Nine Utility Systems Successfully Convert to Chloramines in 48 Hours

Tampa Bay Water Converts Wholesale Water System to Chloramine Disinfection

Glenn Yaney, Richard Anderson, Christine Owen, Andre Dieffenthaller, and Timother Brodeur

On May 6, 2002, Tampa Bay Water began the conversion of its disinfection scheme from free chlorine to chloramines. A state agency, Tampa Bay Water is the largest wholesale water supplier in Florida, providing high-quality drinking water to six member governments which, in turn, supply water to nearly 2 million residents in the Tampa Bay area as shown in **Figure 1**.

The member governments include the cities of Tampa, New Port Richey, and St. Petersburg; and Hillsborough, Pasco, and Pinellas counties. Several of these governments have interconnected and consecutive systems that include the cities of Clearwater, Pinellas Park, and Oldsmar.

Like the majority of Florida water suppliers, Tampa Bay Water has historically relied on groundwater as its source of potable water. Large wellfields located throughout the region (**Figure 2**) have provided the vast majority of drinking water. Increasing demand because of population growth over several decades has resulted in an over-reliance on the regional wellfields and unacceptable impacts on the aquifer and the surrounding environment.

To reduce these unacceptable environmental impacts, the Southwest Florida Water Management District (SWFWMD) and Tampa Bay Water, through a historic "partnership plan," agreed to a series of groundwater withdrawal reductions aimed at restoring the aquifer and the environment. This plan required Tampa Bay Water to develop other sources of potable water. Through a master planning process, the agency elected to pursue several alternatives.

As part of the first phase of developing alternative sources, a surface-water treatment plant and a desalination plant would be constructed in the south part of the region to offset the demands on the groundwater supplies. These new treated surface waters would blend with the existing groundwater supplies—some from great distances, as far as 50 miles or more—before being transmitted to the various member governments, as illustrated in Figure 2.

These long transmission distances gave rise to concerns about free chlorine residual stability and the potential for the formation of disinfection byproducts. It was critical to maintain a disinfectant residual in the transmission main because the two new source waters were surface waters. If the disinfectant residual were lost, the member governments receiving the water would have to comply with the Surface Water Treatment Rule, including filtration of the water.

Glenn Yaney is an operations manager with Tampa Bay Water. Richard Anderson is an operations supervisor with Tampa Bay Water. Christine Owen, Ph.D, is a water quality assurance officer with Tampa Bay Water. Andre Dieffenthaller, P.E. is a project manager with Malcolm Pirnie Inc Timothy Brodeur is regional director of water quality and treatment with Boyle Engineering. [1]

Conversion to Chloramines

In the Master Water Plan, Tampa Bay Water evaluated several disinfection and treatment schemes for the new source waters with significant emphasis on maintaining the residual throughout the miles of large-diameter transmission mains (60-84 inch) while minimizing the formation of byproducts. Following a series of public workshops, the Tampa Bay Water Board decided to use chloramine as the most cost-effective way of disinfecting all the source waters while meeting the anticipated new regulations. The board voted unanimously in January 2000 to employ chloramines as the secondary disinfectant in the wholesale system.

To provide required disinfection for all the existing wellfield supplies, it would also be necessary to construct new treatment/chemical feed systems at existing facilities that would be compatible with the new source-water disinfection, chloramines. The existing facilities which were the focus of this project included the Cypress Creek Water Treatment Facility (WTF), the Morris Bridge Booster Pump Station, the Lake Bridge WTF, the South Pasco Wellfield, and the Lake Park WTF/Section 21 Wellfield.

