Designing communication,

Training and digital logbooks help close the communications gaps at DC Water

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DC Water

one link at a time

"I don't know; I just came on duty after a long weekend."
"I didn't know the shutdown was completed."
"I didn't know the pump was partially clogged."

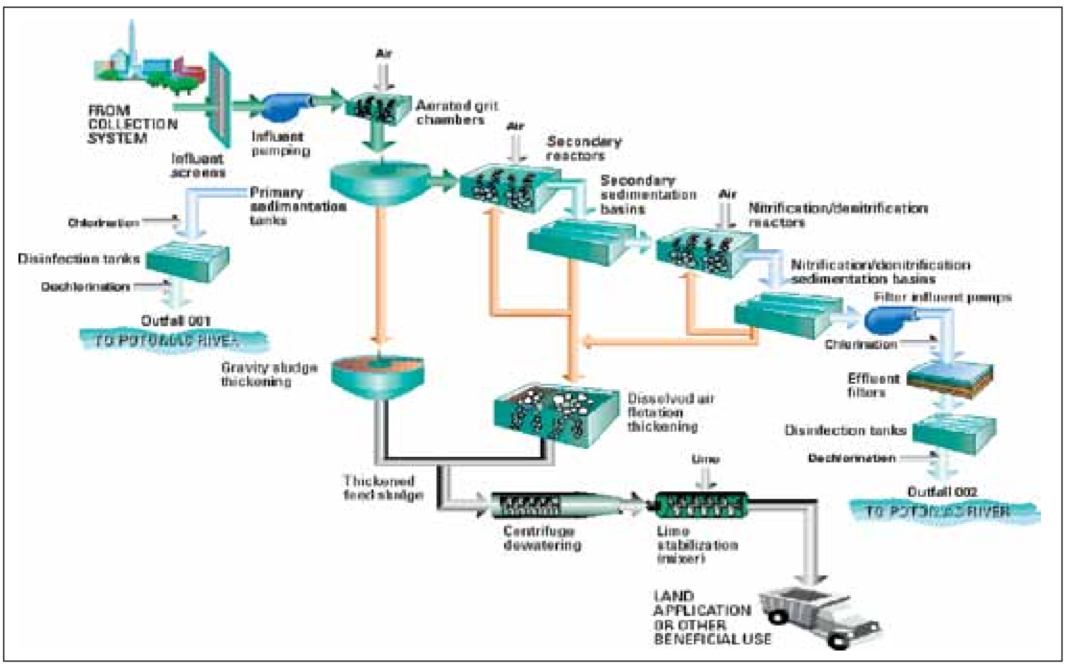
These are all examples of routine responses to a problem heard from operations staff at the Blue Plains Advanced Wastewater Treatment Plant operated by the District of Columbia Water and Sewer Authority (DC Water). These accountability-deflecting comments point to a weak link characteristic of facilities that operate with multiple shifts, separate process treatment sections, or ongoing construction and upgrades. This weak link is communication.

While communication challenges are universal, medium-size to large plants with multiple shifts and multiple crews on each shift are particularly susceptible. Operations structured as silos are even more prone to this problem. Ultimately, the operations department of DC Water was able to overcome these organizational challenges, identify key impediments to communication, and implement solutions to overcome them.

Large, complex plant

Blue Plains is a 64-ha (157-ac) plant with a design capacity of 1.4 million m^3/d (370 mgd) and a peak capacity of 4 million m^3/d (1076 mgd; see figure, below). Primary treatment was constructed in 1938, and since then, the plant has been upgraded continuously. The plant currently is on track to meet enhanced nitrogen removal limits that approach the limit of technology. It has operated without a violation for 5 consecutive years.

Blue Plains Advanced Wastewater Treatment Plant



The plant operates with a two-stage activated sludge process: carbon removal followed by suspended-growth nitrification/denitrification with 100% supplemental carbon. The plant uses approximately 53,000 L/d (14,000 gal/d) of methanol for denitrification to meet current permit requirements. Following the suspended-growth process, wastewater flows through an anthracite–sand filter, then is disinfected and dechlorinated prior to its release to the Potomac River.

