Aqualane Canal Water Quality Improvements

Marla M. Hough

Aqualane Water Quality Inlet

Aqualane Canal water quality improvements include a maintenance dredge and installation of innovative stormwater quality inlets. The maintenance dredge was funded by contributions from residents in the neighborhood and the quality inlets' design, construction, and monitoring were funded by a joint grant between EPA and Sarasota County Stormwater Division. The quality inlets are being monitored for performance and considered for use in 22 similar sites in Sarasota County.

Aqualane Estates is a waterfront subdivision in Sarasota County, Florida with three finger canals connecting with the Intercoastal Waterway. The subdivision was constructed in the 1950's, at which time the man-made canals were dredged. The northernmost canal was maintenance dredged for the first time since its construction in the 1950's and the construction of water quality inlets followed in the latter part of 1994. The Intercoastal Waterway flows into Sarasota Bay, which is currently under study by the Sarasota Bay National Estuary Program. Among the seven goals established by that Program to improve the bay's quality, one of the key goals is to reduce the quantity and improve the quality of stormwater runoff into the Sarasota Bay. Based upon the interrelatedness of this project with the program's goals, a grant was obtained with joint funding provided by EPA and Sarasota County for the water quality inlet portion of this project.

In early 1992 several neighborhood meetings were held with residents living along the northernmost canal of Aqualane Estates. Boating activity was stymied particularly in the easternmost dead-end portion of the canal, except during high tide due to the excessive build-up of sediments in the canal. The neighbors agreed to undertake a dredge project funded by contributions from the affected neighbors. A corporation named Sludge Busters, Inc. was formed to represent the group and allow them to proceed with permitting and establishment of an escrow account to hold their monies for the dredge project.

A combination of conversation with longtime residents along the canal and research of aerial photographs demonstrated that the last of the three finger canals to be constructed was the northernmost canal, which is the subject of this paper. Testimonials indicate that a rock layer was encountered during construction and dynamiting was utilized to construct the canal. Aerial photographs and survey measurements show that the canal narrows as you move toward the easternmost deadend portion of the canal, evidencing the "giving up" on the expensive dynamiting construction technique.

For the proposed dredging to qualify for a permit exemption as a maintenance dredge with DEP, it must be demonstrated that the soils to be removed were not in place after the original construction. This can be accomplished in several ways. Old construction plans and record drawings can suffice as evidence; unfortunately, records dating back to the 1950's for this project could not be located. Ardaman & Associates, a soils engineering consultant hired to perform soil analysis in the canal, encountered the underlying rock fragment shelf and determined it to be the maintenance dredge limit.

With the soils report and other requested information about the proposed dredging, DEP was able to make a determination that this project qualified for an exemption as a canal maintenance dredging project. An exemption letter from DEP, Florida Department of Natural Resource (FDNR) and the Department of Army (DOA) were obtained for the project.

A Minor Work Permit was required from the Natural Resource Department. The permit review process was complex and was finally issued.

The Minor Work Permit provided for removal of 2253 cubic yards of spoil from the canal, with drying to occur on an adjacent vacant lot and subsequent trucking of the fill to an approved offsite location. Original pledges from neighbors to fund the dredging were not all honored, and the project was scaled back to meet the project's available budget. Approximately 1500 cubic yards of spoil were removed from the canal. The greatest sedimentation buildup occurred at the location of two stormwater outfall pipes as evidenced by a survey of the canal bottom, which was performed prior to dredging and as part of the permit review process. Although the project funding was scaled back, full funding was obtained from neighbors adjacent to the two stormwater outfall locations and complete dredging was performed at these locations.

During the Minor Work Permit review process with the Sarasota County Natural Resource Department, the Sarasota County Stormwater Department was approached with a suggestion to construct sedimentation basins at the two outfall locations to prevent stormwater quality concerns and siltation buildup in the canal in the future.

The Stormwater Division was responsive and approached EPA with the idea; both agencies were mutually interested in the project. The formal paperwork was prepared by Sarasota County and submitted to EPA for ranking among other projects which were vying for EPA participation. Fortunately, the project was ranked favorably by EPA and a joint funded project between EPA and Sarasota County Stormwater resulted.

Sarasota County solicited proposals from three consulting firms for the water quality project. Bishop & Associates was ranked number one and was successful in negotiating a contract with Sarasota County to prepare stormwater calculations, construction plans, obtain the necessary permits, oversee construction, and certify the completed construction.

Survey work was performed to determine the drainage basins associated with the two proposed water quality inlet locations. It was determined that the basin areas were 4.47 acres and 6.15 acres. Sediment storage volume calculations were performed for a two year storm, utilizing a formula contained in the Florida Department of Transportation Drainage Manual, 1987.

Limited storage depths were available in the water quality inlets based upon the retrofit nature of the project. Compatibility of the proposed structures with existing roadway elevations, finished floor elevations, outfall pipe elevations, and tidal water elevations of the receiving canal had to be ensured. At the eastern end of the canal where the finished floor elevations of the houses were in the 12.0 to 13.0 range, two feet of storage depth was available, so a smaller water quality inlet 6 feet wide by 15 feet long was able to handle the sediment storage volume. At the westernmost outfall location where finished floor elevations were in the 8.0 to 9.0 range, only .83 feet of storage depth was available, so a larger water quality inlet 6 feet wide by 37.75 feet long was required to handle the sediment storage volume.

The water quality inlets were designed to satisfy the project specific requirements and incorporate the concepts contained in the City of Rockville, Public Works Department, Maryland project of 1984. A three chamber structure with a trash rack and baffle in the sediment chamber, an inverted elbow in the oil chamber, and a final chamber was designed.

The project improvements were exempt from SWFWMD permitting since the project could be accomplished without any activity in waters of the state, without increasing stormwater flows, and without increasing negative water quality impacts. Basic information about the project was provided to SWFWMD for an exemption determination. A letter was obtained from SWFWMD declaring the project exempt from its permitting.

Sarasota County Stormwater Division also reviewed and approved the project calculations and plans.

Sarasota County publicly solicited bids for the construction of the water quality inlets. Frederick Derr & Company were the successful contractors on the bid and were hired to construct the project. Construction commenced in early November of 1994 and was completed in late December of 1994.

Periodic observation of construction was performed by Bishop & Associates and Sarasota County Stormwater personnel. Record drawings were prepared, certified, and issued to Sarasota County and EPA on January 3, 1995, to complete the construction phase of the water quality inlet project.

Sarasota County is currently studying the quantity and quality of the trapped sediments in the water quality inlets and will determine whether this approach should be applied to other areas in the County. Twenty-two similar canal situations are involved in this consideration.

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Forecast for Federal Storm Water Permits in Florida

Patrick S. Collins, Eric H. Livingston and Jeannie McNeill

Federal regulations, with origins in the Water Quality Act of 1987, set forth application requirements for NPDES permits nationwide and provide a mechanism for monitoring and controlling the discharge of pollutants to waters of the United States. Municipal stormwater permits require identified communities to regulate discharges to municipal separate storm sewer systems (MS4's) through implementation of comprehensive Storm Water Management Programs (SWMP's) and monitoring. In 1991 EPA Region IV implemented the regulations in the Southeast.

