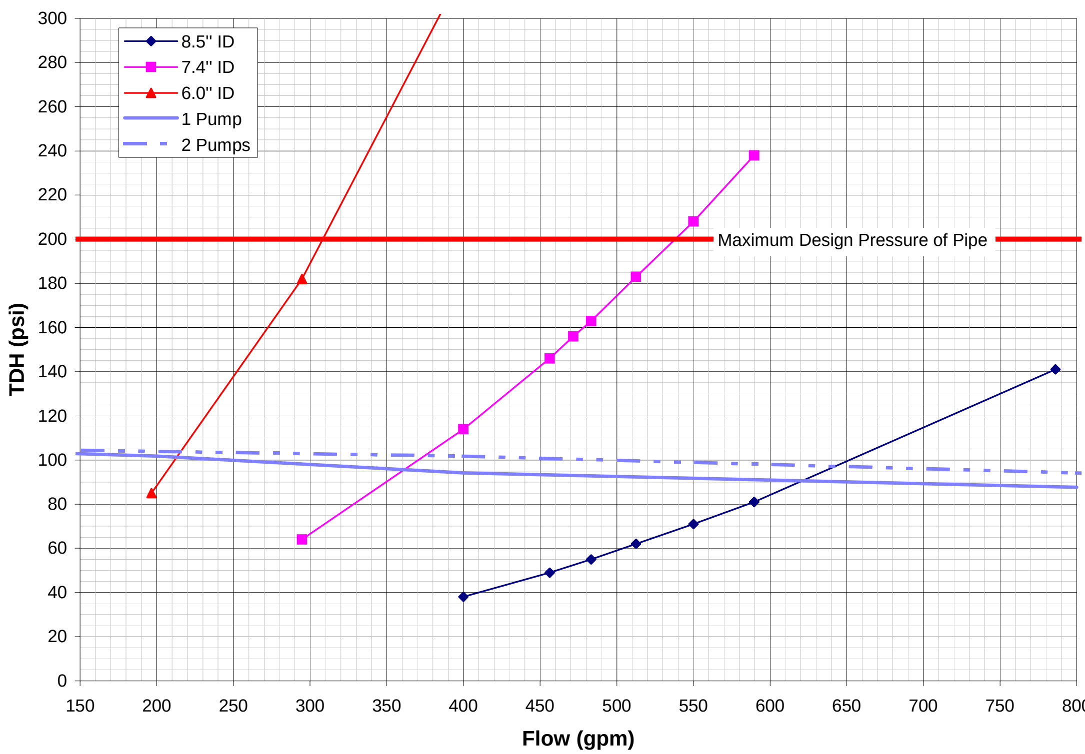
Recommendations

The following recommendations have been made regarding the reduced capacity of the BFM and the digested sludge pumps:

- Implement the acid cleaning process of the BFM and closely monitor the results. The struvite buildup in the pipe is the key issue affecting the capacity of the system. If left untreated, or if the acid cleaning system that is currently being installed is not effective, the effective diameter will continue to diminish at an increasing rate.

- Evaluate methods or operational procedures within the WPCF to control struvite formation and thus help to reduce and potentially alleviate buildup in the BFM.
- Consider implementing alternative pumping durations, as mentioned previously.
- If current acid cleaning is successful, then consider expanding the cleaning loops to additional points along the BFM.

FIGURE 5
Digested Sludge Pump Analysis



Biocycle Farm

MWMC's biosolids disposal methods have traditionally involved the land application of dewatered biosolids on local cooperative farms. Approximately 7,500 acres of land is available as part of the cooperative farm program. To expand their biosolids application program, MWMC purchased a 596-acre parcel of land adjacent to the BMF with the intent that the site would be developed to land apply dewatered and liquid biosolids and effluent on poplar trees and grass hay. The site is referred to as the Biocycle Farm.

The BF will initially be planted with grass and poplars and will be phased in over the next 6 years, as indicated in Table 4. The poplars will be developed in six management units (MUs) and harvested on 10-year cycles. The first phase, scheduled to become operational in the summer of 2004, consists of the distribution system installation (pipeline, hose reels, and pump stations), and site preparation and tree planting in MU 1 and MU 2. Additional hose reels (two for each additional phase) will need to be purchased as Phases 2 and 3 come online; however, the pipeline and pump stations installed as part of Phase 1 will satisfy buildout conditions for the entire BF.

TABLE 4
Biocycle Farm Management Unit Acreage and Planting Schedule
MWMC Facility Plan, Eugene-Springfield

Management Units	Type	Acres	Planting Date	Replanting Date
MU 1 & MU 2	Non Buffer	165	2004	2014
MU 3 & MU 4	Non Buffer	130	2006	2016
MU 5 & MU 6	Non Buffer	130	2008	2018
All MU	Buffers	84		
NE Corner field	Buffer “Type” Application*	48		
TOTAL BUFFER AREAS		132		
TOTAL NON-BUFFER AREAS		425		

Notes
*Although the corner lot is not a buffer area, if used in the future it would only receive dewatered biosolids, because of access difficulties.

As seen in Table 4, 425 acres are available for land application of liquid biosolids. The remainder of the BF is composed of:

- Roadways – approximately 23 acres
- Non-developed NE corner – approximately 48 acres
- Feed store – approximately 16 acres
- Buffers – approximately 93 acres

The BF biosolids capacity is related to three components: the amount of land developed for land application, the type of product applied (effluent, liquid, or de-watered biosolids) and the crop mix. The capacity of the BF will vary over the years as the mix of grass and poplars (young and mature) evolves. There are two main alternatives that exist at the BF, both relating to the total capacity the BF can receive.

Alternative 1 – Operate BF as a Non-Irrigated Land Application Site

Operating the BF under Alternative 1 represents the “do nothing” alternative. Under this alternative, biosolids could be applied to the BF at the capacities shown in Table 5.

The majority of the costs associated with Alternative 1 have already been absorbed in the purchase of the land, installation of the distribution pipeline, construction of the BF pump station (under construction), and the purchase of four hose reel application systems. Future modifications/requirements include two hose reels for each Phase 2 and 3, as well as site preparation.

TABLE 5
Biocycle Farm Alternative 1 Capacity (dry tons)
MWMC Facility Plan, Eugene-Springfield

Year	Liquid Biosolids on Non-Buffer Areas (425 Acres)	Dewatered Biosolids on Buffer Areas (132 Acres)	Total
2005	1609	612	2221
2010	2228	675	2903
2015	1868	612	2480
2020	2228	675	2903
2025	2128	612	2740

Alternative 2 – Operate BF as an Irrigated Land Application Site

Alternative 2 represents operating the BF as an irrigated land application site. The primary benefit of this alternative is that a greater amount of biosolids (liquid and dewatered) could be applied to the site. Under this alternative biosolids could be applied to the BF at the capacities shown in Table 6.