The solids from the facility are lime-stabilized to Class B standards and land-applied. A thermal hydrolysis process that is expected to be complete by 2015 will enable the facility to produce Class A biosolids.

Plans also are under way for a 50-m-deep (160-ft-deep) combined sewer overflow tunnel and pumping station, and an associated 850,000-m^3/d (225-mgd) chemically enhanced clarification facility.

Drivers for change

Fifteen years ago, the utility operated quite differently than it does today. Its operations and maintenance staff had spent decades in an environment that was chronically short on budgets, and equipment was run to failure. Since capital projects were viewed as surrogates to maintenance, there was a pervasive attitude that inhibited innovation in maintenance practices. Since equipment was not maintained to the requisite standards, over time, line operations staff adopted an attitude of "Why report it if it won't be fixed?"

In 1996, DC Water (then known as DCWASA) became an independent entity separate from the government of the District of Columbia. The new board of directors categorically rejected the previous operating philosophies and embarked on a new model for the plant to become a world-class advanced wastewater treatment facility. This focus was in large part driven by an internal report outlining the staffing levels required to make the facility competitive with the private sector.

DC Water approached this challenge on several fronts, beginning with the execution of a fast-tracked facility-planning effort to correct the highly visible and obvious result of

The size and complexity of the Blue Plains plant made it difficult for staff to share vital information. DC Water

disinvestment in existing assets. A state-of-the-art distributed control system also was implemented. But physical upgrades of assets, while critical, were not enough to reach the bar set by the board. In order for the benefits of these upgrades to be fully realized, the work force also had to change.

The task of optimizing staffing while simultaneously creating a changed work force with existing staff was left to management. Changes of this magnitude accompanied by a downward pressure on staffing can lead to rumors and fear-mongering. Therefore, communication became very important.

Communication hurdles

At the time DC Water was created, there were 240 operations staff organized as five independent sections within the liquid and solids treatment processes at the plant. Each silo, while striving to perform well, defined success narrowly in relation to the silo itself and not the entire plant as a system. There were operators with more than 10 years of experience who had not visited processes in other parts of the plant. Even within individual silos, operational success was defined by execution of tasks, rather than process-based actions.

At the time, the District of Columbia was not required to have certified operators on staff. Therefore, the employees' knowledge and skill base were limited to performing repetitious tasks within the silo in which they operated.

Intersilo communication on technical issues was stymied because of individuals' inabilities to understand the implications of their actions or inactions. For example, staff at the influent pump station would diligently increase the number of pumps in service to prevent a combined sewer overflow bypass resulting from a high well. The resulting step-changes in flow rates were not necessarily communicated to the affected areas of the plant – secondary treatment, nitrification, and multimedia filtration – resulting in occasional washouts and clogged filters.

The management team took full responsibility for the flow of communication among different sections of the plant, which had advantages and disadvantages. On the plus side, the team's efforts enabled the plant to meet permit limits despite internal communication problems. The downside was the lack of redundancy: The success or failure of plantwide communications was dependent on a single point in the communications train.

Resolving the problem

Having recognized the challenges presented by the status quo, the management of the Wastewater Operations Department took several steps.

First, it required certification of the work force. This was a more than 3-year effort that included developing a relationship with an established testing agency, negotiating with unions, and

establishing an onsite school and training center for operators. Training helped operators understand different processes and taught them the fundamentals behind processes they had been operating.

The second step was developing a systemwide perspective on the plant. When developing its control system, DC Water decided to provide operators access to the entire plant, rather than only to their assigned process. The added benefit of providing operators a real-time window into plantwide operations far outweighed the security risk. The consequences of actions and inactions by an individual operator were visually apparent to the operator, as well as the entire plant.

Third, the department began cross-training staff, moving them from their assigned areas and comfort zones, training them in other parts of the plant, and providing them opportunities to work in these new areas. This effort was formalized to create a higher operator grade for those who successfully passed their duty station tests and demonstrated true cross-training skills.