By 1994 Kentucky, Georgia, and North Carolina had issued the first MS4 permits, which were simple and authorized by reference the SWMP's proposed in permit applications. To date, the most thoroughly scoped MS4 permit has been issued to Sarasota County, Florida. The December 1994 permit is the result of mutual efforts between EPA and the co-applicants to establish clear, precise milestones that allow the co-applicants and EPA to assess permit effectiveness and compliance.

Under 40 C.F.R. §122.26(b)(7)(iii), EPA has the authority to designate on a case-by-case basis other municipal separate storm sewer systems (MS4s) not meeting the population criteria, as part of a listed large or medium MS4. These designations are based on the interrelationship between the storm sewer discharges of the listed municipality and the storm sewer discharges of the designated municipalities. EPA considers factors such as physical interconnections between MS4s and the proximity of discharges from designated MS4s to discharges from the listed MS4s.

On December 13, 1990, EPA met with state officials to discuss stormwater permitting for Florida. Based on the results of that meeting and the above regulatory considerations, the NPDES MS4 program in Florida, unlike most states, was implemented on a county-wide basis. This decision was made to maximize the environmental benefits of the permitting program, since it was unlikely that receiving water would be improved if only a small number of the dischargers were required to participate in the program. For example, in Sarasota County, only the unincorporated county exceeded the program's population threshold of 100,000. Yet, stormwater discharges owned by the FDOT and the municipalities of Sarasota, Venice, North Port, and Longboat Key also adversely affect receiving waters that receive stormwater from the county's MS4.

Format

The permit covers Sarasota County, and the municipalities of Sarasota, Venice, North Port, Longboat Key (including portions in Manatee County) and the Florida Department of Transportation (FDOT). It includes all areas within the political boundaries of the permittees that are served by MS4's, excluding agricultural areas.

The permit is divided into eight sections and includes two appendices. The sections specify authorized discharges, SWMP's, implementation schedules, monitoring and reporting requirements, standard conditions, modification procedures, and definitions. A future section is reserved for numeric effluent limitations. The appendices are excerpts from the SWMP's submitted by the Co-applicant's and the FDOT.

Authorized Discharges

The permit authorizes all existing and new stormwater discharges to waters of the United States from all portions of the MS4's owned or operated by the permittees. Each permittee is individually responsible for operating its MS4 in compliance with permit conditions. Permittees must meet requirements for discharge standards, SWMP implementation, MS4 specific criteria and have a contingency plan for dissolved or defaulted interlocal agreements. Permittees are jointly responsible for submission of an annual report and collection of monitoring data specified in the permit. Interlocal agreements between permittees are authorized and may transfer operating or SWMP implementation responsibilities. However, both the owner and operator are jointly liable for non-compliance, unless otherwise specified by the interlocal agreement.

Non-stormwater discharges are not authorized by the permit. Exceptions are those discharges covered by an NPDES permit or determined not to be a source of pollutants to waters of the U.S. (water line flushing, rising ground water, lawn watering, etc.). Spills are also prohibited by the permit, unless they are the result of an Act of God (and attempts to minimize adverse impacts can be demonstrated), or an emergency which threatens human life or threatens to cause severe damage to property (also must attempt to minimize its impact).

Stormwater Management Program

The Stormwater Management Program (SWMP) is the principal focus of the NPDES stormwater permit. SWMP's emphasize pollution prevention at the municipal level in dealing with urban runoff pollution. The SWMP contains techniques and policies that the permittees must employ to reduce the amount of pollutants available for transport in urban runoff. Permittees are responsible for implementing SWMP's, for developing and implementing needed legal authority, and for implementing other means to control the quality of discharges from MS4's to waters of the U.S.

The SWMP contains nine mandatory program components. Program components target sources that have historically contributed to non-point source (stormwater) pollution. Components include: structural control maintenance; areas of new and significant redevelopment; roadway maintenance; flood control projects; municipal waste and disposal facilities; pesticides applications; illicit and illegal connections; industrial and high risk runoff; and construction site runoff.

The SWMP's were developed by the permittees together with EPA and DEP. Special care was taken to limit programs to manageable commitments but not jeopardize their potential environmental benefits. This approach reduced the likelihood of EPA having to take an enforcement action or a permittee having to meet a difficult obligation. Programs shall be implemented to effectively, "reduce the discharge of pollutants from MS4's to the Maximum Extent Practicable (MEP) and shall not cause or contribute to violations of state water policy standards of the receiving stream pursuant to FAC 62-40.320(1)-(4)".

Each permittee must annually evaluate the SWMP for effectiveness. Procedures to modify SWMP component activities during the life of the permit are provided. They include procedures to add activities, replace ineffective activities, adjust activity schedules and subtract activities. The permit specifies the permittees shall provide adequate legal authority to control discharges from the MS4 that it operates and the fiscal resources to implement the programs set forth in the permit. Provisions for transfer of ownership, operational authority, or SWMP implementation responsibility are also contained in the permit.

STORMWATER MANAGEMENT PROGRAM	PERMITTEE (S)		DATE DUE/ FREQUENCY
6. Control of Pollutants Related to Application of Pesticides, Herbicides, and Fertilizers	ALL	Provide the details, for incorporation into the permit, of the specific public education program(s) designed to encourage the public to reduce their use of pesticides, herbicides and fertilizers.	Provide in First ANNUAL REPORT
		Implement public education program(s).	Effective Date of the Permit
	ALL except for FDOT	Evaluate current training requirements & certification procedures for employees who handle pesticides, herbicides and fertilizers.	Within 24 Months of the Effective Date of the Permit
		After completing the evaluation, include a summary of the results in the subsequent ANNUAL REPORT for incorporation into the permit.	As Necessary - Within 36 Months of the Effective Date of the Permit
	ALL	Require evidence of proper certification and licensing for all applicators contracted to apply pesticides, herbicides, and fertilizers on municipal and FDOT property.	Effective Date of the Permit

Table 1. Implementation Schedule.

Implementation Schedule

The “MEP” standard has made writing and administering NPDES permit conditions especially challenging for EPA. Traditionally, NPDES permits have had numeric standards that are effective for demonstrating environmental benefit and determining permittee compliance. However, since the regulations specified that numeric standards could not be scoped initially in municipal permits, EPA decided to administer Sarasota County’s permit according to an implementation schedule. The schedule contains clear, precise milestones that allow the EPA and permittees to assess permit effectiveness and compliance. The milestones were scoped by both the EPA and permittees at the time of application.

Table 1 is an excerpt of the implementation schedule in the Sarasota County permit. The schedule is tabulated by SWMP component, permittee name, capsulized activity objectives, and due date or frequency (e.g. within 12 months of effective date of permit or five employees per year). As shown in Table 1, permittees are to provide the details of the public education programs they implemented during year one to control pollutants from public application of pesticides, herbicides and fertilizers. The permittees will demonstrate permit compliance by performing this activity during year one and providing the details to EPA in the first annual report. The implementation schedule covers the life of the permit or five years. The schedule contains milestones for all activities in the SWMP.

Monitoring Requirements

The NPDES MS4 regulations require applicants to propose in their Part 2 application a monitoring program for representative data collection. The applicant must describe the location of outfalls to be sampled or the location of in-water sampling stations, why the location is representative, the frequency of sampling, parameters, and a description of the sampling equipment. Potential goals of the monitoring program includes discharge characterization and evaluating the source of specific pollutants, performance of BMPs, and impact of stormwater discharges on receiving waters.