Tampa Bay Water's first challenge was to

continued on page 14

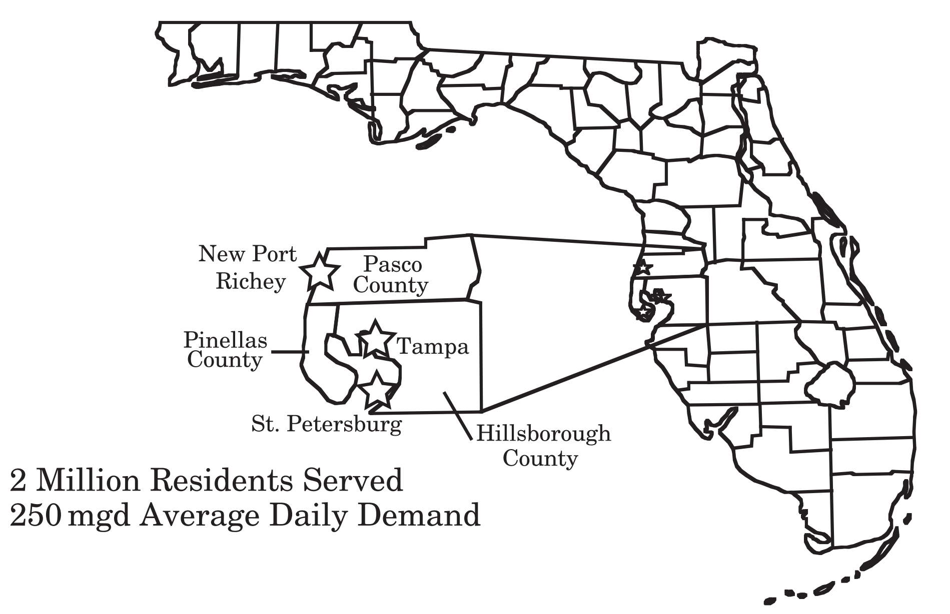

Figure 1

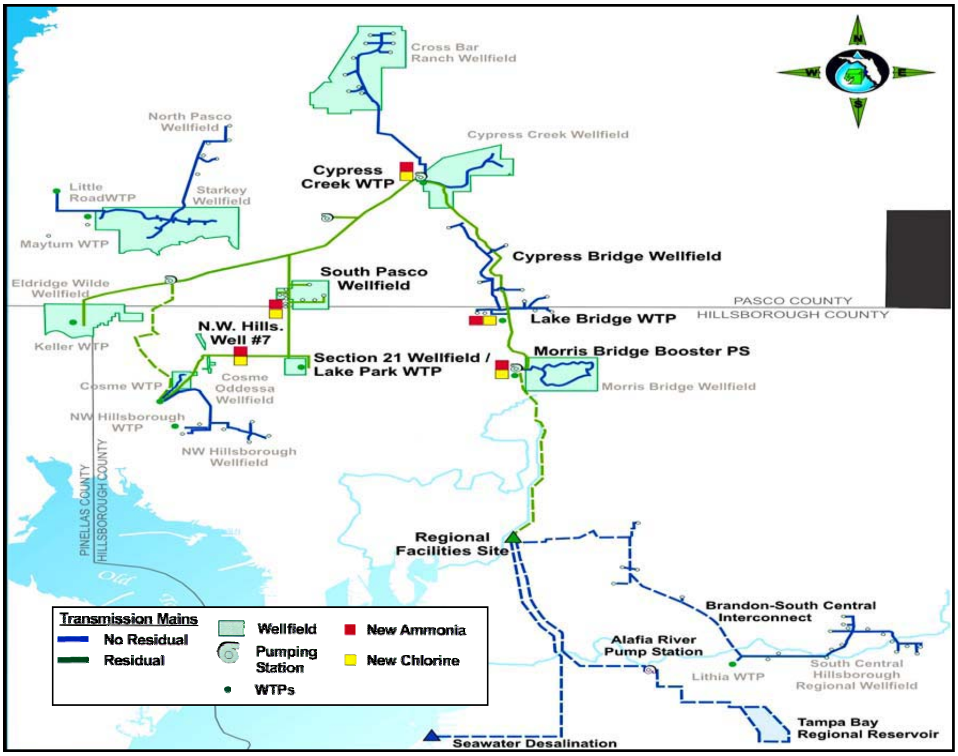

Figure 2 – Location of Treatment Facilities

continued from page 13

convert the existing facilities and transmission mains to chloramines in anticipation of the introduction of the new source waters. This would allow the agency and its member governments to assess and adjust to any impacts that resulted from the chloramine conversion before introducing two new water sources into the system.

