001515_UP02_04-B0876

RECEIVED
JUN 1 4 2005
Remedial Bureau C
Division of Environmental Remediation

Engineer's Report for the High Falls Water Treatment Plant

Final Engineer's Report

June 2005

Prepared for:

UNITED STATES ARMY CORPS OF ENGINEERS
CENWK-EC-ED
601 E. 12th Street
Kansas City, MO 64106-2896

STATE OF NEW YORK
GERALD A. STROBEL, P.E.
044479
LICENSED PROFESSIONAL ENGINEER

6/8/05

ecology and environment engineering, p.c.
BUFFALO CORPORATE CENTER 368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

recycled paper

Table of Contents

Table of Contents (cont.)

Section **Page**

Table of Contents (cont.)

Appendix

List of Tables

List of Figures

List of Abbreviations and Acronyms

AMSL	above mean sea level
ARAR	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
bgs	below ground surface
BPD	backflow prevention device
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	code of Federal Regulations
CPVC	chlorinated polyvinyl chloride
CWC	Catskill Watershed Corporation
DCA	dichloroethane
DI	ductile iron
DBP	disinfection by-product
DPD	n,n-diethyl-p-phenylenediamine
EEEPC	Ecology and Environment Engineering, P.C.
EPS	extended-period simulation
FEMA	Federal Emergency Management Agency
FCV	flow control valve
FIRM	Flood Insurance Rate Map
FRP	Fiber-reinforced plastic
FS	Feasibility Study
ft^3	cubic feet
GAC	granular-activated carbon
GCL	geosynthetic clay liner
gpcd	gallons per capita per day
gpd	gallons per day

List of Abbreviations and Acronyms (cont.)

gpm	gallons per minute
GWTS	Groundwater Treatment System
HFWD	High Falls Water district
HGL	hydraulic grade line
IAG	Interagency Agreement
ID	inside diameter
IIWA	Immediate Investigation Work Assignment
ISO	Insurance Services Office
JMA	John Milner Associates, Inc.
kg/L	kilograms per liter
LF	linear feet
MAC	maximum allowable concentration
MCL	maximum contaminant level
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/L	milligrams per liter
MGD	million gallons per day
MRIP	Mohonk Road Industrial Plant
NACE	National Association of Corrosion Engineers
NaOCl	sodium hypochlorite
NFPA	National Fire Protection Association
NPL	National Priorities List
NTCRA	non-time-critical removal action
NTU	nephelometric turbidity unit
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York Codes, Rules, and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	operation and maintenance
OIU	Operator Interface Unit
OSHA	Occupational Safety and Health Administration
PAC	polyaluminum chlorite

List of Abbreviations and Acronyms (cont.)

PE	polyethylene
PLC	Programmable Logic Controller
POTW	publicly owned treatment works
POU	point of use
PP	polypropylene
ppb	parts per billion
ppm	parts per million
PRV	pressure-reducing valve
psi	pounds per square inch
psig	pounds per square inch (gauge)
PVC	polyvinyl chloride
PWSA	Proposed Water Service Area
RAO	remedial action objective
RD	remedial design
RI	Remedial Investigation
ROD	Record of Decision
RPZ	reduced pressure zone
SPDES	State Pollutant Discharge Elimination System
SWTR	Surface Water Treatment Rule
TCA	trichloroethane
TCE	trichloroethene
THM	trihalomethane
UCHD	Ulster County Health Department
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WTP	water treatment plant
μg/L	micrograms per liter

1 Introduction

Background and History

The hamlet of High Falls is located in Ulster County, New York, approximately 12 miles south-southwest of the city of Kingston and 7 miles north-northwest of the village of New Paltz. It is situated within the towns of Marbletown and Rosendale. The area is primarily residential.