While these goals sound good they reflect a conventional “point source” mentality. Additionally, the methods set forth by EPA for stormwater sampling are not consistent with guidance on sampling stormwater discharges in a scientific and statistically valid method that was prepared after the 1980’s National Urban Runoff Program. This weakness is evident by a review of data collected as part of the NPDES MS4 application process which is much different from characterization data collected during NURP. One reason for this is that much of the “first flush” was missed using NPDES MS4 sampling protocols. Furthermore, because of Florida’s stormwater program, an incredible amount of reliable data already exists on stormwater discharge characteristics and the effectiveness of BMPs.

Since a lack of funding for stormwater management programs is the primary reason why we have stormwater problems (the orphan infrastructure), and because stormwater sampling is very expensive, DEP requested EPA to allow a modification of the original language in MS4 draft permits. If monitoring is going to be required, we need to ensure that it is cost-effective and, most importantly, that it provides scientifically valid information that truly assesses the ecological

NPDES
SUMMARY TABLE
STORMWATER MANAGEMENT PROGRAM

PROGRAM ELEMENT	ACTIVITY	REQUIRED BY SWMP	COMPLETED	ACCOMPLISHED	ACTIVITIES PERFORMED & COMMENTS
Operations and Maintenance of Structural Controls and Stormwater Collection System	Perform inspections and maintenance of structural controls. Maintain and internal record keeping system to track inspections and maintenance activities performed during the permit. Conduct an annual assessment of the effectiveness of inspection and maintenance schedule and provide a summary of the assessment in each ANNUAL REPORT.	Annual Requirement	NO		
	Identify and inventory each privately-owned and maintained stormwater management facility which discharges into the MS4.	Within 12 months of the Effective Date of the Permit (1-1-96)	NO		
	Complete Florida Water & Pollution Control Operators Association (FW&PCOA) course or equivalent.	5 employees/ year	NO		

Table 2. Summary Table.

effects of stormwater discharges and the environmental benefits of program implementation. Accordingly, thanks to EPA staff concurrence, the following language was placed in the Sarasota MS4 permit. Similar language is anticipated in all of the MS4 permits issued in the state of Florida:

1. *Monitoring:* Establish local monitoring stations in conjunction with the DEP's Surface Water Ambient Monitoring Program (SWAMP). The selection of the monitoring stations shall be the result of a cooperative effort between the permittees and the Bureau of Surface Water Management, Florida Department of Environmental Protection (FDEP). Acceptance of the monitoring program components proposed by the permittees in the May 1993 Part 2 application submittal and the March 1994 "Final Results" submittal shall be explored before any alternative monitoring programs are introduced. The monitoring program established may extend beyond the present scope of the state of Florida's Surface Water Ambient Monitoring Program where necessary to address local areas of concern. The number of monitoring stations as well as the type of sampling performed shall be established in accordance with the following:

a.) The costs associated with the monitoring program developed shall not exceed the projected costs for the monitoring program proposed by the permittees in the May 1993 Part 2 application submittal and the March 1994 "Final Results" submittal.

b.) The monitoring program developed shall assist in determining the impact of stormwater discharges on receiving waters located in the geographical area covered by this permit.

c.) The monitoring program developed shall assist in determining the effectiveness of the stormwater management programs being implemented under this permit and shall assist in identifying and prioritizing portions of the MS4 requiring additional controls.

d.) The monitoring program developed shall be designed to help identify local sources and impacts of specific pollutants considered a problem in the geographic area covered by this permit. Once the source and the impacts are identified, these pollutants may be more effectively reduced or eliminated.

e.) The selection of the monitoring stations and sampling program schedule shall be agreed upon by the permittees, the Bureau of Surface Water Management, FDEP and EPA. The monitoring program developed shall be implemented by the permittees within 24 months of the effective date of this permit or within 12 months of the date of program development, whichever is later. The details of the monitoring program shall be submitted to EPA in the subsequent ANNUAL REPORT; status reports shall be given in any Annual Reports prior to this one.

It is the intent of EPA to use the monitoring information collected to evaluate any trends in the reduction in pollutant loads discharged to waters of the U.S. during the term of the permit. The pollutant loading trends will be used to evaluate the effectiveness of the permittees' Stormwater Management Program to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP).

"Surface Water Ambient Monitoring Program" refers to a comprehensive program implemented by DEP's Bureau of Surface Water Management and designed to accomplish the following: (1) Identify and document the existing condition of the surface waters of the state, (2) Document potential problem areas, (3) Establish stream ecoregion reference sites for comparison purposes, (4) Collect biological data at ecoregion reference sites to establish preliminary biological integrity measurements techniques, and (5) Establish a statewide ambient monitoring network which will eliminate duplication, share data, increase efficiency, and improve assessment and management capabilities.

To date, the monitoring strategies included within the state of Florida's Surface Water Ambient Monitoring Program have been based on: • Ecoregion Subregionalization and the associated stream Community Bioassessment Protocols (CBA) developed for the nonpoint source program, • Chemistry Trend Network to fulfill the need to evaluate the state's water quality over time, • Chemistry Status Network with emphasis on water bodies with fair or poor water quality or areas which have not been recently sampled, and • Lake Ecoregion and Community Bioassessment Projects.

NPDES PESTICIDES, HERBICIDES & FERTILIZERS				
ACTIVITY	**REQUIREMENT**	**COMPLETED**	**ACCOMPLISHED**	**ACTIVITIES** PERFORMED & COMMENTS
Develop and Implement Public Education Program Permit Reference: Part III, page 28	Implement by Date of Permit (1-1-95) Provide in First Annual Report (7-1-96)	NO	% Completed	
Evaluate current training and certification procedures for employees who handle pesticides, herbicides and fertilizers and implement any revisions to these procedures. Permit Reference: Part III, page 28	Complete Evaluation within 24 Months of Permit Date (1-1-97)	NO	% Completed	
	Implement Revised procedures within 36 Months of Permit Date (1-1-98)	NO	% Completed	

Table 3. Activity Sheet

Annual Reporting Requirements

Each permittee must appoint a representative to a committee which is charged with developing a system-wide Annual Report. The Annual Report covers the 12 month period following the effective date of the permit and is submitted no later than six months following the period covered by the report. Subsequent reports are required annually thereafter.

Specific annual reporting requirements are outlined in the permit. These requirements include a summary table of SWMP elements, a SWMP narrative report, a monitoring report narrative, a fiscal report and appendices which contain analytical data collected, results of illicit connection screening, and other supporting data specified by EPA. Table 2 depicts a portion of the summary table specified in Sarasota County's permit.

The Annual Report must be signed and certified by the principal executive officer or ranking elected official for each permittee. The executed reports are sent to EPA, Region IV with copy to the Florida Department of Environmental Protection. Copies of the SWMP and monitoring information must be retained for at least three years after the expiration of the permit.

Remaining Permit Sections

The remaining permit sections include standard permit conditions, definitions and appendices. Permittees must comply with permit conditions or be considered in violation of the Clean Water Act (CWA). Violations of the CWA are subject to criminal, civil and administrative penalties. The standard permit conditions list penalties for non-compliance or avoidance. Severe violations are considered criminal and include negligence, knowing violations, knowing endangerment and false statements. Another standard condition includes the duty to reapply. To continue the stormwater activities regulated by the permit, the permittees must reapply at least 180 days prior to expiration of the permit. EPA is currently involved in the rulemaking process which will establish the permit reapplication requirements for those MS4s subject to the NPDES stormwater program.