Project Schedule

Since the decision to convert to chloramines at the existing facilities was not part of the original Master Water Plan, the project had to be fast-tracked in order to be completed by the tight, regulatory-driven deadlines for the startup and operation of the new source waters. The SWFWMD Partnership Agreement required Tampa Bay Water to reduce groundwater withdrawals from the existing regional wellfields from 158 million gallons per day (MGD) to 121 MGD by December 2002. To meet these groundwater reductions, the agency planned to complete a 66-MGD surface-water plant and 25-MGD desalination facility. In order to utilize these new water supplies, the existing water system needed to be converted to chloramines before facility startup.

Since the new water supplies were expected online by the fall of 2002, May of that year was the goal for the chloramination project, providing approximately six months of adjustment ahead of the new water supplies. Notice to proceed for the chloramination project was issued in June 2000, allowing less than two years to plan, design, construct, and coordinate the startup of chloramination facilities.

The decision process for the chloramine conversion was a public process, observed with great interest by the member governments. Tampa Bay Water published the anticipated completion date at least 1-1/2 years before the actual startup of the facilities, allowing the member governments that elected to convert to chloramines to plan, design, and construct modifications to their facilities in anticipation of the conversion. The short project schedule for the governments to convert their facilities made good communications and coordination throughout the process crucial.

Design and Construction Issues

Tampa Bay Water designed its chloramination facilities independently of the member governments; however, designs and ideas were shared openly among the various agencies to facilitate the completion of the projects, as all were on parallel paths. Tampa Bay Water designed modifications to each of the six existing facilities/wellfields that included the installation of new sodium hypochlorite and aqua ammonia chemical facilities within climate controlled buildings.

The chloramines conversion allowed for the retirement of a gaseous chlorine feed system and the introduction of sodium hypochlorite for disinfection. Some facilities also required sodium hydroxide feed systems for pH adjustment, and most required some type of piping modifications to accommodate the chemical injection points and the CT requirements. **Table 1** summarizes the facility and chemical equipment capacities for each facility.

The chlorine at all the facilities is injected first to meet anticipated groundwater CT requirements; ammonia is then added for the chloramine residual. In some cases, CT calculations are based on the contact time with both the free chlorine residual and the chloramine residual. The chlorine feed is controlled by flow and the free chlorine residual based on a desired set point.

The ammonia is then added based on the free chlorine residual and the desired chlorine-to-ammonia ratio by weight. Monochloramine analyzers are installed to monitor free ammonia, total chlorine, and monochloramine. Operators use the monitoring data to make any minor adjustments to the feed rates or chlorine-to-ammonia ratios.

These chemical facilities were located within three different counties. Each project had varying degrees of obstacles, such as wetlands, easements, permitting, and other site/building issues, depending on local regulatory agencies. In order to facilitate the most critical component of the project, the conversion of the main groundwater facility at the Cypress Creek facility, the design was separated

Facility	Treatment Capacity (mgd)	Sodium Hypochlorite Capacity		Aqua Ammonia Capacity		Major Piping Modifications
		Storage (gallons)	Metering Pumps (gph)	Storage (gallons)	Metering Pumps (gph)	
Cypress Creek	90	37,000	160	3,800	16	Yard Piping Modifications (42-inch) including 2 GST penetrations for new inlets
Lake Bridge	20	4,000	50	400	6.5	600 feet 36-inch piping; 80 feet 84-inch
Morris Bridge	10	9,000	110	600	8	N/A
South Pasco	20	25,000	135	1000	6	6200 feet 42-inch piping; 300 feet 36-inch piping
NW No.7	3	400	10	400	1	N/A
Lake Park/ Section 21	20	N/A	N/A	N/A	N/A	4200 feet 12-inch line; yard piping modifications (42- and 36-inch piping) including 2 GST penetrations for new inlets

Table 1

into the following three phases to accommodate bidding and construction for the work:

- Phase 1 – Cypress Creek, Morris Bridge, and Lake Bridge WTFs
- Phase 2 – South Pasco and NW Hillsborough Well No. 7
- Phase 3 – Lake Park and Section 21 Wellfield Modifications

These phases provided Tampa Bay Water with greater flexibility in selecting multiple contractors, if necessary, to work simultaneously on the various project sites. Early in the design phase, the engineer and Tampa Bay Water decided to prepurchase the long lead items that could potentially delay the project's completion. The large-diameter valves, venturi meters, metering pumps, and chemical storage tanks were prepurchased and delivered directly to the job site.