TABLE 6
Biocycle Farm Alternative 2 Capacity (dry tons)
MWMC Facility Plan, Eugene-Springfield

Year	Liquid Biosolids on Non-Buffer Areas (425 Acres)	Dewatered Biosolids on Buffer Areas (132 Acres)	Total
2005	1880	824	2704
2010	2561	905	3466
2015	2165	824	2989
2020	2561	905	3466
2025	2451	824	3275

Alternative 2 provides an average of 17 percent more capacity than Alternative 1.

Similar to Alternative 1, the majority of the costs associated with Alternative 2 have already been absorbed in the purchase of the land, installation of the distribution pipeline, construction of the BF pump station (under construction), and the purchase of four hose reel application systems. However, Alternative 2 contains the future additional cost of installation of a dedicated irrigation pipeline. The dedicated irrigation system would consist of irrigation tubes on 20- to 30-foot grids with microsprays on a minimum 20- to 30-foot spacing. The irrigation tubes would be connected to a submain manifolded off of a 14-inch buried pipeline.

There are several advantages to building a dedicated irrigation pipeline. The system would provide a more efficient irrigation application and increase the biosolids receiving capacity at the site. The pipeline would also reduce the labor requirements associated with current irrigation methods, resulting in better application, less labor, and less money toward labor associated with moving hose reels.

Recommendations

The BF is a valuable asset to MWMC's biosolids application program. As shown above, modifications could be made to the BF to provide even greater biosolids receiving capacity. However, as indicated previously, the capacity of the BF as a non-irrigated land application site provides enough capacity to reduce and maintain solids inventory in the FSLs throughout the design planning. Similarly, the reduction in labor costs associated with Alternative 2 does not appear to outweigh the increased cost in installing a dedicated irrigation system. Consequently, development of the BF under Alternative 1 is recommended. Development of Phases 2 and 3 will also require additional hose reels (two per phase) to allow for biosolids application. It is recommended that four additional hose reels be purchased.

In 2014, the Phase 1 poplar trees will be harvested. At that time, MWMC plans to evaluate the market demand of the land contained within the Phase 1 development. The reason is that Phase 1 land is contained within the Urban Growth Boundary and zoned as industrial. However, 70 percent of this land is wetlands. A cost and market analysis is recommended in the future when Phase 1 is closer to being harvested and land application of reuse and biosolids at the BF is fully established. If this land is sold, other land and/or processes may be needed to account for the loss of the 165 acres and the effect on liquid and dewatered biosolids application.

Seasonal Industrial Waste Facility

Built in 1983 to remove high-strength industrial wastewater from the WPCF on a seasonal basis, the SIWF is a 290-acre site with 190 acres of irrigated cropland and 25 acres of non-irrigated cropland. The total farmable area is approximately 215 acres. It is currently developed with three 60-acre circles and one 16-acre circle of grass. The irrigation system consists of 1996 Pierce center pivots. The site also contains a 14-acre, 57-MG storage lagoon that currently stores industrial wastewater. The site is located approximately 1 mile from the BMF and 5 miles north of Eugene. The site is located on land designated as exclusive farm use (EFU) and is operated under an Industrial Wastewater National Pollutant Discharge Elimination System (NPDES) permit.

Eugene-Springfield now owns the site and leases the land to a local farmer and forage producer to ensure that the site is continuously farmed using sound farm management practices. The land is leased for $6,450 per year. The small amount of industrial wastewater still remaining in the lagoon is applied on the SIWF land. Potential future uses for the lagoon include effluent equalization/storage, BFP filtrate storage, and FSL supernatant equalization/storage/treatment. Potential future uses for the SIWF land include land application of biosolids, and effluent reuse. The Oregon Department of Environmental

Quality (DEQ) recently authorized the site as acceptable for receiving dewatered biosolids trucked to the SIWF, and MWMC is incorporating the SIWF into their Biosolids Management Plan.

Alternatives for future use of the SIWF have been evaluated. These include:

- Alternative 1 – Continue to lease the SIWF and not develop the site further (No Action)
- Alternative 2 – Sell the land
- Alternative 3 – Convert the 14-acre lagoon at the SIWF into a fifth FSL
- Alternative 4 – Land-apply effluent and biosolids at the SIWF without upgrading the lagoon

Alternative 1 – No Action, Continue to Lease the SIWF

Alternative 1 consists of not developing the SIWF and continuing to lease the land. Advantages and disadvantages of this alternative are listed below.

Advantages:

- This alternative provides a small annual revenue from leasing the land ($6,450).
- Maintains ownership of the SIWF for future use.

Disadvantages:

- Not a profitable alternative for MWMC if the existing permitting structure is maintained. The existing annual permitting costs of the SIWF are $11,500.

It would be financially beneficial to terminate the existing SIWF NPDES permit and include the SIWF in the WPCF's NPDES permit to decrease annual permit costs. This action would also reduce regulatory paperwork associated with the permitting of two separate sites.

Alternative 2 – Sell the SIWF

Alternative 2 is to decommission and sell the land. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Selling the SIWF would avoid the capital costs associated with the infrastructure onsite.
- Eliminates annual operations and maintenance (O&M) costs.
- Would eliminate future site liability.

Disadvantages:

- Lose a potentially valuable asset (land and existing facilities) related to the overall long-term strategies of MWMC's biosolids and effluent reuse program, as well as to potential regulatory changes.
- To receive the highest possible value for the site, decommissioning efforts will be required. This is based on selling the land as it is currently zoned (E-30, EFU).

- Availability and proximity of land to the BMF, if required in the future, may be scarce commodities.
- Future cost for development of a site similar to the SIWF will be great.

Alternative 3 – Convert the 14-acre Lagoon at the SIWF into a New Facultative Sludge Lagoon

Alternative 3 consists of upgrading the SIWF lagoon to a new FSL. Under this alternative, liquid biosolids could be applied onsite. It is also assumed that biosolids, if applied at the SIWF, would be applied on grass crops at the SIWF and that the existing land lease agreement would remain in place. The SIWF lagoon would become the fifth FSL. Because the site is zoned EFU land and an FSL may be considered treatment, this alternative may encounter regulatory hurdles. A treatment process on EFU land is classified as a "utility facility" and is only allowed under certain circumstances, as defined in Oregon Revised Statutes (ORS) 215.275. It is likely that MWMC would have to hold further discussions with DEQ regarding this alternative.

Advantages and disadvantages of this alternative are listed below.