The fourth step, currently under way, is reducing the five operating sections of the plant to two logical sections – liquids and solids – with the ultimate goal of consolidating these into one section. This step will provide staff opportunities to routinely apply cross-training skills.

Training efforts

Plant upgrades present a training challenge. While the major push is to cross-train operators across all sections, this is a long-term effort. In the interim, the process itself may have changed. Operators in the section that has changed have priority to be retrained, but the entire plant staff eventually must be retrained.

The lesson is that training can never end, especially in a large plant that is responding to dynamic changes in treatment limits and regulations. While DC Water anticipated some training of new staff and limited retraining, it was not prepared for the redevelopment of training materials and fine-tuning of standard operating procedures and operations and maintenance manuals.

This continued training effort has a ripple effect on staff availability and overtime costs. Cross-training is being provided onsite through contracted trainers and the effort repeated multiple times so that most operating crews can be accommodated within their shift, thereby minimizing overtime.

Since 1996, the plant operations staffing has been reduced from 240 to 120 while additional treatment processes have been brought on-line. The benefits realized through the capital upgrades, automation, certification, and cross-training have enabled the plant to operate and meet permit requirements each year at these reduced staffing levels. The new enhanced nutrient removal, thermal hydrolysis, and enhanced clarification processes will be implemented without a substantial change in current staffing levels. In addition to operating existing and new facilities, the staff must meet key performance indicators for power, chemical, and permit compliance.

The benefits of physical plant upgrades such as the supervisory control and data acquisition system were fully realized once staff training and enhanced communication tools were implemented. DC Water

Accountability is key

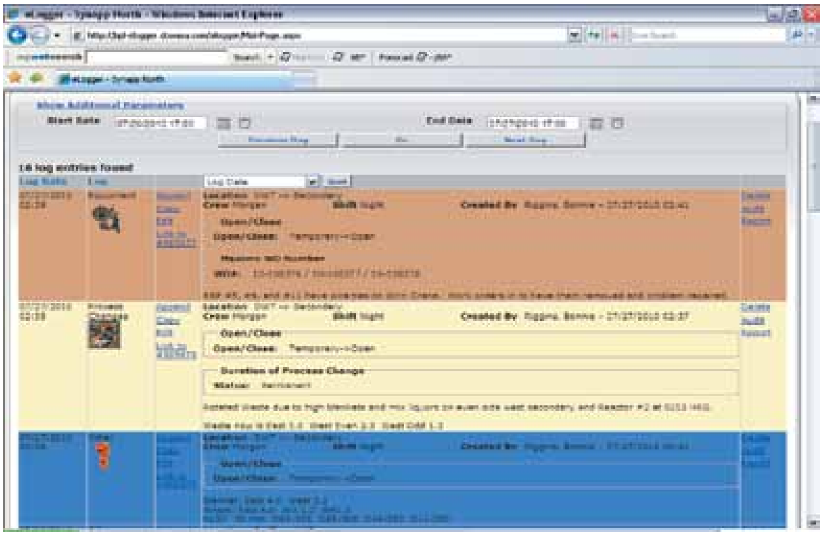
Training, while critical for a safe and knowledgeable work force, is still only a building block. The glue that assembles these blocks is the clear establishment of expectations and the effective communications of these expectations. Expectations not only must be communicated, they must be supported by enforcing accountability.

Missed connections. Blue Plains is required by permit to be staffed 24 hours a day. Therefore, the plant operates with rotating shifts and four crews, each having one general foreman, three shift supervisors, and operators. Ensuring that all staff had the information needed to do their jobs was a challenge.

Historically, the plant relied on logbooks and logsheets to capture and share information. The general foremen maintained their own logbooks, as did the shift supervisors in their offices. Operators logged entries at each duty station, as well as on logsheets. The effectiveness of the logs was dependent on the quality and completeness of the entries, as well as wide access to the recorded information.