A definition section is provided to further clarify words or phrases commonly used throughout the permit. Appendix A contains excerpts from the proposed SWMP's submitted by the permittees in the original application. Most of these application excerpts provide details on existing programs and contain limited information on new or expanded program activities specified in the permit. Appendix B is similar to Appendix A, but contains excerpts from the statewide SWMP submitted by the Florida Department of Transportation.

Implementing the Permit

Most Sarasota County permittees have elected to use the same reporting procedures and document forms to collect data specified in the permit. Completed forms will be compiled to create the main body of the Annual Report. The advantage to collecting data in this manner is that it provides consistent permittee information to facilitate the development of the overall text.

The permittees have developed computerized spreadsheet forms for documenting the activities contained in the SWMP. Table 3 shows the activity sheet developed for documenting public education programs for pesticide, herbicide and fertilizer application. Column one contains capsulized activity objectives and cites references where more detailed information can be found in the permit (Part III, page 28 in this case). Column two specifies the milestone dates that activities are to be completed (1-1-95 and 7-1-96). Column three is a toggle switch within the spreadsheet (yes or no) for the permittees to specify whether the activity was completed. Columns four and five are fields for documenting additional information. By providing activity sheets with permit references, milestone dates and direction for collecting additional information, permittees hope to make it easier for their managers and supervisors who have little knowledge of NPDES regulations, but who must comply with required permit conditions.

The same permittees will also be distributing questionnaires to responsible departments or divisions to collect additional required information for the narrative portion of the Annual Report. The questionnaires survey for specified infor-

SARASOTA COUNTY
NPDES ANNUAL REPORT QUESTIONNAIRE

SWMP Element: ______

Element Objective: ______

Activities Completed or In Progress: ______

Discussion of Results, Deficiencies, Etc.: ______

Status with Compliance, Implementation and Augmentation: ______

SWMP Element Strengths & Weaknesses: ______

Assessment of Element Controls: ______

Required Element Revisions: ______

Table 4. SWMP Questionnaire

MUNICIPAL STORMWATER PERMITS TRACKING CHART			
LEAD APPLICANT	NO. OF CO-APPLICANTS	DRAFT ISSUED?	FINAL ISSUANCE
Sarasota County	6	Yes	12/01/94
City of St. Pete	1	Yes	2/10/95
City of Tampa	1	Yes	Summer 95
Hillsborough County	2	Yes	Summer 95
Broward County	26	Yes	Summer 95
City of Ft. Lauderdale	2	Yes	Summer 95
City of Hollywood	2	Yes	Summer 95
Palm Beach County	42	Yes	Summer 95
Dade County	20	Yes	Fall 95
City of Miami	0	No	Fall 95
City Hialeah	0	No	Fall 95
Pinellas County	25	No	Fall 95
Orange County	10	Yes	Fall 95
City of Temple Terrace	1	No	Fall 95
Polk County	17	Yes	Fall 95
City of Jacksonville	2	No	Late Fall 95
City of Neptune Beach	0	No	Late Fall 95
City of Jacksonville Beach	0	No	Late Fall 95
City of Orlando	0	No	Late Fall 95
Reedy Creek District	0	No	Late Fall 95
Escambia County	3	No	Late Fall 95

Table 5. Florida Issuance Status

mation regarding SWMP status and fiscal requirements. Table 4 lists the information which must be provided for all SWMP activities. A separate questionnaire was developed for fiscal resource requirements.

Forecast Summary

Other Florida communities may anticipate similarly scoped and formatted permits for their jurisdiction. Differences will vary according to MS4 operating conditions and program components.

Although there are few new SWMP activities to be implemented in year one of Sarasota County's permit, the largest initial challenge will be to document existing SWMP activities in accordance with the annual reporting requirements. The permittees look forward to this challenge.

1990 CENSUS APPLICANT'S APPLICATION DUE DATES: Part 1 - June 1995 Part 2 - June 1996			
Pasco County	7	—-	Spring 97
Leon County	1	—-	Spring 97
City of Tallahassee	0	—-	Spring 97
Lee County	10	—-	Spring 97
Manatee County	5	—-	Spring 97
City of Bradenton	0	—-	Spring 97
Seminole County	8	—-	Spring 97

Table 6. Florida Application Status

The forecast for permit issuance for the remainder of Florida is shown in Table 5. In all, twenty-one permit applications have been received by EPA. To date, two permits have been issued. The EPA plans to issue permits to all remaining Florida communities by late Fall 1995.

Looking ahead, the future forecast calls for six additional permits to be issued by Spring 1997. The application status for these six communities is shown in Table 6. The permittees will continue to monitor permit status throughout Florida as it progresses.

Patrick S. Collins, P.E., is NPDES program manager for Sarasota County's Stormwater Environmental Utility. Eric H. Livingston is an environmental administrator, DEP, Tallahassee. Jeannie McNeill, P.E., is with the water permits section of EPA Region 4, Atlanta.

Implementation of the Lead and Copper Rule in Florida

Hsiaochung Charles Wu

Only in the last several decades has it been recognized that lead can cause adverse health effects. Lead is a common, natural, and useful metal found throughout the environment in lead-based paint, air, soil, household dust, food, and in certain types of pottery, porcelain, and pewter. It is also found in water. The most serious adverse health effects associated with low-level lead exposures involve abnormal mental development and function in babies and young children. Small deficiencies in IQ, attention span, and hearing have also been associated with low-level lead exposures. Other effects include alteration in red blood cell metabolism and vitamin D synthesis, premature birth and low birth rates, and small increases in blood pressure in adults.

Although beneficial at lower levels, copper can also be a health risk at levels above 1.3 mg/l in water. Acute exposure has resulted in gastrointestinal effects, such as nausea and diarrhea. Individuals with enzyme deficiencies and Wilsons's disease are at a higher risk than the general public.

After recognizing the fact that drinking water may be the key source to human exposure to high levels of lead and copper, in 1991 EPA promulgated the Federal Lead and Copper Rule to regulate the lead and copper levels in drinking water at action levels of 0.015 mg/l and 1.3 mg/l respectively. Florida began implementing the Federal Lead and Copper Rule in 1992 and adopted the state Lead and Copper Rule in 1993.

More than 3,300 water systems were required to initiate corrosion control treatment steps between 1992 and 1994. The initial sampling results were collected and analyzed by the water systems and the state.

A consensus has been reached for general lead and copper corrosion control. The three most viable corrosion control approaches are pH/alkalinity adjustment, corrosion inhibitor application, and plumbing materials replacement.

The Lead and Copper Rule is the most complex legislation ever promulgated by EPA. The state has tried many different strategies to help people understand this rule, including workshops and seminars. In order to provide technical assistance to water systems, the state initiated a program that involved collecting water quality parameter (WQP) data from public water systems, analyzing these data, and sharing the results with the systems. Further assistance was offered through a contract with the Florida Rural Water Association (FRWA) to the small systems on WQP samples and corrosion control recommendations. The ultimate goal was to protect the public from lead and copper exposures resulting in adverse health effects. Helping systems to comply with this rule will achieve this goal and relieve unwarranted hardship on the water systems.