Advantages:

- Provides additional sludge stabilization and solids storage, which may be needed in the future
- Continued leasing of the land for local farming activity ensures that the site is continuously farmed using sound farm management practices
- Maintains flexibility in MWMC's Biosolids Management Program

Disadvantages:

- Must meet the requirements of ORS 215.275, which may require lengthy and extensive efforts, public involvement, and a land review
- The lagoon would be remote from the other four lagoons located at the BMF
- Piping interconnections and pumping facilities would need to be installed between the SIWF and BMF
- Potential for increased complexity of control strategies
- O&M is remote from the BMF facilities

As mentioned above, the conversion of the SIWF lagoon into a fifth FSL would provide the lagoon capacity needed by 2015. This assumes that future modifications and additions to the digestion process at the WPCF do not decrease the VSS loads to the existing lagoons. The lagoon conversion would require cleaning out the SIWF lagoon and repairing the liner if an inspection showed signs of leakage. An equipment inventory and condition assessment would also be required.

For comparison purposes, the estimated cost to construct a new lagoon is approximately $2 million. This assumes that 10 acres of new land (agriculturally zoned) can be purchased for approximately $50,000/acre. This does not include additional mechanical costs (piping and pumping) to connect the lagoon to the existing lagoons, as well as costs associated with the regulatory process related to ORS 215.275.

Under this alternative the following modifications would be required:

- A tee and an 8-inch pipeline off of the existing 8-inch biosolids force main that conveys digested sludge from the WPCF to the BMF. This extension would serve the dual purpose of conveying liquid biosolids to the SIWF and back from the SIWF to the mixing tanks, if required. It is assumed that the existing digester sludge pumping capacity at the WPCF would be sufficient to convey digested sludge to the SIWF lagoon. A pump station would be required to pump liquid biosolids from the SIWF lagoon to the mixing tanks at the BMF.
- A 10-inch pipeline and pump station to convey supernatant overflow from the SIWF lagoon to the existing collection system.
- An optional pipeline and pump station to convey filtrate from the BFPs at the BMF to the SIWF lagoon. Further analysis of this option would be recommended if this alternative were selected. For cost purposes, a pressate flow of 500 gpm and pipeline diameter of 6 inches was assumed.

In this alternative, MWMC could either continue to lease the SIWF for local farming activity, or develop the site to apply liquid biosolids and/or supernatant and effluent. If supernatant and/or effluent were applied on the SIWF land, the existing center pivots would require retrofitting the sprinklers on the center pivot to allow for irrigation of this material. The site would also require a pump station and hose reel system if liquid biosolids were to be applied.

This alternative would provide a source of supernatant and liquid biosolids at the SIWF for effluent and biosolids reuse on the 215 acres, as well as a convenient "lower-cost" location for future biosolids overflow/storage. This alternative appears to be attractive with regards to MWMC's long-term biosolids and effluent reuse program.

Alternative 4 – Use the SIWF for Biosolids and Effluent Reuse

Alternative 4 represents using the SIWF for dewatered biosolids and effluent reuse only. It is assumed that biosolids and/or effluent reuse would be applied on grass crops at the SIWF and that the land lease agreement would remain in place. Dewatered biosolids would also be applied on buffers, as allowed. As mentioned previously, the site has recently been approved by DEQ as acceptable for application of dewatered biosolids that are trucked to the site. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Reclaimed water main already constructed to the SIWF
- Lowest cost alternative for beneficially using the SIWF
- Provides MWMC with a readily available effluent reuse location
- No modifications required to the SIWF lagoon
- Maintain small revenue source through lease agreement

Disadvantages:

- None

This is an attractive alternative because the reclaimed water main from the WPCF is already connected to the SIWF. Effluent could be applied at the SIWF with minor modifications to the piping and application system (that is, sprinklers on the center pivots).

Alternatives Cost Comparison

Table 7 provides a cost estimate comparison between alternatives. The net cost presented in the table is the difference between revenue and cost.

TABLE 7
Alternatives Cost Benefit Comparison
MWMC Facility Plan, Eugene-Springfield

Alternative	Revenue	Cost	Net Cost	Comments
Alternative 1 No action – continue to lease the SIWF	$6,450	$11,500	($5,050)	Only 1 year of annual costs
Alternative 2 Sell the SIWF	$2,030,000	$300,000	$1,700,000	Excludes site replacement cost; assumes $7,000/ac; 6% closing costs and decommissioning
Alternative 3 Convert the 14-acre lagoon at the SIWF into a new FSL	$6,450	$2,200,000	($2,193,550)	Capital costs only - does not include annual O&M costs
Alternative 4 Biosolids and effluent reuse only.	$6,450	$400,000	($393,550)	Capital costs only - does not include annual O&M costs or costs related to trucking dewatered biosolids to the site

Recommendations

The SIWF provides long-term program flexibility for MWMC's biosolids and effluent reuse program. General conclusions regarding the SIWF can be grouped into three categories:

- Financially – the proximity to the BF and BMF and the value of the land will help reduce costs in the future for any expansion of the current treatment and reuse program.
- Politically – the surrounding community accepts the current program and facilities. Siting and construction at another location will likely incur additional regulatory costs and obstacles.
- Strategically – the SIWF lagoon can provide additional storage for sludge, effluent, or supernatant as these needs occur in the future. The land itself offers a significant buffer capacity and a strategic location for reuse of effluent, biosolids, BFP pressate and/or supernatant. The site also provides a buffer for the 165 acres associated with the BF Phase 1 development that may be sold in the future.

Based on the above conclusions and the previous discussion of the alternatives, recommendations are as follows:

- Selling the land is not recommended.
- Alternative 4 is the preferred alternative. A reclaimed water pipeline is already in place, and with fairly minimal additional investment it could receive effluent. The site has also been approved for application of dewatered biosolids.
- At a minimum, MWMC should continue to lease the land and attempt to reduce its permitting fees at the site to make the lease more profitable. MWMC should terminate the existing industrial wastewater NPDES permit and incorporate the SIWF and pertinent activities on the site into the WPCF's NPDES permit. The existing permit should not be terminated until the site is included and permitted under the WPCF's NPDES permit.
- Incorporation of the SIWF into the WPCF's NPDES permit in conjunction with Alternative 4 is attractive because the WPCF is currently permitted to discharge Level II and III effluent.
- Assuming that Alternative 4 is implemented, an effluent reuse plan needs to be developed and the existing Biosolids Management Plan needs to be modified to account for the activities at the SIWF.
- Storage in the lagoon is not recommended at this time; however, storage in the lagoon in the future is acceptable without further permitting requirements. Effluent is the most likely material to be stored. If the lagoon were used for storage, the lagoon liner would need to be closely monitored and evaluated. This is because of the condition of the liner, which is best classified as poor, and as a result it may leak. Leaking of less than 1/8-inch per day is acceptable by DEQ. Leaking of greater than 1/8-inch per day requires corrective action (that is, liner patching or replacement) or groundwater monitoring. This leaking rate applies to all stored material.
- Because the need for effluent or liquid biosolids storage is not currently required based on other analyses, upgrading the lagoon for storage purposes is not recommended at this time.