Fortunately, separate contractors were selected to complete Phases 1 and 2. The contractor for Phase 2 filed for bankruptcy at about the 90-percent stage of the project, while the contractor for Phase 1 completed the work ahead of schedule. After months of delay and negotiations with the bonding company, the Phase 2 project was completed and started up in May 2003. Phase 3 was on hold for a time because of site issues, but construction began in April 2003.

During the design process, several meetings were held to explain the overall project to the regulatory agencies, including the Florida Department of Environmental Protection (FDEP) and the Hillsborough County Department of Health. Regulatory staff members were made familiar with the impacts these projects had on the regional water system and the general, overall goals of the program. Clearance requests and the responsible agency were identified in advance to facilitate the response time on clearance requests for the various stages of the project. In many cases, clearances were received on the same day they were submitted or on the following day, which allowed startup activities to remain on or ahead of schedule.

Water Quality Concerns/Issues

As anticipated, a focus of concern for member governments was the impact on the water quality within the distribution system when the system was converted to chloramines, especially since many had no previous history with chloramine use. Once the conversion was completed, more changes in water quality were expected with the introduction of the new water sources (treated surface water and desalinated seawater). Potential impacts of concern were corrosion control for iron, lead and copper; bacteriological/biofilm changes; nitrification; and aesthetic considerations such as taste, odor, and color.

One of the main concerns of the member governments was the potential for taste and odors from chloramines and the need to understand how to manage the system to control nitrification. Consequently, much of the training included information on these issues and the need to monitor the system to understand the chemistry dynamics. Tampa Bay Water provided information on tank maintenance and flushing methods to assist the governments with maintenance of residuals in their systems.

In order to characterize potential impacts and provide valuable operating information, Tampa Bay Water embarked on an expansive research program that included a Corrosion Study and Report by HDR, in-house continuous pipe loop studies, and an American Water Works Association Research Foundation Tailored Collaboration Project (TCP). The TCP is ongoing and uses pipe extracted from actual member government distribution systems, which is exposed to varying blends of the historical and new-water supplies.

To date, valuable information regarding iron and copper release has been obtained from this work, as well as guidance for controlling potential negative impacts from the introduction of the new water supplies. The need for alkalinity adjustment has been a key operating parameter garnered from this study.

Tampa Bay Water also initiated several other key actions to provide technical information for member governments, including:

- An AWWA chloramine workshop with national speakers
- A workshop with several other Florida utilities using chloramines for open discussion
- A training program for member government staffs on chloramine chemistry
- A public-outreach program coordinated by Tampa Bay Water to assist staffs and their respective PR departments

Member Government Coordination

With concerns about the impacts on water quality and the tight conversion schedule, coordination between the member governments and Tampa Bay Water was critical, as was the coordination between all other parties. This coordination was accomplished through a variety of processes, including formal workshops, routine coordination meetings and informal discussions.

Tampa Bay Water hosted monthly water-quality meetings during this 1.5-year time frame that focused on key personnel from each member government who were involved in the overall conversion. These meetings provided a forum for voicing concerns and reviewing the schedules of the various construction projects. Problems were identified and solutions were discussed. The meetings also provided a venue for answering questions on chloramination chemistry and what to expect in the distribution system. This concern, distribution system water quality, was a key issue because there was a great deal of apprehension and misunderstanding among some personnel and many customers.

Member governments also met with representatives of consecutive or interconnected systems supplied by their systems to explain the overall process and share information on the conversion program. Tampa Bay Water staff supported these activities. Monthly updates were presented to the Tampa Bay Water Board that included the design and construction progress of all the chloramination projects, providing an opportunity for board members to understand the project schedule and the expected impacts on customers.