Operators and supervisors have their own areas of responsibility within the plant. Even if they rotate duty stations, on any shift, they are assigned fixed locations to operate. On the other hand, logbooks were located in fixed locations within the duty stations. Therefore, the logged information was seen only by supervisors who read log entries while making their rounds. There was no mechanism to make this information available to the process engineers and technicians or to the supervisors and operators in other areas of the plant.

Centralized information needed. In a brainstorming session, the general foremen and shift supervisors seized on the idea of an electronic logbook. Several options were explored, ranging from a word-processing document to a database to a customized application. Discussions with operators at other large plants confirmed this was a common need but did not yield a solution.



Supervisors were trained to write helpful logbook entries with an appropriate level of detail.

After nearly a year, staff found a software program that showed promise and learned that another wastewater utility had purchased it for the same purpose. After comprehensive review by general foremen, supervisors, process technicians, and engineers, the operations department decided that the program would serve its need for online, real-time log entries. DC Water made several decisions in planning for implementation:

- It would not customize the software. All logs had to be structured with tools that were "out of the box." DC Water wanted the ability to upgrade the program seamlessly to the next version or versions without having to reprogram the customized code.
- The program would integrate field logs both horizontally across sections and spatially across time. The shift supervisors would have a place to log their observations, as well as view those of other supervisors on their shift. A supervisor coming on duty would be able to review past entries in any section of the plant over any length of time.
- The general foremen would log their information and could selectively review only general foremen logs or those of sections reporting to them.
- Process engineers and technicians would have the ability to add logs in any section and view logs from any time period.
- Shift supervisors would review log entries in their sections and organize their priorities based on the criticality of the issues, such as safety and process outages.
- Departmental managers would receive automatic notification based on type of log and criticality of the issue.

In addition to the different types of logs, each log was assigned features to enhance accountability, including

- login based on active directory server login, so that each entry had a signature;
- full audit capability;
- a general comment area for explanations on each log, which became the basis for making decisions transparent;
- log entries organized by crews assigned to general foremen, as well as process area, which permitted searching by process area and enabled supervisors to come up to speed quickly on history in their area; and
- a binary selection tagging the entry as temporary or permanent, so that a temporary tag would alert the current and subsequent supervisor and general foreman that there was still an open issue that had to be addressed.

Implementation. The initial rollout of the logbook was limited to supervisors, general foremen, and process engineers. The management team tested the product for several months and determined whether it was user-friendly and met the communication intent.

As management soon recognized, supervisors' logbook entries varied wildly across the plant with regard to data recorded, usefulness, and level of detail. This was an ongoing problem with the paper logbooks that became more apparent once the electronic logbooks were reviewed daily for compliance. This recognition alone made the use of the digital logbook worthwhile. It highlighted a critical area that had to be resolved in order to get the entire work force on a level plane.

The first step was training supervisors to log an entry for all issues without exception. It took nearly 6 months to achieve compliance.

Blue Plains service area

The Blue Plains plant serves an extensive area including Washington, D.C., and parts of Virginia and Maryland.

The second step was improving the quality of the written descriptions accompanying the logged entries. Supervisors were encouraged to write descriptions as if the person reading them were returning from a long weekend and the log entry was the primary means to understand a problem. A longer-term goal is to help the staff learn effective writing techniques.

When soliciting feedback from the end users, DC Water heard one universal comment: Staff did not see the point of entering equipment outages in both the digital logbook and the utility's asset management software. Digital logging of equipment status had been intended to communicate status across the plant sections. However, the operations department already maintains an Excel status sheet to track work orders independent of the asset management software. Given this feedback, supervisors were asked to suspend equipment status entry in the digital logbook.

Once supervisors and general foremen began using the digital logbook, they uncovered additional shortcomings in how information was being logged. The new system gave them the opportunity to resolve similar issues with the field logbooks maintained by operators and to eliminate all paper logs.

Two other divisions within DC Water – Sewer Pumping Stations and Water Pumping Stations – also were struggling with communication within their departments. They have since adopted the digital logbook, and their staffs are presently making the transition from paper logs to electronic logs.

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