Effluent Reuse

The effluent reuse alternatives evaluated in this document are based on application of Level II (secondary effluent) and Level IV (filtered) process water from the WPCF. Effluent quality influences the alternatives available for disposal. In general, effluent reuse alternatives were based on application of reuse to poplar trees, grass for hay, pasture, green spaces, and golf courses. Because of regional climate conditions, reuse alternatives are focused primarily on application during the dry season months of June through September. Regional crops uptake the greatest amount of liquid during these months.

Drivers for MWMC effluent reuse include:

- Strengthening public awareness and perception
- Regulatory requirements related to temperature of effluent discharge to receiving waters

- Increasing biosolids (liquid and dewatered) loading rates to land application sites

Filtration improvements identified in this Facilities Plan will provide 30 mgd of filtration capacity through the design period (2025). These improvements will achieve Level IV effluent. Current planning efforts are to provide 10 mgd of reuse through the design period, through phased implementation. To see this in perspective, estimated reuse land requirements need to be considered. For example, during the maximum crop uptake (liquid) months of July and August, an estimated 620 acres of land is required for 2.5 mgd of reuse, based on applying the reuse to grass. If reuse were applied June through September, more acreage would be required because crop water uptake during the months of June and September is almost half of the peak uptake during the months of July and August.

Five effluent reuse alternatives have been developed. These alternatives apply either Level II or IV water. The overall intent of effluent reuse is to develop approximately 10 mgd of reuse within the design period. As noted previously, the WPCF is currently permitted to discharge Level II and III quality wastewater.

Alternative 1 – Level II Reuse at the Seasonal Industrial Waste Facility

Alternative 1 is to apply Level II reuse on the 190 acres of agricultural land available at the SIWF site. A RWM is currently connected from the WPCF to the SIWF. This pipeline conveys Level II plant water. Improvements to the RWM have been made such that 2,400 gpm (1.24 mgd assuming 8 hours per day irrigation) of effluent could be conveyed to the site.

Assuming that grass continues to be grown at the SIWF, the net irrigation requirement is 14 inches. This corresponds to reuse of approximately 0.5 mgd in June, 0.9 mgd in July, 0.75 mgd in August, and 0.4 mgd in September, based on applying reuse 8 hours/day. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Because the RWM already extends to the SIWF, effluent can be applied at the site almost immediately
- Minimal financial investment
- Rural SIWF site meets all Level II reuse requirements
- WPCF permitted to discharge Level II effluent
- Minor inspection and retrofitting of the sprinklers on the center pivots at the SIWF would be required

Disadvantages:

- Only provides for 0.9 mgd (maximum) of reuse

This alternative would require rerouting of the RWM piping at the SIWF such that effluent could be applied through the center pivots, and replacement of the sprinklers on the center pivots.

Alternative 2 – Local Reuse Demonstration Site (Level IV)

Alternative 2 represents an initial, local reuse demonstration project. This alternative would provide 0.5 to 1.0 mgd of Level IV effluent reuse to public areas located within a 2-mile radius of the WPCF. The demonstration project would most likely supply water to park vegetation and areas with high public visibility. Assuming the reuse were applied on grass, approximately 250 acres would be required during an application period of July and August. This is based on providing a daily reuse application rate of 1 mgd. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Provides the ability to gauge public reaction and receive public response from the use of reclaimed water on public areas without fully developing a Level IV reuse program
- Fewer restrictions associated with application of Level IV reuse as compared to Level II effluent
- Level IV effluent can be applied on a greater variety of crops (for example, golf courses) than Level II effluent

Disadvantages:

- Level IV reuse is more costly to achieve than Level II
- Need to develop conveyance and distribution system
- Study required to evaluate all potential urban reuse sites
- Permit modifications required
- Requires significant amount of land in proximity to WPCF

This alternative would require the installation of an ultraviolet (UV) disinfection system capable of treating the desired quantity of Level IV effluent, a conveyance pipeline, and a distribution system (that is, laterals, sprinklers, etc.). The cost assumptions for this alternative are based on identifying land within 2 miles of the WPCF, a 1-mgd UV disinfection system, and leasing a transportable pilot filtration unit.

Alternative 3 – Level II Reuse at the Biocycle Farm

Alternative 3 is to apply Level II effluent at the BF. The RWM mentioned in Alternative 2 is also routed to the BF pump station located at the BMF. At the BF pump station, effluent is blended with liquid biosolids from the FSLs and then pumped to the BF, where it is applied through hose reels to poplar tree and grass crops. In this alternative a dedicated effluent reuse pipeline would be installed at the BF, parallel to the existing biosolids irrigation pipeline.

Assuming an available flow rate of 2,400 gpm, a peak application rate of 0.5-inch a day of effluent could be applied. Assuming 8 hours/day operation, approximately 1.5 mgd of reuse could be applied to the BF. A further evaluation between reuse and biosolids application already occurring at the site is needed to ensure that the site is maximized for the biosolids application strategies outlined as part of this Facilities Plan. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Because the RWM already extends to the BMF, only the effluent irrigation pipeline would have to be constructed
- Increases the biosolids receiving capacity of the BF, thus providing additional program flexibility in the future
- WPCF currently permitted to discharge Level II effluent
- Uses the full potential of the BF as a dedicated biosolids and reuse site

Disadvantages:

- Only provides for 1.5 mgd of reuse

The reuse irrigation system would consist of two new effluent reuse pumps (one for redundancy) located at the BF pump station, a 14-inch buried pipeline, and irrigation tubes on 20- to 30-foot grids with microsprays on a minimum spacing of 20 to 30 feet. The irrigation tubes would be connected to a sub-main manifolded off the 14-inch reuse main.

Alternative 4 – Level IV Reuse Phase 2

Alternative 4 would provide approximately 1.5 mgd of additional Level IV effluent, for a total of 2.0 to 2.5 mgd of Level IV reuse. The implementation of this alternative would be based on the public acceptance of Alternative 1, as well as general operational results. Similar to Alternative 1, the Level IV effluent would be applied to areas in proximity to the WPCF. The application area would have to be expanded. Assuming the reuse were applied on grass, approximately 370 additional acres of land would be required during an application period of July and August. This is based on providing an additional daily reuse application rate of 1.5 mgd (2.0-2.5 mgd total). Advantages and disadvantages of this alternative are listed below.