Public Relations/ Educational Programs

Specific FDEP permit conditions required that the public be made aware of the changeover and be advised about options. The development of the public-information campaign included a literature review, case studies, press coverage, and public notification programs implemented by other utilities that had made the switch to chloramines. Planning for the public-information program began in February 2001, more than a year prior to the major introduction of chlo-

continued on page 16

Figure 3

continued from page 15

ramines scheduled for May 2002. Two consultants, Roberts Communications and JT Professional Associates, coordinated the public-relations efforts. Numerous materials were developed by Roberts Communications and Tampa Bay Water staff, including:

1. *Fact Pack* – A package of information that explained the conversion in terms that the member governments agreed upon. This ensured a common source of reference and consistent messages and themes. The package provided information to reporters, member governments, Tampa Bay Water's board of directors and other interested parties. The Fact Pack was used by member governments to educate and train their public-information and customer-service staffs. They also used it extensively to develop their own public-information materials. Contents included a one-page project overview, detailed background information, special information for kidney dialysis patients and centers, special information for pet stores and fish aquarium owners (**Figure 3**), questions and answers, and a glossary.
2. *White Paper* – A short document summarizing the most pertinent information in the Fact Pack. It was formatted as a self-mailer for Tampa Bay Water and the member governments.
3. *Web Site* – A water-quality portal on the Tampa Bay Water Web site. The link on the home page is illustrated with Hydro the Dog, a character featured in TV, newspaper, and radio ads, as well as consumer brochures.
4. *Homeowner's Association Letter and Newsletter Article* – The letter included an offer to send a speaker to the organization's next meeting.
5. *Speaker's Bureau PowerPoint Presentation* – Developed to help residents and other interested parties understand the switch to chloramines. Tampa Bay Water and its member governments used the presentation when speaking to neighborhood, civic, and professional associations. More than 50 presentations were made by Tampa Bay Water staff alone. Over 20 neighborhood associations requested group presentations from the city of St. Petersburg.
6. *Dialysis (Direct Mail, Follow-up Phone Calls)* – Process and documentation of efforts made to inform dialysis centers and hospitals of the chloramines conversion.
7. *Aquatic Life (Point-of-Purchase Display, Direct Mail)* – A point-of-purchase display sign with a pocket holding "take-one" cards designed to reach fish owners. The "take-one" cards explained how to protect fish. In addition, a series of three letters was sent to businesses such as pet stores, seafood wholesalers, and bait shops informing recipients about the change and requesting their assistance in spreading the word.
8. *Multi-media (TV, Radio and Newspaper Ads)* – An informational campaign including TV, radio, and newspaper ads ran for seven weeks before and after the introduction of chloramines. The ads communicated information about the changes, provided a toll-free phone number, and offered a brochure and Web site information. The media plan included 390 cable spots, 175 TV spots, more than 1,100 radio spots, and 66 newspaper insertions.
9. *Consumer Brochure* – Mailed to consumers upon request and provided to member governments in quantity so they could also fulfill requests for information.
10. *Call Center* – Scripts were developed and a call center was created to field inquiries generated by the multi-media campaign. The call center collected information, answered frequently asked questions and forwarded calls as needed to Tampa Bay Water or the appropriate member government.

Tampa Bay Water staff provided training opportunities for internal staff and member government staffs on chloramine chemistry, operations, and customer service. Training included seminars, workshops, presentations, and printed materials.

This public notification program was successful based on a number of metrics. A few people (fewer than 10 calls in a community of more than 2 million) reported that their aquaria fish had died. The vast majority of these incidents were traced back to a single pet supply store that, unfortunately, had a lot of defective de-chloramination agent. There were no deaths or harm to any dialysis patients and no disruptions to the dialysis treatment industry.

The coordination between Tampa Bay Water and the organization that oversees the industry was exemplary; it presented Tampa Bay Water with its Community Service Award. Consensus among Tampa Bay Water's member governments was achieved. They used the communications materials extensively in their own campaigns and regularly participated in monthly water-quality team meetings. Pinellas County also won two awards for its related campaign: the National Association of Counties Achievement 2002 Award and the Tampa Bay Regional Planning Council – Future of the Region Award.

Startup

Coordinating the timing of the startup of the chloramination facilities was critical to avoid blending a chloraminated supply with chlorinated supplies in the existing distribution systems. As the target start date approached, discussions between the various member governments increased to ensure that each entity would be ready to startup at the same time. If one single entity were not ready, the start date would have to be delayed.

Even more critical was the fact that the public-information campaign had published May 2002 as the conversion date to chloramines. Changing dates at this point in the process would be difficult from a public-notification perspective, perhaps even engendering complacency in the member governments or the public.