Public Education

DEP has offered workshops and seminars to the water systems, state regulators, and the public since 1991. The major topics included lead and copper corrosion control steps, sampling protocols, and compliance requirements. Most of the workshops, such as Focus on Change and Lead and Copper Rule workshops, were held by the FRWA. People attending these workshops shared the up-to-date Lead and Copper Rule information. With the support of EPA and its contractors, four other Reviews of Corrosion Control Study workshops were also provided to the state regulators to enhance the state's capability in reviewing corrosion control studies in 1994.

Gathering and Analyses of Data

First Draw Lead and Copper Samples

The first corrosion control step required by the Lead and Copper Rule was to collect the lead and copper first-draw tap samples. A first-draw sample means a one-liter sample of tap water that has been standing in plumbing pipes at least six hours and is collected without flushing the tap (62-551, F.A.C.). Action levels of 0.015 and 1.3 mg/l for lead and copper are set respectively to determine if a system's water is corrosive. The lead or copper action level is exceeded when the concentration of lead or copper in more than 10 percent of tap samples collected during any monitoring period is greater than the action level. This is the so called 90th percentile exceedence."

Which action a system would have to take to comply with the Rule should be based on whether the 90th percentile lead or copper level exceeds the action level. All large systems started the lead and copper monitoring in 1992, and their exceedence rates of lead and copper action levels are depicted in Figure 1. Based on the data collected by the large systems, copper corrosion seemed more serious than lead corrosion in drinking water in Florida.

Medium size systems serving populations between 3,300 and 50,000 started lead and copper tap sampling in July 1992. The exceedence rates of lead and copper action levels are shown

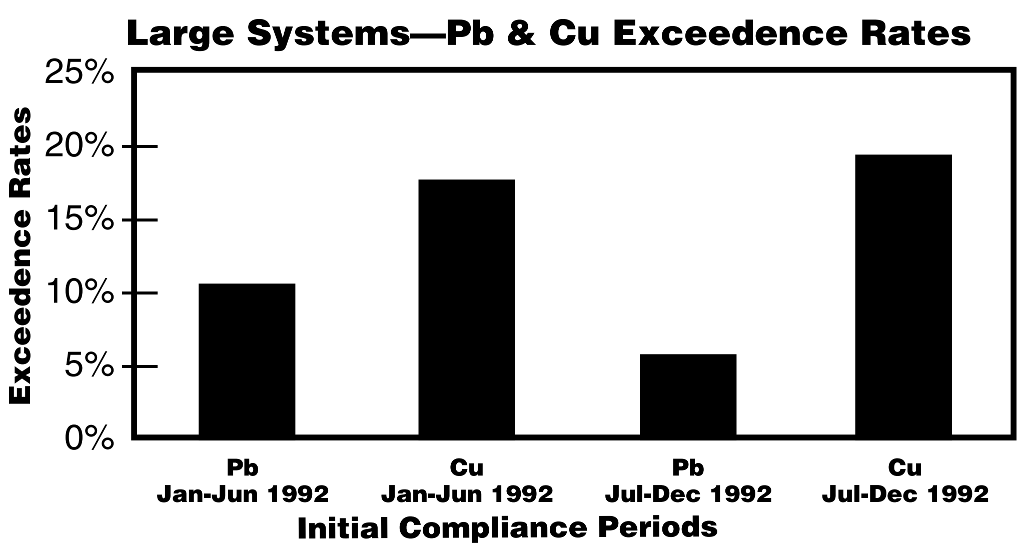

Figure 1. Large System's 90th Percentile Lead and Copper Action Level Exceedence Rates during the Initial Monitoring Periods.

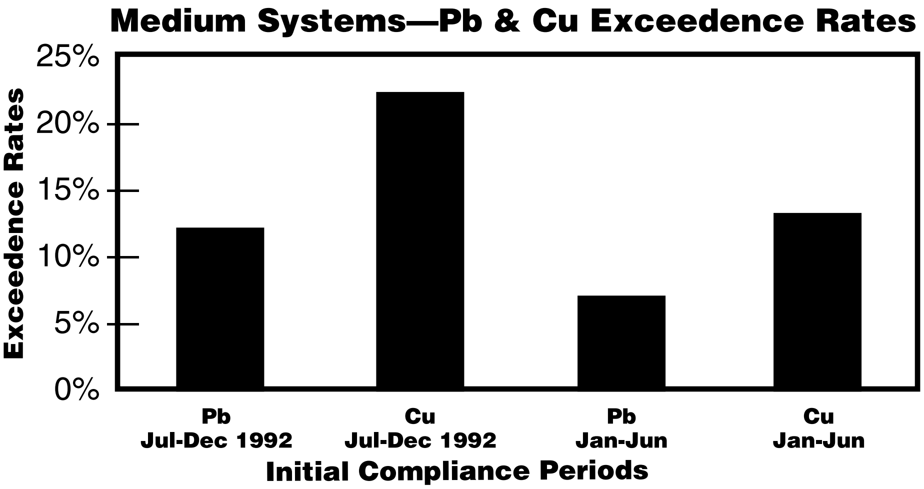

Figure 2. Medium System's 90th Percentile Lead and Copper Action Level Exceedence Rates during the Initial Monitoring Periods.

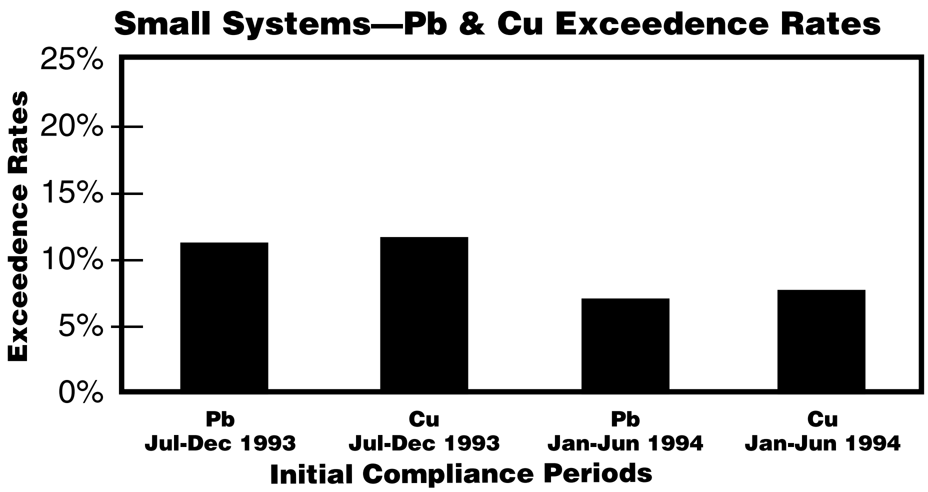

Figure 3. Small System's 90th Percentile Lead and Copper Action Level Exceedence Rates during the Initial Monitoring Periods.

in Figure 2. As with the large systems, more copper corrosion problems than lead corrosion problems were shown.

The higher copper exceedence rate was not restated in for small systems, as depicted in Figure 3. This may be caused by different types of plumbing materials used by the systems, varied sizes of the sample pools, and location of the systems. Some systems drew water samples at the sites that had been unoccupied for a long period.

To simulate the real condition of water consumption at a household, and realizing that more lead would be dissolved into water when water has been stagnant in the pipe or plumbing materials for a longer period (EPA, 1992), it was recommended to take first draw samples after the taps remained unused for six to eight hours. These systems were advised to resample and to flush the water lines six to eight hours before sampling if a site had not been occupied for weeks or months. Some of these systems took the advice to resample and passed both action levels for two consecutive monitoring periods.