The Mohonk Road Industrial Plant (MRIP) Superfund Site (Identification No. NYD986950012) is located on Mohonk Road, south of High Falls (see Figure 1-1). The site consists of the MRIP property (186 Mohonk Road), as well as surrounding properties that have been impacted by a contaminated groundwater plume originating from the MRIP property. The groundwater plume extends approximately 4,000 feet from the MRIP property and has adversely affected many residential, commercial, and industrial water supply wells (USEPA 2000). The MRIP site was added to the National Priorities List (NPL) on January 19, 1999 (USEPA 2000).

The site first came to the attention of state and local authorities in April 1994 when a resident near the MRIP property contacted the Ulster County Health Department (UCHD) concerning the quality of her drinking water (USEPA 2000). The analytical results for water samples collected from the private well by the UCHD indicated that water from the well contained elevated levels of volatile organic compounds (VOCs). Additional sampling around the area has been performed by UCHD, New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA) Region II in March 2000 (refer to Appendix A of EEEPC 2002). To date, 74 wells of residences and businesses downgradient of the MRIP property have been determined to have VOC concentrations above New York State (NYS) maximum contaminant levels (MCLs) (5 parts per billion [ppb] for individual VOCs). As an interim action to address immediate health threats, NYSDEC and USEPA have installed granular-activated carbon (GAC) filters at these 74 homes and businesses whose wells exceeded the NYS MCLs.

According to the Site Remedial Investigation (RI) (LMS 1998) (refer to Appendix B of the Engineer's Report [EEEPC 2002]), the contaminated groundwater plume has an areal extent of approximately 170 acres where the total VOC concentrations are at least 10 ppb; in some cases the concentration is over 10,000 ppb. The plume extends approximately 1 mile north of the MRIP property (see Figure 1-2). Total VOCs present in the plume consist mainly of 1,1,1-trichloroethane (TCA) and its degradation products (e.g., 1,1-dichloroethane [DCA] and 1,1-trichloroethene [TCE]). TCE also was frequently detected in groundwater wells (LMS 1998).

The results of a baseline risk assessment of the site conducted by NYSDEC indicated that the VOC-contaminated groundwater at the site poses an unacceptable risk to human health. As a result, a remedial action objective (RAO) was established to "eliminate inhalation and ingestion of, and dermal contact with, contaminated groundwater associated with the site that does not meet state and federal drinking water standards" (USEPA 2000). Groundwater, drinking water, and surface water standards identified for the site are based on NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC 1998); Part 5 of the NYS Sanitary Code; and the Federal Safe Drinking Water Act, 40 Code of Federal Regulations (CFR) Part 141, MCLs for drinking water.

As a result of the RI, specific alternatives were developed to provide a permanent, safe water supply for all the private well owners impacted or threatened by contamination from the site. Alternatives were described and evaluated in the *Feasibility Study Report for the Mohonk Superfund Site* (LMS 1999) (refer to Appendix C of the Engineer's Report [EEEPC 2002]).

Alternative means to supply potable water to the selected service area include either maintaining the current GAC treatment technology at each private well or creating a new water supply distribution system that would be supplied with water from a reliable, uncontaminated source. Each remedial alternative, and variation thereof, was evaluated based on a comparative analysis of protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); short- and long-term effectiveness; reduction of toxicity, mobility, and volume through treatment; implementability; and cost.

In a March 2000 Record of Decision (ROD) (USEPA 2000), the USEPA, with concurrence from NYSDEC, selected as the preferred water supply remedy the construction of a public water supply system to provide potable water to residences and businesses in the towns of Marbletown and Rosendale impacted or threatened by the contaminated groundwater plume. The primary water supply for the system will be the Catskill Aqueduct, which runs approximately 100 feet south of the MRIP property (see Figure 1-3). The individual GAC filtration systems currently in use will be operated until the new public water supply system is operational.