Through the water-quality meetings, it

Activity No.	Activity	Responsible Party	Scheduled Start Date	Scheduled Completion Date	Completed Date
	Startup Procedure for Week Before and After Conversion				
1	Develop Tank Conversion Plan (with and without tank isolation)	MPI/TBW	04/22/2002	04/24/2002	4/24/02
2	Develop Sample Plan during Conversion	MPI/TBW	04/22/2002	04/24/2002	4/24/02
3	Install Additional Anchors in 84-inch plug	W/S	04/29/2002	05/02/2002	5/1/02
4	Complete hydraulic test through 42-inch line	TBW	05/02/2002	05/02/2002	5/2/02
5	Confirm Tank Conversion Method	TBW/MPI	05/02/2002	05/02/2002	4/29/02
6	Complete draft of startup procedure	MPI	04/22/2002	04/23/2002	4/24/02
7	Review draft of startup procedure	TBW/MPI	04/23/2002	04/24/2002	4/24/02
8	Finalize startup procedure	MPI	04/24/2002	04/30/2002	4/30/02
9	Review startup procedure with Ops Staff	TBW/MPI	**04/30/2002**	**04/30/2002**	
	Metering Pumps/Transfer Pumps				
1	Verify calibration of ammonia metering pumps	Prom/TBW	04/15/2002	04/26/2002	4/26/02
2	Confirm settings of backpressure valves, pressure relief valves	Prom/TBW	04/15/2002	04/26/2002	4/26/02
3	Operate ammonia pumps in automatic using water	TBW	04/15/2002	04/26/2002	4/26/02
4	Check/Repair leaks in chemical piping	W/S-TBW	04/15/2002	04/26/2002	4/26/02
5	Correct any calibration problems	Prominent	04/23/2002	04/26/2002	4/26/02
6	Tighten all fittings and connections	W/S	04/22/2002	04/26/2002	4/29/02
7	Clean Strainers	TBW	04/22/2002	04/26/2002	4/30/02
8	Confirm/set pressure switch for transfer pumps	W/S	04/22/2002	04/26/2002	4/26/02
9	Operate transfer pumps	TBW	04/22/2002	04/26/2002	4/26/02
10	Confirm availability of spare parts and O&M Manual	TBW	04/22/2002	04/24/2002	4/24/02
11	Replace check valves on pre-ammonia standby pump	Prominent	04/29/2002	05/02/2002	5/1/02
	Chemical Discharge Piping				
1	Complete relocation of pre-chlorine injection point	W/S	04/22/2002	04/30/2002	5/2/02
2	Change out ball valves from pre-injectors	W/S	**04/22/2002**	**05/06/2002**	
3	Verify no leaks in containment pipe	TBW	04/23/2002	04/24/2002	4/29/02
4	Flush lines with ammonia to injection point and Verify soln. Strength	TBW	04/26/2002	05/01/2002	5/1/02
5	Tie-In post ammonia line	W/S	04/29/2002	04/30/2002	4/29/02

Figure 4 – Pre-Startup Checklist (Partial List)

was decided that Tampa Bay Water would first convert its system and track the residual as it approached the member governments. Tampa Bay Water would advise the governments on the location of the "slug" as it moved down the transmission main to them. As each member government was about to receive the supply from the agency, it in turn would convert its system. Some, such as the city of St Petersburg, developed a detailed flushing program for the conversion to facilitate the dispersion of the new supply throughout the entire system in a shorter period of time.

Since Tampa Bay Water had to initiate the startup process, it was very important that the startup day go without a hitch. Crucial factors for success were identified. First, Tampa Bay Water and its engineer conducted several training sessions, both in the classroom and in the field, to provide operators with a better understanding of the chemistry, operation of the new equipment (since all the equipment was new for the staff), and the control sequences. This training started several months before the actual conversion.

Second, a pre-startup checklist was developed a few weeks before startup, as shown in **Figure 4**. This detailed list included tasks that needed to be completed before the facilities could be operated. It identified each task by component (such as metering pumps, tanks, piping, controls), the associated outstanding items, and the responsible party for completing each item. The responsible parties included Tampa Bay Water operation and maintenance staff, the engineer, vendors, the contractor, and the construction manager.