Advantages:

- Fewer restrictions associated with application of Level IV reuse compared to Level II effluent
- Level IV effluent can be applied on a greater variety of crops (for example, golf courses) than Level II effluent
- Provides a buffer for future effluent thermal load regulations
- Potential to further strengthen public perception of reuse

Disadvantages:

- Level IV reuse is more costly to achieve than Level II
- Must expand the conveyance and distribution system constructed in Alternative 1
- Permit modifications required
- More public land required

This alternative would require the expansion of the UV disinfection system installed as part of Alternative 1, and expansion of the conveyance pipeline and distribution system. A permanent structure housing the reuse equipment at the WPCF would also be needed. The cost assumptions for this alternative are based on identifying land within 3 miles of the WPCF, and an additional 1.5 mgd of UV disinfection capacity.

Alternative 5 – Full Scale Level IV Reuse

Alternative 5 represents full development of reuse during the design period. This alternative assumes that all or parts of Alternatives 1 through 4 have been implemented. The intent of this alternative is to implement full-scale reuse of Level IV effluent. This would be accomplished through the additional application of effluent on green spaces, golf courses, and agricultural lands. 2.5 mgd (poplars) to 5.0 mgd (grass) of reuse would be developed under this alternative, based on application during July and August. Approximately 450 and 1250 acres would be required for application on poplars and grass, respectively. Implementation of Alternative 5 would provide an overall reuse (Level II and IV) production rate of 7.75 to 10.25 mgd. Advantages and disadvantages of this alternative are listed below.

Advantages:

- Provides for up to 10 mgd of total (Level II and IV) reuse

Disadvantages:

- Costly
- Permit modifications required
- Extensive amount of land required

This alternative would require the expansion of the UV disinfection system installed as part of Alternatives 1 and 4, expansion of the conveyance pipeline and distribution system, and upgrade of the reuse pumps. The cost assumptions for this alternative are based on identifying land within 6 miles of the WPCF, and an additional 2.5 to 5.0 mgd of UV disinfection capacity.

Recommendations

The following general conclusions can be made regarding reuse of effluent produced from the WPCF:

- Because of the regional climate, wet season reuse is not available.
- Dry season reuse is recommended from June through September, with the most optimal months being July and August.
- Local, urban reuse will provide the potential to improve public perception of reuse.
- Urban reuse will require application of Level IV effluent, which is more expensive to produce than Level II and will require modification of the existing WPCF NPDES permit.
- Level II reuse is already permitted under the WPCF’s existing NPDES permit.

- The SIWF and BF are owned by MWMC and provide a combined 748 acres of land on which reuse could be applied.
- Application of reuse on the BF must be determined in relation to maximizing the biosolids application of the BF.

Based on the above conclusions, the following is recommended:

- Develop a Level IV effluent reuse demonstration project close to the WPCF, initially capable of producing 0.5 to 1.0 mgd of Level IV effluent.
- Assuming public acceptance of the Alternative 2 reuse demonstration project, further develop Level IV reuse as identified in Alternative 4.
- Proceed with Alternative 1 – use the SIWF for effluent reuse and apply on the existing grass crop.
- Proceed with Alternative 3 – develop the BF for effluent reuse through the construction of a dedicated effluent irrigation pipeline and installation of irrigation pumps.
- Develop an effluent reuse plan, working closely with DEQ.
- If all reuse projects identified in Alternatives 1 through 4 are successful (publicly and operationally), go forward with measures to implement Alternative 5 – full scale Level IV reuse of 2.5 to 5.0 mgd of additional Level IV reuse.

Conclusions and Recommendations

Based on the analysis conducted (as documented in this memorandum), the following conclusions and recommendations were made about solids treatment processes, solids conveyance systems, the BF, the SIWF, and effluent reuse.

Solids Treatment Processes

Use the upper limit flow and load projections developed in Technical Memorandum No. 3, Flow and Load Projections, to determine when the capacity of existing solids treatment processes is exceeded. Also use the design criteria identified in Technical Memorandum No. 13, *Projected Flowstreams for Solids Processes and Capacity Analysis of Biosolids Treatment Processes and Facilities*, to determine appropriate process phasing. Using the projected flows and loads with process-specific design criteria, the recommendations are as follows:

- Expand the thickening building and install a third GBT and polyblend unit. Predesign evaluations may modify this recommendation.
- Replace the existing digester gas mixing system with a new digester mixing system as a near-term (0-5 years) project. The new mixing system needs to consider the existing struvite problem and should be designed accordingly.
- The capacity of the anaerobic digesters will be exceeded within 10 years. To provide flexibility in the sludge stabilization process, to help increase VSS destruction, and to provide additional digester volume, it is recommended that the fourth digester be an

advanced digestion system similar to TPAD or pre-pasteurization. Implementation of advanced digestion will not require a fourth mesophilic digester to be built.

- Once installed, monitor the performance of the new digestion system and the digested sludge influent into the FSLs. A fifth lagoon is not recommended.
- To reduce the solids levels in the FSLs, apply liquid and dewatered biosolids to the BF at its maximum, non-irrigated capacity during sludge harvesting season and operate all three BFPs 85 percent of the time March through September, 12 hours/day, 5 days/week.
- Reline the southwest lagoon and then monitor the surrounding groundwater to determine if leaking is still occurring. If signs of leaking are still present after the relining of the southwest lagoon, then the three remaining lagoons should also be relined in phases. During the relining process ensure that three lagoons are online at any one time.
- Expand the aerated static pile composting process located at the BMF. The composting process will be able to process 5 to 10 percent of the annual biosolids production. Expansion of the composting process will provide a dedicated, covered compost storage area, an upgraded aeration and electrical system, and a static mixer for the compost material. This recommendation is based on the 1999 Class A Biosolids/Compost Evaluation and MWMC's commitment to providing biosolids diversification and public focus.

Solids Conveyance Systems

There are three major conveyance systems between the WPCF and the BMF. Two of these lines, the RWM and the supernatant line, are in good working condition and no repairs are recommended at this time. The capacity of the third major pipe, the BFM, is being reduced by the buildup of struvite in various locations along the line. It is recommended that:

- The pressure and flow of the digested sludge pumps continue to be monitored to determine whether the acid cleaning system to be implemented is effective at reducing struvite buildup. Pumping a similar daily volume of digested sludge at increased pressures will indicate that the capacity of the pipe is still being reduced and that the struvite problem exists.
- Evaluate alternative methods or operations within the WPCF that may help reduce the potential for struvite precipitation.
- If the acid cleaning in the BFM is effective, then implement the process at other locations along the BFM.