Water Qualify Parameter Samples

The WQP data can reveal water's corrosiveness and indicate a proper corrosion control approach. Therefore, collecting the WQP samples for corrosion control studies became the other important task for water systems. All large systems were required to complete two rounds of the water quality parameter (WQP) samples and source water lead and copper samples during the two initial monitoring periods in 1992.

The state required medium and small systems to perform WQP sampling within the successive six months after exceeding lead or copper action levels. In addition, medium and small systems were required to complete corrosion control studies within 18 months after exceeding either action level. However, the Federal Rule requires all medium and small systems to commence WQP sampling within the same monitoring period that they sample for lead and copper at taps and to make corrosion control recommendations to the state within six months after exceeding action levels. The state rule has thus been revised to be consistent with the Federal requirements and became effective August 18, 1994. Along with these two changes, a general permit form was also added into the state rule for smaller-size systems' corrosion control recommendations. This general permit form was developed to facilitate smaller-size systems' corrosion control recommendation and permit application processes. All key WQP data were required to be provided in this permit form for corrosion control recommendations.

To help systems in finding the analogous systems and WQPs for their corrosion control studies, a request for the WQP sampling results was sent out by DEP's Tallahassee office to all large and medium systems exceeding action levels in 1993. The key water quality parameter data requested from the systems included pH, alkalinity, dissolved oxygen, temperature, Cl^-, SO_4^{-2}, lead, copper, calcium hardness, and phosphate or silicate if applied. Within three months, 67 large and medium systems responded and 100 sets of the WQP data were received.

Through statistical analyses of these data, two preliminary conclusions were drawn. First, pH changes are essential to copper corrosion; a downward trend in the 90th percentile copper level has been observed when pH increases. The 90th percentile copper level is below the action level (1.3 mg/l) when pH is above 8.0, as shown in Figure 4. Second, alkalinity may play an important role in lead corrosion. The 90th percentile lead level is below 0.015 mg/l when alkalinity is above 150 mg/l as $CaC0_3$ (18 mg/l as C), as depicted in Figure 5. These two findings concurred with the results derived from researches conducted by EPA and its contractors (EPA, 1992). These analytical results were then shared with the state regulators, FRWA circuit riders, and engineering consultants through seminars and training workshops.

Considering the financial and technical inability of small systems for sampling WQPs and conducting desk-top evalua-

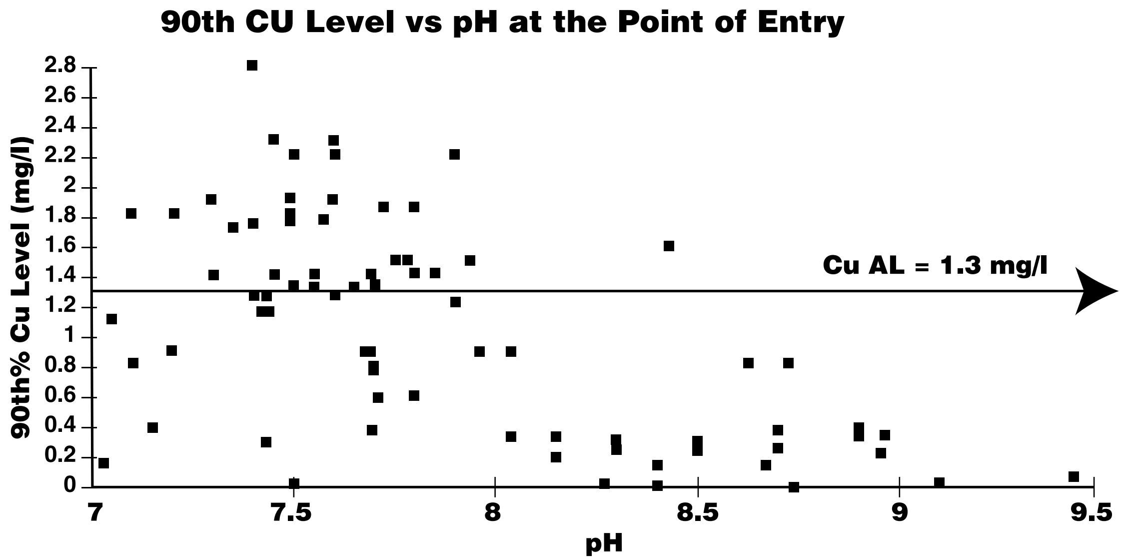

Figure 4. Large and Medium System's 90th Percentile Copper Level versus pH at Point of Entries.

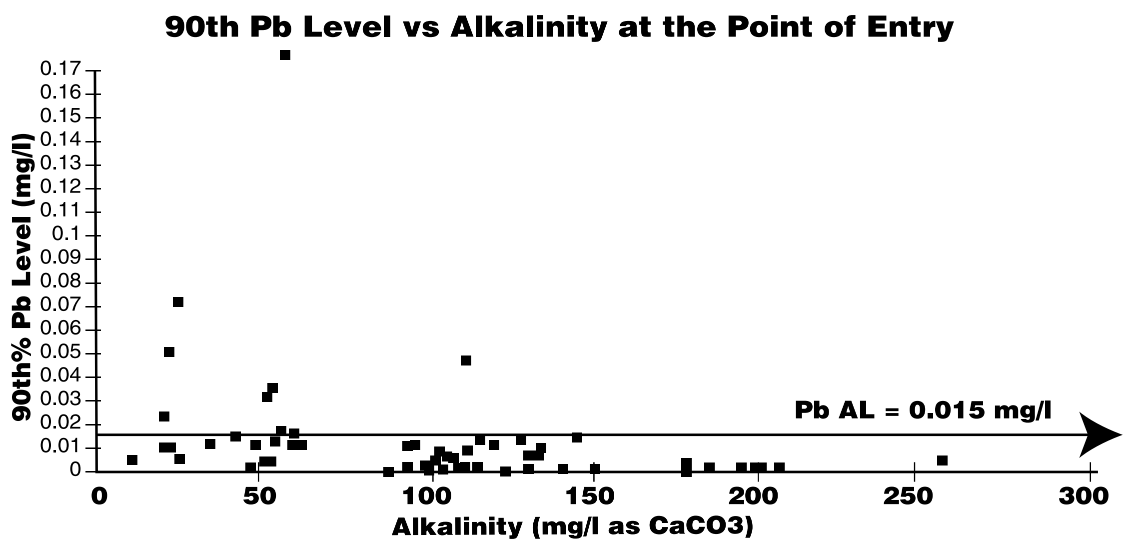

Figure 5. Large and Medium System's 90th Percentile Lead Level versus Alkalinity at Point of Entries.