Once developed, the list was circulated and updated routinely to ensure that the tasks were completed. After the completion of all tasks, the chemical facilities were started up and operated with water for a couple days to provide the operators with an opportunity to familiarize themselves with the equipment and controls and to identify any "bugs" within the system before the actual startup.

Another important task completed during the pre-startup activities was the preconversion of one of the ground storage tanks to chloramines at the Cypress Creek facility. The Cypress Creek facility has two 5-MG storage tanks that under free-chlorine conditions had maintained a chlorine residual within the tanks. Since the new process involved chloraminating the raw water before the ground storage tanks, there was concern about blending the two residuals in the tank during startup and the possible formation of taste and odor compounds. Tampa Bay Water decided to preconvert one of the tanks a few days before actual startup. A detailed plan was developed with the operations staff, which included the following main steps:

Chlorine dose (mg/L as Cl_2)		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Plant flow (MGD)	1	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
	2	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
	3	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
	4	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.2	6.9
	5	0.9	1.7	2.6	3.5	4.3	5.2	6.1	6.9	7.8	8.7
	6	1.0	2.1	3.1	4.2	5.2	6.2	7.3	8.3	9.4	10.4
	7	1.2	2.4	3.6	4.9	6.1	7.3	8.5	9.7	10.9	12.2
	8	1.4	2.8	4.2	5.6	6.9	8.3	9.7	11.1	12.5	13.9
	9	1.6	3.1	4.7	6.2	7.8	9.4	10.9	12.5	14.1	15.6
	10	1.7	3.5	5.2	6.9	8.7	10.4	12.2	13.9	15.6	17.4
Plant flow (MGD)	11	1.9	3.8	5.7	7.6	9.5	11.5	13.4	15.3	17.2	19.1
	12	2.1	4.2	6.2	8.3	10.4	12.5	14.6	16.7	18.7	20.8
	13	2.3	4.5	6.8	9.0	11.3	13.5	15.8	18.1	20.3	22.6
	14	2.4	4.9	7.3	9.7	12.2	14.6	17.0	19.4	21.9	24.3
	15	2.6	5.2	7.8	10.4	13.0	15.6	18.2	20.8	23.4	26.0
	16	2.8	5.6	8.3	11.1	13.9	16.7	19.4	22.2	25.0	27.8
	17	3.0	5.9	8.9	11.8	14.8	17.7	20.7	23.6	26.6	29.5
	18	3.1	6.2	9.4	12.5	15.6	18.7	21.9	25.0	28.1	31.2
	19	3.3	6.6	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33.0
	20	3.5	6.9	10.4	13.9	17.4	20.8	24.3	27.8	31.2	34.7

Figure 5 – Example of Chemical Dosage Worksheet

- Increase production at another facility and decrease production at the Cypress Creek facility.
- Reduce the GST levels to the lowest practical level with the facility online.
- Completely isolate one of the GSTs and continue operating the facility with the other tank online.
- Measure free chlorine residual in the isolated GST and determine the volume of ammonia required to convert the remaining water to chloramine residual.
- Confirm ammonia piping is fully flushed and open.
- Pump the desired amount of ammonia as a slug into the isolated tank's influent piping.
- Temporarily increase the prechlorine feed to achieve 5 mg/L free residual.
- Start the ammonia feed to the isolated tank influent line.
- Open the influent line and begin refilling the isolated tank at a set flow rate with chloraminated water.
- Monitor total chlorine, free ammonia, and monochloramines in the influent piping and the isolated GST.
- Fill the isolated tank to a few feet below the maximum water level.
- Close the influent valve and completely isolate the GST until the day of startup.

Converting one of the tanks to chloramines and having the pumps ready with chemical provided greater flexibility during startup, since Tampa Bay Water would only have to open the discharge valve from the GST to pump chloraminated water into the regional system from the chloraminated tank.

For the day of the conversion, another detailed checklist was developed for the actual startup of the facility, but this was probably the least extensive of the previous lists, since much of the work and checking was complete. The tasks on the startup day mainly entailed final checks and coordination among the various staff members and member governments. Worksheets such as shown in **Figure 5** were developed to assist the operators in making chemical adjustments during the startup.