Biocycle Farm

- Based on non-irrigated capacity, apply the maximum amount of biosolids (liquid and dewatered) to the BF.
- Utilize the BF as a dedicated Level II effluent reuse site.

Seasonal Industrial Waste Facility

- Maintain ownership of the SIWF.
- Continue to lease the land as per the current lease agreement and use the site for Level II effluent reuse and dewatered biosolids application.
- Terminate existing industrial wastewater NPDES permit and incorporate the site into the WPCF's NPDES permit.

Effluent Reuse

The existing RWM provides up to 3.5 mgd of Level II reuse over a distance of 5.5 miles. It is recommended that reuse at the end of this line (SIWF and BF) be used to the maximum extent. MWMC should develop an effluent reuse plan documenting reuse locations and site receiving capacities. It is recommended that Level II effluent be applied to the SIWF and the BF. A dedicated effluent irrigation line at the BF is recommended to maximize application of effluent at the site.

To provide the opportunity for increased public awareness with regards to reuse and to provide a buffer for future effluent regulatory changes, it is recommended that a Level IV reuse demonstration project of 0.5 to 1.0 mgd be implemented in proximity to the WPCF. Assuming the public successfully receives the reuse demonstration project and there are no major operational issues, it is then recommended that additional Level IV reuse capability be provided for in subsequent phases. It is recommended that Level IV reuse production of up to 7.5 mgd be implemented through the year 2025.

Attachment A
Phasing Chart Data

E/S WPCF WASTEWATER FACILITIES PLAN
GBT Phasing

At Wet Weather Maximum Week

Unit Capacities:

Existing Units:

Solid Loading	2010	dry lbs solids/hr
Hydraulic Loading	720	gpm
Hours of operation	2 @	24 hrs/day

Future Units:

Solid Loading	2010	dry lbs solids/hr
Hydraulic Loading	720	gpm
Hours of operation	24	hrs/day

Assumptions/Notes:

Upper limit flow projections used.
Future units are the same size as existing
9th SC online by 2010, 10th SC online by 2020
8 Aeration Basins online by 2015 and step-feed operation
Also checked DWMW, but WWMW limits

Calculations:

Year	Projected Flows & Loads			Existing CAPACITY				Future Capacity						
	Influent Flow	WAS		All Units Operating		One Unit Out		Additional Units			All Units Operating		One Unit Out	
				Cap_{Flow}	Cap_{WAS}	Cap_{Flow}	Cap_{WAS}		Cap_{Flow}		Cap_{Flow}	Cap_{WAS}	Cap_{Flow}	Cap_{WAS}
	(mgd)	(mgd)	(ppd)	(mgd)	(ppd)	(mgd)	(ppd)	No.	(mgd)	Cap_{WAS} (ppd)	(mgd)	(ppd)	(mgd)	(ppd)
2001		0.462	32,823	2.074	96480	1.037	48,240	0	0.000	0	2.074	96,480	1.037	48,240
2002		0.503	38,916	2.074	96480	1.037	48,240	0	0.000	0	2.074	96,480	1.037	48,240
2005	124.9	**0.745**	**40,500**	2.074	96480	1.037	48,240	0	0.000	0	2.074	96,480	1.037	48,240
2006.25		**0.763**	**47,350**	2.074	96480	1.037	48,240	0	0.000	0	2.074	96,480	1.037	48,240
2006.25		**0.763**	**47,350**	2.074	96480	1.037	48,240	1	1.037	48240	3.110	144,720	2.074	96,480
2010	135.0	**0.815**	**67,900**	2.074	96480	1.037	48,240	1	1.037	48240	3.110	144,720	2.074	96,480
2015	145.1	**1.632**	**71,800**	2.074	96480	1.037	48,240	1	1.037	48240	3.110	144,720	2.074	96,480
2020	155.2	**1.632**	**77,044**	2.074	96480	1.037	48,240	1	1.037	48240	3.110	144,720	2.074	96,480
2025	165.3	**1.631**	**81,900**	2.074	96480	1.037	48,240	1	1.037	48240	3.110	144,720	2.074	96,480

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Digester Phasing with Mesophilic Digestion

Maximum Month Flow Conditions

Unit Capacities:

Primary Digester	1.168	MG active volume	Number of Units	3
Secondary Digester	0	MG active volume	Number of Units	0

Design Criteria:

SRT	15	day
SLR	0.15	lb VSS/cf-day

Assumptions:

Active volume of digesters improved to 95% based on near-term mixing improvements

Calculations at Wet Weather:

			Digester Influent			Volume Required (MG)		Volume Available (MG)		
	Year	WWMM Flow (mgd)	Flow (gpd)	Total Solids (ppd)	VSS (ppd)	Based on SLR	Based on SRT	Existing	New	Total
(a)	2003		0		0	0.000	0.000	3.504		3.504
(b)	2005		219,000		61,100	3.047	3.285	3.504		3.504
	2010		232,000		63,413	3.162	3.480	3.504		3.504
	2015		246,000		68,300	3.406	3.690	3.504		3.504
	2020		264,000		73,300	3.655	3.960	3.504		3.504
	2025		**283,000**		**78,300**	3.905	4.245	3.504		3.504

Notes
(a) Taken from plant data (20255 gpd GBT cake flow + 17263 gpd PS flow)
(b) Solids flow and loads taken from Pro2D model runs for 2005, 2010, 2015, 2020, and 2025

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Digester Phasing with Mesophilic Digestion

Annual Average Day Flow Conditions

Unit Capacities:

Primary Digester	1.14 MG active volume	Number of Units	3
Secondary Digester	0 MG active volume	Number of Units	0

Design Criteria:

SRT	20 day
SLR	0.15 lb VSS/cf-day

Assumptions:

Active volume of digesters improved to 95% based on near-term mixing improvements

Calculations:

			Digester Influent			Volume Required (MG)		Volume Available (MG)			Volume Available w/ One Unit Offline (MG)		
	Year	AA Flow (mgd)	Flow (gpd)	Total Solids (ppd)	VSS (ppd)	Based on SLR	Based on SRT	Existing	New	Total	Existing	New	Total
(a)	2003		131,207		0	0.000	2.624	3.42		3.42	2.42		2.42
(b)	2005		167,500		47,250	2.356	3.350	3.42		3.42	2.42		2.42
	2009.5		175,150		49,005	2.444	3.503	3.42		3.42	2.42		2.42
	2009.5		175,150		49,005	2.444	3.503	3.42	1.14	4.56	2.42		2.42
	2010		176,000		49,200	2.453	3.520	3.42	1.14	4.56	2.42		2.42
	2012.5		181,500		51,025	2.544	3.630	3.42	1.14	4.56	2.42		2.42
	2012.5		181,500		51,025	2.544	3.630	3.42	1.14	4.56	2.42		2.42
	2015		187,000		52,850	2.635	3.740	3.42	1.14	4.56	2.42		2.42
	2020		200,500		56,550	2.820	4.010	3.42	1.14	4.56	2.42		2.42
	2025		**214,000**		**60,250**	3.004	4.280	3.42	1.14	4.56	2.42		2.42