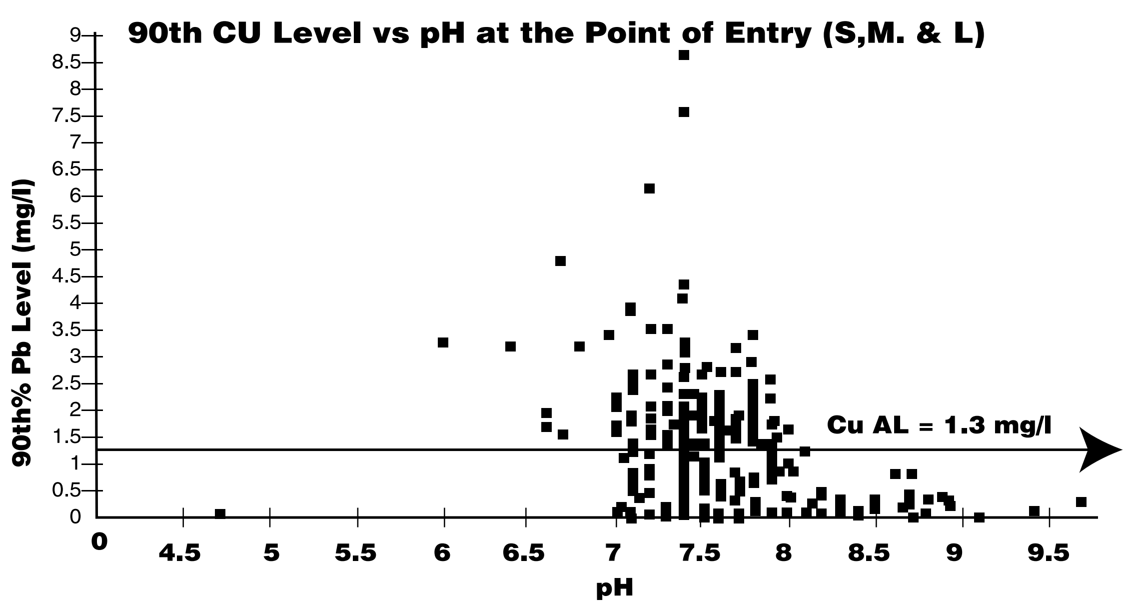

Figure 6. All System's 90th Percentile Copper Level versus pH at Point of Entries.

tions, DEP contracted with the FRWA to assist small systems in taking the WQP samples and in summarizing corrosion control recommendations in March 1994. Under this contract, each FRWA circuit rider was equipped with a notebook computer, a set of the WQP test kit, and an appropriate computer program for WQP analyses. A computer modem system was established between the DEP and FRWA to transfer the small systems' WQP data. An additional 215 sets of the small systems' WQP data were entered into the WQP data base. These data were then analyzed for correlation between WQPs and 90th percentile lead or copper levels.

The preliminary findings with respect to large and medium systems and the correlation between alkalinity and 90th percentile lead level did not always apply to small systems. It is believed that the deviation between large and small systems might be caused by the different sampling pools. All large systems were required to monitor water quality during initial monitoring periods. Medium and small systems were required to monitor water quality only when they exceeded lead or copper action levels. All medium and small systems which responded to our request to provide water quality data are systems that exceeded lead or copper action levels. However, the 90th percentile copper level still decreased by raising pH. Only two systems had the 90th percentile copper level above 1.3 mg/l when pH was more than 8.0 (see Figure 6).

Reconfirming the link between pH and copper corrosion was encouraging. Raising pH to solve copper corrosion problems became a constant approach.

Further analyses focused on the relationship between alkalinity and the 90th percentile copper level. It was speculated by several researchers that the copper failure may be associated with high alkalinity. Among 315 sets of water quality data stored in our data base, about 60 percent of the systems failed copper action levels (157 systems), 90 percent of which had alkalinity above 100 mg/l as $CaC0_3$. However, more than 90 percent of these systems had a pH value less than 8.0. These copper level exceedences may be caused more by low pH than high alkalinity. It is still inconclusive if high alkalinity contributes a positive or negative effect to copper corrosion.

Attempts were made to correlate WQPs and 90th percentile lead/copper levels by teaming two of the WQPs using three dimensional charting computer programs. A solid correlation or trend of pH, alkalinity/dissolved organic carbon, and 9Oth percentile lead or copper levels, was not attained as the lead solubility diagram represented in the Lead Control Strategies. The high background noise might be caused by uncontrollable factors such as plumbing materials, sampling protocols, and sampling pools. Looking into the water chemistry, it is also realized that all the water quality parameters are interactive. A small change to alkalinity in water may also affect pH. Further investigations on WQPs, and lead and copper levels are recommended.

If a system is eligible for reduced monitoring, it is required to take samples during the months of June, July, August, and September. The rationale behind this requirement is that water tends to be warmer and more corrosive during the hot season. Seasonal temperature changes (±4°C to 6°C) can complicate the ongoing process of operating chemical feed systems so as to maintain stable water chemistry.

Normally metal solubility increases and adsorption decreases in water with an increase in temperature. This may not always be true while applied to systems using calcium carbonate precipitation as a major corrosion control treatment due to the unique characteristic of calcium carbonates. Calcium carbonates are less soluble in water as the temperature increases. As a result, the calcium carbonate deposition on the pipe wall is harder and protection can be obtained by this barrier between water and pipe surface. Because controlling the deposition of the calcium carbonate precipitate is difficult and because the formation of calcium carbonates will reduce the hydraulic capacity of the distribution system, calcium carbonate precipitation was not recommended as a major corrosion control alternative for small systems.

Corrosion Control Studies

The corrosion control studies and recommendations have been submitted to the state since July 1994. The systems conducted either bench scale tests, full scale tests, or desk-top evaluations to derive solutions for corrosion control. The most common corrosion control techniques used in Florida are replacement of plumbing materials containing lead, pH/ alkalinity adjustment, and phosphate-based inhibitor application.

Rothberg , Tamburini, and Winsor Model

The Rothberg, Tamburini, and Winsor (RTW) Model is a very useful tool for corrosion control and process chemistry analyses. It is used by many water systems and state regulators to analyze the water quality. A copy of this computer model was purchased for each DEP district office to assist in review of corrosion control treatment recommendations. Although the RTW model lacks the ability to predict effectiveness of employing corrosion control inhibitors, it is indicative for pH and alkalinity adjustment.

Replacement of Plumbing Materials:

Plumbing materials and fixtures containing high percentages of lead have been shown to contribute significant amounts of lead to drinking water at the consumer's tap. So, small size water systems and non-transient non-community water systems are always advised to look at replacing all brass faucets and plumbing materials containing lead before even considering any other corrosion control treatment approaches. The Pratt-Whitney Aircraft Inc. Water System is an example of a medium system which replaced all plumbing materials and fixtures containing high lead levels. It successfully reduced the 90th percentile lead level from 0.130 mg/l to 0.013 mg/l. It made nop modifications to the existing treatment. A modification to the lead and copper sampling plan approved by the state may be needed after replacement of plumbing materials.

pH Adjustment

As indicated in the EPA guidance manual for corrosion control and the results of our WQP data analyses, pH adjustment is very efficient for reduction of copper levels. The target pH level for copper corrosion control was set at 8.0 or above when the water is stabilized or well buffered. Through varieties of chemical addition to water, pH can be raised. The typical chemicals used for raising pH included sodium hydroxide, sodium bicarbonate, and lime. In order to have enough buffering intensity and capacity, the alkalinity and dissolved inorganic carbon (DIC) should be monitored so pH will not fluctuate throughout the distribution system. It is possible that some systems with high DIC have precipitated carbonate films or have developed mixed calcium plus solids on their pipes, thus limiting lead exposure to water. Which process dominates the corrosion control activity is still questionable when both calcium carbonate precipitation and phosphate passivation are employed as treatment processes.