Approximately one hour before the actual conversion, the chemical facilities were started up and the influent valve into the isolated chloraminated tank was opened to top off the tank to its maximum water level. The effluent valve remained closed during this time. This period gave Tampa Bay Water another opportunity to check out the system and catch any "bugs" before officially going "online".

Once confirmation was received that all the member governments were ready to receive the chloraminated water, the effluent valve from the chloraminated tank was opened at the GST isolated for conversion to chloramines. The residual leaving the facility was closely monitoring on the SCADA system and also in the field. The operators collected field samples throughout the morning to confirm/cross check the readings from the online monitors.

Two operators were also stationed along the transmission main to track the progress of the residual. As the free chlorine residual decreased and the monochlorine residual increased, as illustrated in **Figure 6**, the operator advised the main console that the chloramine residual had reached that location before proceeding to another monitoring point further down the transmission main.

Tracking the residual allowed Tampa Bay Water to provide the member governments with an estimated time to expect the chloram-

continued on page 18

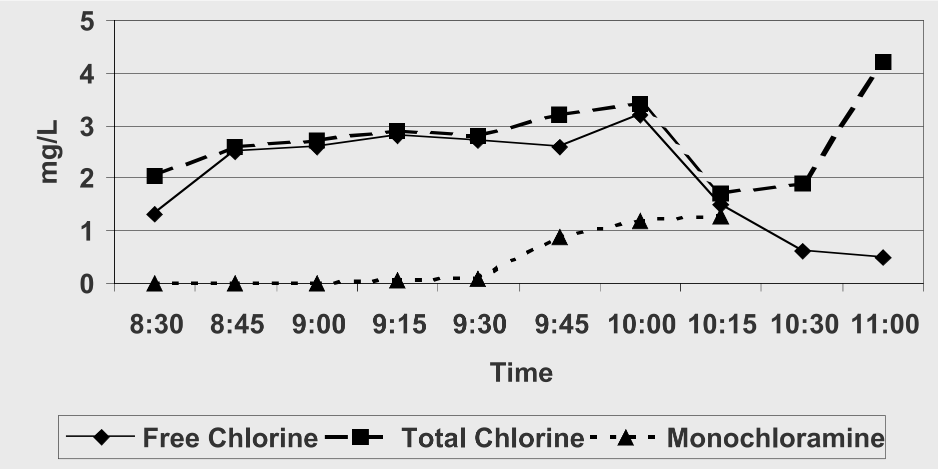

Figure 6 – Residual Tracking along the Transmission Main

continued from page 17

inated water and also to determine whether any undesirable reactions were occurring in the transmission system. The member governments, in turn, started up their facilities and pumped chloraminated water into their distribution systems as the chloraminated water arrived at each of their locations.

Operation

After the conversion, an initial operational plan was developed to monitor and adjust the chloramine residuals, as summarized in **Table 2**.

Days	Residual	Ratio
1 to 7	4.0 mg/L	3:1
8 to 11	3.5 mg/L	3.5:1
12 to 14	3.0 mg/L	4:1
15 to 17	2.5 mg/L	4.5:1

Table 2

The goal was to operate initially at a lower chlorine-to-ammonia ratio in order to have excess free ammonia available to tie up any free chlorine at the interface as the chloraminated water blended with any chlorinated water in the distribution systems. The excess ammonia minimized the likelihood of forming di- and tri-chloramines, which cause taste and odors. Tampa Bay Water also started up with a higher total residual to provide a "stronger" residual during the initial conversion process. Over time as the system stabilized, the plan was to reduce the residual while increasing the ratios. In reality, however, because of the system conditions and the request of the member governments, the residuals remained around 4.0 mg/L while the ratio has increased to approximately 4:1.

Conclusion

Tampa Bay Water had a huge task to accomplish within a short time period: to proceed from the planning and design to construction and startup of a chloramine conversion that would affect nine utilities and over 2 million customers. Without a high level of planning and coordination, the startup would not have occurred on schedule and without any major problems for either Tampa Bay Water or any of the member governments. This project is an example of how good communication and proper planning is essential for the successful completion of any project.

Note 1 (page 13): Timothy Brodeur was an employee of Malcolm Pirnie Inc. at the time of this project.