Notes
(a) Taken from plant data (20255 gpd GBT cake flow + 17263 gpd PS flow)
(b) Solids flow and loads taken from Pro2D model runs for 2005, 2010, 2015, 2020, and 2025

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Digester Phasing with TPAD Process

Max Month Flow Conditions

Unit Capacities:

Primary Digester	1.14	MG active volume	Number of Units	3
Secondary Digester	0	MG active volume	Number of Units	0

Design Criteria:

SRT	10	day	(Meso tanks)
SLR	0.3	lb VSS/cf-day	

Assumptions:

Active volume of digesters improved to 95% based on near-term mixing improvements

Calculations:

	Year	WWMM Flow (mgd)	Digester Influent Flow (gpd)	Digester Influent Total Solids (ppd)	Digester Influent VSS (ppd)	Volume Required (MG) Based on SLR	Volume Required (MG) Based on SRT	Volume Available (MG) Existing	Volume Available (MG) New	Volume Available (MG) Total	Volume Available w/ One Unit Offline (MG) Existing	Volume Available w/ One Unit Offline (MG) New	Volume Available w/ One Unit Offline (MG) Total
(a)	2003		0		0	0.000	0.000	3.42		3.42	2.42		2.42
(b)	2005		219,000		61,100	1.523	2.190	3.42		3.42	2.42		2.42
	2010		232,000		63,413	1.581	2.320	3.42	0	3.42	2.42		2.42
	2014		243,200		67,323	1.679	2.432	3.42	0	3.42	2.42		2.42
	2014		243,200		67,323	1.679	2.432	3.42	0	3.42	2.42		2.42
	2015		246,000		68,300	1.703	2.460	3.42	0	3.42	2.42		2.42
	2020		264,000		73,300	1.828	2.640	3.42	0	3.42	2.42		2.42
	2025		**283,000**		**78,300**	1.952	2.830	3.42	0	3.42	2.42		2.42

Notes
(a) Taken from plant data (20255 gpd GBT cake flow + 17263 gpd PS flow)
(b) Solids flow and loads taken from Pro2D model runs for 2005, 2010, 2015, 2020, and 2025

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Facultative Sludge Lagoons

Annual Average Flow Conditions

Criteria:

Each Lagoon Area, Acres	6.25
Number of Lagoons	4.0
Total Lagoon Area, SF	1089000
% dry solids in DS	2.4%
% VSS in DS	63%

Assumptions:

DS influent flow is average of WWA and DWA DS flows
One FSL offline for 6 months per year

New Lagoon:		SIW:	
No.	1	No.	1
Area, Acres	4	Area, Acres	14
Area, SF	174240	Area, SF	609840

Calculations:

CONSTRUCTING NEW LAGOON

	DS Influent Flow(1) (gpd)	TSS Influent Flow (ppd)	VSS Influent Flow(1) (ppd)	FSL Area Available Aug-Jan (6 months) (sf)	FSL Area Available Feb-July (6 months) (sf)	VSS Loading Aug-Jan (6 months) (lb VSS/1000 sf/day)	VSS Loading Feb-July (6 months) (lb VSS/1000 sf/day)	Annual Average (lb VSS/1000 sf/day)
2005	167500	33547	21135	1089000	816750	19.41	25.88	22.64
2010	176000	35249	22207	1089000	816750	20.39	27.19	23.79
2015	187000	37452	23595	1089000	816750	21.67	28.89	25.28
2015	187000	37452	23595	1263240	947430	18.68	24.90	21.79
2020	200500	40156	25298	1263240	947430	20.03	26.70	23.36
2025	214000	42860	27002	1263240	947430	21.37	28.50	24.94

(1) DS flows taken from Pro2D model runs

USING THE SIW

	DS Influent Flow(1) (gpd)	TSS Influent Flow (ppd)	VSS Influent Flow(1) (ppd)	FSL Area Available Aug-Jan (6 months) (sf)	FSL Area Available Feb-July (6 months) (sf)	VSS Loading Aug-Jan (6 months) (lb VSS/1000 sf/day)	VSS Loading Feb-July (6 months) (lb VSS/1000 sf/day)	Annual Average (lb VSS/1000 sf/day)
2005	167500	33547	21135	1089000	816750	19.41	25.88	22.64
2010	176000	35249	22207	1089000	816750	20.39	27.19	23.79
2015	187000	37452	23595	1089000	816750	21.67	28.89	25.28
2015	187000	37452	23595	1698840	1274130	13.89	18.52	16.20
2020	200500	40156	25298	1698840	1274130	14.89	19.86	17.37
2020	200500	40156	25298	1698840	1274130	14.89	19.86	17.37
2025	214000	42860	27002	1698840	1274130	15.89	21.19	18.54

(1) DS flows taken from Pro2D model runs

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Belt Filter Press Phasing
Annual Average Flow Conditions

Unit Capacities:

Solids Loading	2440	lb/hr
Hydraulic Loading	140.0	gpm
	102480	gpd

Assumptions:

Harvested Sludge	3%	DS
Solids Capture	98%	
BFP Cake	17%	DS
BFP Washwater	100	gpm per BFP
	73200	gpd per BFP
Operation	12.2 hr/d, 5 d/wk, 7 months/yr	
Percent online	85%	(annually)

Calculations:

Determine Limiting Design Criteria:

Hydraulic	21807	ppd	Limiting
Solids	29768	ppd	

Mass Balance:

	DAILY		SEASON	
Influent	One Unit	All Units	One Unit	All Units
Total Influent, LB =	726,916	2,180,749	110,164,159	330,492,478
Solids In, LB =	21,807	65,422	3,304,925	9,914,774
Water In, LB =	705,109	2,115,326	106,859,234	320,577,703
Effluent				
Solids In Cake, LB =	21,371	64,114	3,238,826	9,716,479
Total Cake, LB =	125,714	377,141	19,051,919	57,155,758
Water In Cake, LB =	104,342	313,027	15,813,093	47,439,279
Total Cake Flow, gal =	15,065	45,194	2,283,034	6,849,102
Cake Volume, CF =	2,011	6,034	304,831	914,492
Cake Volume, CY =	74	223	11,290	33,870
Pressate				
Water In Pressate, LB =	600,766	1,802,299	91,046,141	273,138,424
Solids In Pressate, LB =	436	1,308	66,098	198,295
Total Pressate, LB =	674,403	2,023,208	102,205,700	306,617,100
Total Pressate Flow, gal =	80,815	242,445	12,247,537	36,742,612

Attachment B
Process Analysis Data

E/S WPCF BIOSOLIDS MANAGEMENT PLAN
Biosolids Management Phasing

Annual Average Flow Conditions

Unit Capacities:

Belt Filter Presses:

No. of Units	3	
Capacity, ea	140 gpm	(limiting criteria)
Capacity, Per Season, ea	13.2 MG	307440 gpd
		76968 ppd

FSL:

Dredging Pump Capacity	2000 gpm	
Total Lagoon Capacity	102 MG	(based on 13.5' depth and 2' of freeboard)

Biocycle Farm:

	2005	2010	2015	2020	2025
Irrigated Cap., DT/Yr	2704	3466	3538	3161	3518
Non-Irrigated Cap., DT/Yr	2220	2903	2968	2625	2949
Non-Irrigated Cap., ppd	12166	15905	16261	14381	16160
Non-Irrigated Cap., mgd	0.04860	0.06353	0.06495	0.05744	0.06455

Assumptions:

Existing Solids Volume in FSLs, MG	72 (based on a 10 ft sludge depth)	
Influent TSS % DS	2.4%	
Effluent TSS % DS	3.0%	
VSS in Digested Sludge	70%	
Percent VSS Destruction in FSLs	25%	
BFP Operation = 12.2 hrs/day, 5 days/wk, 7 months/yr		
Percent BFP Online	85%	
BFP Pressate	42.5 MGY	(see BFP tab for calcs)
Annual Precipitation	44.0 inches	
Supernatant Capacity	783 gpm	(capacity of the 10" supernatant line) 205.8 MG = cap if operated 12 hrs/d, 365 days/yr
	82 MGY	(Avg from '01, '02, and '03)
Annual Evaporation	35 in/yr	

Calculations:

	EXISTING	EXISTING	INFLUENT SOLIDS (DIGESTED SLUDGE)						INFLUENT LIQUIDS				EFFLUENT SOLIDS		EFFLUENT LIQUIDS		CUMULATIVE TOTALS		
	$VOL_{LIQUIDS}$ (MG)	VOL_{SOLIDS} (MG)	$FLOW_{TOTAL}$ (GPD)	TSS_{TOTAL} (PPD)	VSS_{TOTAL} (PPD)	$VSS_{DESTROYED}$ (PPD)	$TSS_{REMAINING}$ (PPD)	VOL_{SOLIDS} (MGY)	VOL_{WATER} (MGY)	$VOL_{PRESSATE}$ (MGY)	VOL_{PRECIP} (MGY)	VOL_{TOTAL} (MGY)	VOL_{BFP} (MGY)	VOL_{BF} (MGY)	$VOL_{SUPERNAT}$ (MGY)	VOL_{EVAP} (MGY)	VOL_{SOLIDS} (MGY)	$VOL_{LIQUIDS}$ (MGY)	VOL_{TOTAL} (MGY)
2003	29	72	146610	25718	15288												72	29.3	102
2005			167500	33547	23483	5871	27676	40.4	60	42.5	29.9	132.0	39.6	17.7	91.0	23.8	55.3	47	102
2006			169200	33887	23721	5930	27957	40.8	60	42.5	29.9	132.6	39.6	17.7	92.0	23.8	38.7	63	102
2010			176000	35249	24674	6169	29081	42.4	63	42.5	29.9	135.1	39.6	23.2	108.0	23.8	34.9	67	102
2015			187000	37452	26217	6554	30898	45.0	67	42.5	29.9	139.0	39.6	23.7	97.0	23.8	16.7	85	102
2020			200500	40156	28109	7027	33129	48.3	71	42.5	29.9	143.8	39.6	21.0	107.0	23.8	4.4	98	102
2025			214000	42860	30002	7500	35359	51.6	76	42.5	29.9	148.6	39.6	23.6	114.0	23.8	-7.2	109	102

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MWMC WASTEWATER FACILITIES PLAN

BIOSOLIDS FORCEMAIN ANALYSIS

	Pumping over 8 hrs:						Pumping over 6 hrs:	Pumping over 10 hrs:	Pumping over 16 hrs:	Pumping over 24 hrs:
Year:	2000	2005	2010	2015	2020	2025	2025	2025	2025	2025
Digested sludge flow (mgd):	0.192	0.219	0.232	0.246	0.264	0.283	0.283	0.283	0.283	0.283
Flow over X hr duration (gpm):	400	456	483	513	550	590	786	472	295	197

Pipe ID (in)	% of Aereal Capacity	C-value	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)	TDH (psi)	Vel (ft/s)
8.5	100	110	38	2.3	49	2.6	55	2.7	62	2.9	71	3.1	81	3.3	141	4.4						
7.4	75	90	114	3.0	146	3.4	163	3.6	183	3.8	208	4.1	238	4.4			156	3.5	64	2.2		
6.0	50	90	322	4.5	412	5.2	458	5.5	513	5.8	584	6.2	665	6.7					182	3.3	85	2.2

Notes:
1) Year 2000 flow based on ~400gpm over 8 hrs per Bob Sprick email 12/19/2003
2) C-value for 8.5" pipe based on cleaned pipe (~20-yr old ductile iron)
3) C-value for all other pipe diameters based on struvite degradation
4) Calculation based on maintaining 2 psi at downstream end of pipe above sludge level in ponds
5) Ignored minor losses as these not significant and accounted for in the choice of C-value

Pump Evaluation Summary

pump brake horsepower, bHP = 43 hp
\# pumps = 1

total brake HP of all pumps = 43 hp

pump efficiency = 52%
fluid sp gr = 1
TDH = 95.2 psi = 220.0 ft

flow rate = 402.5 gpm at original design point

1 pump:

Flow (gpm)	Pump 1 TDH (ft)	Pump 2 TDH (ft)	Average TDH (ft)	Average TDH (psi)
0	240	250	245	106
200	230	240	235	102
400	215	220	217.5	94
600	210	210	210	91
800	200	205	202.5	88
1000	185	195	190	82
1200	170	180	175	76

2 pumps:

Flow in 1 pump (gpm)	Total Flow (gpm)	Pump 1 TDH (ft)	Pump 2 TDH (ft)	Average TDH (ft)	Average TDH (psi)
0	0	240	250	245	106
200	400	230	240	235	102
400	800	215	220	217.5	94
600	1200	210	210	210	91
800	1600	200	205	202.5	88
1000	2000	185	195	190	82
1200	2400	170	180	175	76