Aeration, another way to adjust pH and useful for removal of hydrogen sulfide from ground water, is currently employed by many systems in Florida and especially in central Florida. If a system has high alkalinity and pH is less than 7.0, aeration may remove carbon dioxide and thus raise pH. However, aeration will also dissolve more oxygen into the water and increase corrosiveness. The role of oxygen in corrosion is that of a cathodic depolarizer, and if the corrosion is under cathodic control, the rate of corrosion will be proportional to the area of the cathode and the rate at which oxygen arrives at the cathode (AWWARF, 1985). For a specific water velocity and ratio of cathode area to anode area, the corrosion rate becomes directly proportional to the oxygen concentration itself. Thus, in these cases, a reduction in the oxygen content of the water is a practical corrosion control procedure, if other factors allow its application. For example, the Pinellas County Water System reduced copper corrosion by reducing aeration (D.O. reduction) and increasing chlorine dosages to remove H_2S. We want the benefit of higher pH for corrosion control while avoiding an increase of the dissolved oxygen content. Balancing the two reactions of dissolving oxygen and removing CO_2 is important.

The city of Winter Park Water System is the other case that successfully controlled copper corrosion by raising its water pH with chemical addition. The system serves approximately 75,000 people and is classified as a large system. The 90th percentile copper concentration exceeded the action level of 1.3 mg/l during two initial monitoring periods. As a large system, the city was required to perform a demonstration test that allows the selection of an optimal treatment method for control of lead and copper in its drinking water. The basic options available for corrosion control that were reviewed in the desktop evaluation included pH adjustment, calcium adjustment, bicarbonate stabilization, and inhibitor addition. Computer models developed by AWWA and Hydranautics were used to evaluate the applicability of pH, alkalinity and calcium adjustment for the City's water (Duranceau, 1994). Through the desk-top evaluation, pH adjustment with sodium hydroxides was selected as the treatment alternative for evaluation in the demonstration test program. The system applied for a permit to install a sodium hydroxide feed system for copper corrosion control. After the corrosion control treatment facilities were in operation, the 90th percentile copper level was reduced dramatically but the trihalomethane (THM) level was increased. In order to maintain the effectiveness of disinfection, increasing the chlorine dosage is almost inevitable when pH is higher. As a result, the THM level is elevated. In this case, the THM level is still below the standard. As the new Disinfectants/Disinfection By-product Rule comes along, high THM levels will become a sensitive issue. The systems should always be cautious of THM elevation when increasing pH for corrosion control.

Phosphate-based Inhibitor Application

The use of phosphate-based inhibitors has proved effective in controlling lead and copper corrosion in Florida and in many other states. The idea of using phosphate-based inhibitors for corrosion control is to apply specially formulated chemicals characterized by their ability to form metal complexes on the surface of the inside pipe walls and thence to reduce corrosion. This is called passivation of the metal surface.

Phosphate inhibitors are manufactured in a variety of compositions, including sodium orthophosphate, zinc orthophosphate, and poly-ortho blended phosphates. Each of these groups of compounds may have differing formulations as to the percentage of effective orthophosphate (PO_4) present (EPA, 1992). The goal is to have sufficient orthophosphate to form a passivation film on the wetted pipe surface or inside plumbing materials. The minimum concentration of PO_4 required for maintaining the film in the distribution system is a key factor to applying a phosphate-based inhibitor.

A system is always required to recommend to the state a minimum orthophosphate concentration to be maintained in the distribution system when a phosphate-based inhibitor is proposed for corrosion control. In addition, the polyphosphate acts as a sequestering agent to reduce iron, calcium, manganese, or magnesium in the water. If a system has excessive hardness in its water, using the poly-ortho blended phosphate may benefit the system with both hardness reduction and corrosion control. Poly-ortho blended phosphates also have higher pH values (between 7 and 10) while compared to orthophosphates. For some small systems, higher pH values also make poly-ortho blended phosphate applications an ideal corrosion control alternative due to operational and maintenance safety concerns. Many testing results showed that orthophosphate may be the most efficient inhibitor for lead and copper corrosion control. Pure polyphosphates (long chain polymers) are sequestering agents but not corrosion inhibitors.

Holm & Schock, concluding that complexation of lead by polyphosphates may increase the solubility of lead in plumbing systems, recommended that formulations containing more orthophosphates would be more advantageous. Schock (1989) also showed that polyphosphates were often not only ineffective, but could increase lead levels by solubilization of protective films on the pipe. Theoretically, polyphosphate may revert to orthophosphate through time. However, no real data has suggested how long this reversion process should take. As described previously, orthophosphate may not be practical for some small systems due to operational difficulties. Some systems are using poly-ortho blended phosphates for corrosion control. Phosphate is a nutrient to many microorganisms and, accordingly, there has been some concern about phosphate promoting algae growth. However, algae has not been reported to be a problem in systems using orthophosphate in Florida.

Silicate-based Inhibitor Application

Silicates have been found to protect pipes from corrosion by formation of a thin silicate film on the pipe surface. Experiments with silicates have shown indications of slow film formation (Schock, 1989). Katsanis et al. (1986) have found that silicate treatment is most effective with soft waters, at low pH, and high oxygen content. The state is not aware of any water systems using silicates for corrosion control in Florida.

Summary

Like any other environmental rules and regulations, the Lead and Copper Rule is not perfect. Everybody involved in development and implementation of this Rule is still learning new aspects of interpretation of the Rule and application of treatment technologies. Any modification to existing treatment processes of a system for corrosion control may affect the water quality and cause the system to incur noncompliance status to current or future drinking water standards. A system's operator, owner, or consultant should always consider water system and regulatory constraints during the evaluation of alternative corrosion control approaches.

Before considering a corrosion control treatment, a system should investigate whether tap sampling was conducted using the correct sampling techniques and whether changing plumbing materials to solve the lead or copper problem is possible. It may be that some systems with high DIC have precipitated carbonate films or have developed mixed calcium plus solids on their pipes, thus limiting lead exposure to water. Which process dominates the corrosion control activity is still questionable when both calcium carbonate precipitation and phosphate are employed. Water quality criteria based on present-day standards and guides are presented in the current rules and the EPA Guidance Manual to assist the establishment of water system performance goals for any plant.

Most of the water systems in Florida are groundwater systems. As a result, high alkalinity and hardness can be expected in most Florida water supplies. The two major corrosion control alternatives are phosphate-based inhibitor addition and pH/alkalinity adjustment. The safety issues should not be ignored anytime if a chemical is applied.

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Glossary of Common Terms Used in the Florida Water Resources Journal

AWT, AWWT	advanced wastewater treatment
AWWA	American Water Works Association
BOD	5-day biochemical oxygen demand
COD	chemical oxygen demand
DEP	Florida Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
FSAWWA	Florida Section of AWWA
FWEA	Florida Water Environment Assoc.
FWPCOA	Florida Water & Pollution Control Operators Association
gpd	gallons per day
gpm	gallons per minute
MGD	million gallons per day
mg/l	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
POTW	public-owned treatment works
SJWMD	St. Johns Water Maangement District
SFWMD	South Florida Water Management District
SRWMD	Suwannee River Water Management District
SWFWMD	Southwest Florida Water Management District
TDS	total dissolved solids
TSS	total suspended solids
USGS	United States Geological Survey
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant