EXECUTIVE SUMMARY

WERF

WATER ENVIRONMENT RESEARCH FOUNDATION

OPERATIONS OPTIMIZATION

Analysis of Integrated Methods for Wastewater Treatment Plant Upgrading and Optimization

This report provides a systematic approach to upgrading and expanding existing wastewater treatment facilities. The cost savings resulting from more effective use of existing facilities could easily be in the range of several billion dollars, especially in the context of mounting wastewater infrastructure rehabilitation requirements nationwide.

This report presents a systematic process for applying analytical methods and testing tools to optimize reliability and capacity at wastewater treatment plants.

The genesis of the project lies in a workshop organized by WERF in 1999: *Research Priorities for Debottlenecking, Optimizing, and Rerating Wastewater Treatment Plants.* Participants identified priority research needs and documented the significant benefits that would result from improved procedures for optimizing existing wastewater treatment plants (WWTPs). WERF continues to address the research needs identified in the workshop: primary and secondary clarification, disinfection, activated sludge treatment, disinfection, membrane treatment, etc.

The last wastewater plant upgrading manual was published in 1998 by Daigger and Buttz (*Upgrading Wastewater Treatment Plants,* Technomics Publishing Co). This project fills the current need to integrate more recent procedures and process modeling tools (such as CFD or computational fluid dynamic modeling, tracer testing, online, real-time monitoring, etc.) that evaluate plant efficiency and capacity based on best practices.

Three Stages to Plant Optimization Assessment

Plant optimization involves maximizing certain functions (e.g., effluent quality, reliability, capacity) while others (e.g., capital investment, operational costs) are to be minimized. The sequential steps for carrying out the analysis are:

- Desktop evaluation
- Detailed evaluation
- Confirmation testing

Plant optimization is depicted in Figure 1.

Stage I of the plant optimization guidance is a desktop evaluation. Data about the plant are collected from as-built plant drawings, operations and maintenance manuals, operational records, and discharge monitoring reports. Additional measurements may be required in some cases. Each unit process is graded in terms of its potential for satisfactory performance, which is compared to its actual performance. Plant monitoring and hydraulics are also assessed.

Stage II is a detailed evaluation. The focus could be at the unit process level if it appears from the initial plant evaluation that the performance of one or more unit processes is below its capabilities. If the main purpose of the study is to increase the plant capacity, and the initial plant evaluation reveals no major unit process deficiencies, the second stage evaluation focuses on plant capacity based on hydraulics and process performance using integrated unit process modeling.

Stage III is field-scale testing. This is performed to verify that unit process improvements lead to expected enhancements in unit process performance. Monitoring may reveal

BENEFITS

- Provides guidance for evaluating the capacity and performance of wastewater treatment plants while identifying bottlenecks.
- Helps maximize plant functions such as effluent quality, reliability, and capacity; minimizes capital and operational costs.
- Lays out procedures (with examples) to evaluate unit processes and plant hydraulic elements.

RELATED PRODUCTS

Benchmarking Wastewater Operations-Collection, Treatment and Biosolids Management (96CTS5)

Improving Wastewater Treatment Plant Operations Efficiency and Effectiveness (97CTS1)

WERF/CRTC Protocols for Evaluating Secondary Clarifier Performance (00CTS1)

Determine the Effects of Individual Wastewater Characteristics and Variance on Primary Clarifier Performance (00CTS2)

Research Priorities for Debottlenecking, Optimizing, and Rerating Wastewater Treatment Plants (99WWF1)

RELATED ONGOING RESEARCH

Best Practices for Sustainable Wastewater Treatment (OWSO4R07a)

Carbon Heat Energy Analysis Plant Evaluation Tool (OWSO4R07c)

Optimizing Biotreatment: Integrated Process Models and Control Technology (03CTS11)

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whether nutrient removal is achieved or performance has improved relative to current standards. It may also be needed to test individual process trains or to assess the effects of changes to factors affecting plant capacity. Those factors could include solids residence time in the activated sludge process, oxygen transfer rates in aeration basins, or loadings to unit processes.

The guidance provides a step-by-step evaluation of several conventional unit processes for removing suspended solids and dissolved organics (pretreatment, primary and secondary treatment, tertiary processes). It also covers new developments in the areas of biological phosphorus removal, implementation of cloth media filters, and emergence of new integrated fixed film/suspended growth processes.

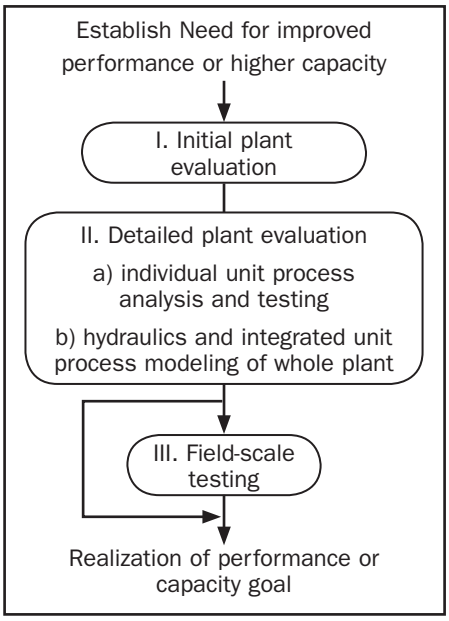

Figure 1. Plant optimization guidance

The report recognizes the array of evaluation tools for wastewater treatment processes that has significantly expanded in the last two decades. These tools incorporate advances in mathematical modeling of biological processes; use numerically powerful CFD models for characterizing hydraulic geometry of reactors and separators; access real-time monitoring sensors for collecting plant operational data; and utilize new techniques for oxygen transfer testing that mimic field conditions.

How to Use the Guidance for Achieving Best Results?

The guidance document presents a "best practices" synthesis of analytical and evaluation methods in the wastewater treatment arena. The document is divided into 15 chapters that cover the fundamentals of analysis and testing of plant monitoring equipment and protocols, hydraulic analysis, and unit process modeling. The early chapters focus on troubleshooting and optimizing the following unit processes:

- preliminary treatment
- primary settling tanks
- attached growth processes
- suspended growth processes
- aeration systems
- secondary settling tanks
- filtration and disinfection
- sludge thickening
- digestion and dewatering operations

The latter chapters deal with the return flows from sludge processing and assessment of their impact on the liquid treatment train.

WERF suggests that potential users of the guidance document follow the three optimization steps noted earlier.

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