Specifically, the ROD based upon an evaluation of the various alternatives and consideration of community acceptance, selected alternate potable water supply Alternative AWS-3: Public Water Supply Using Catskill Aqueduct, contaminated

001002_UP02_05_03-B0912 I:\buffalo\mohonk\maps\figure_1-1_mrip_site.mxd - GIS

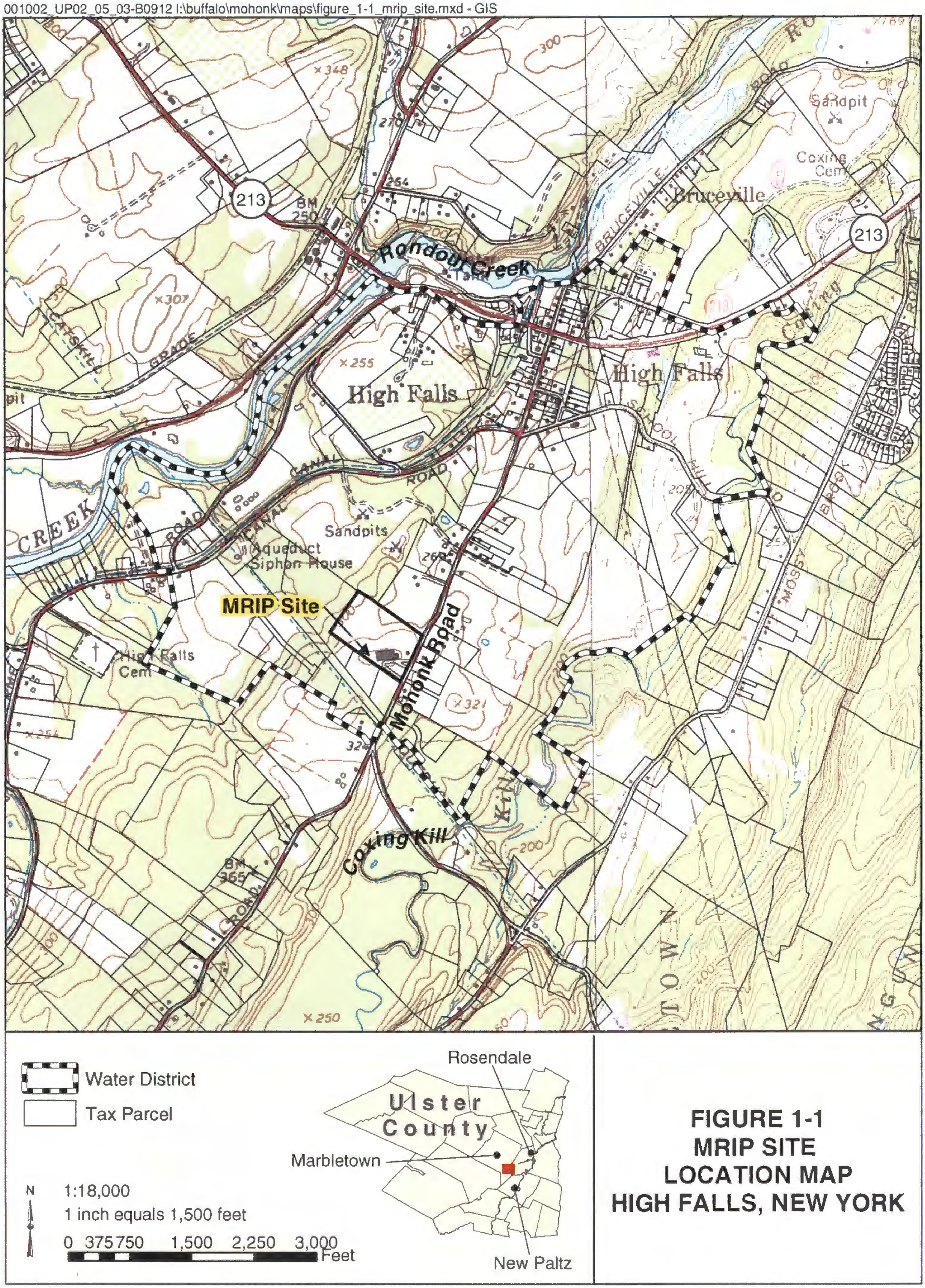


FIGURE 1-1
MRIP SITE
LOCATION MAP
HIGH FALLS, NEW YORK

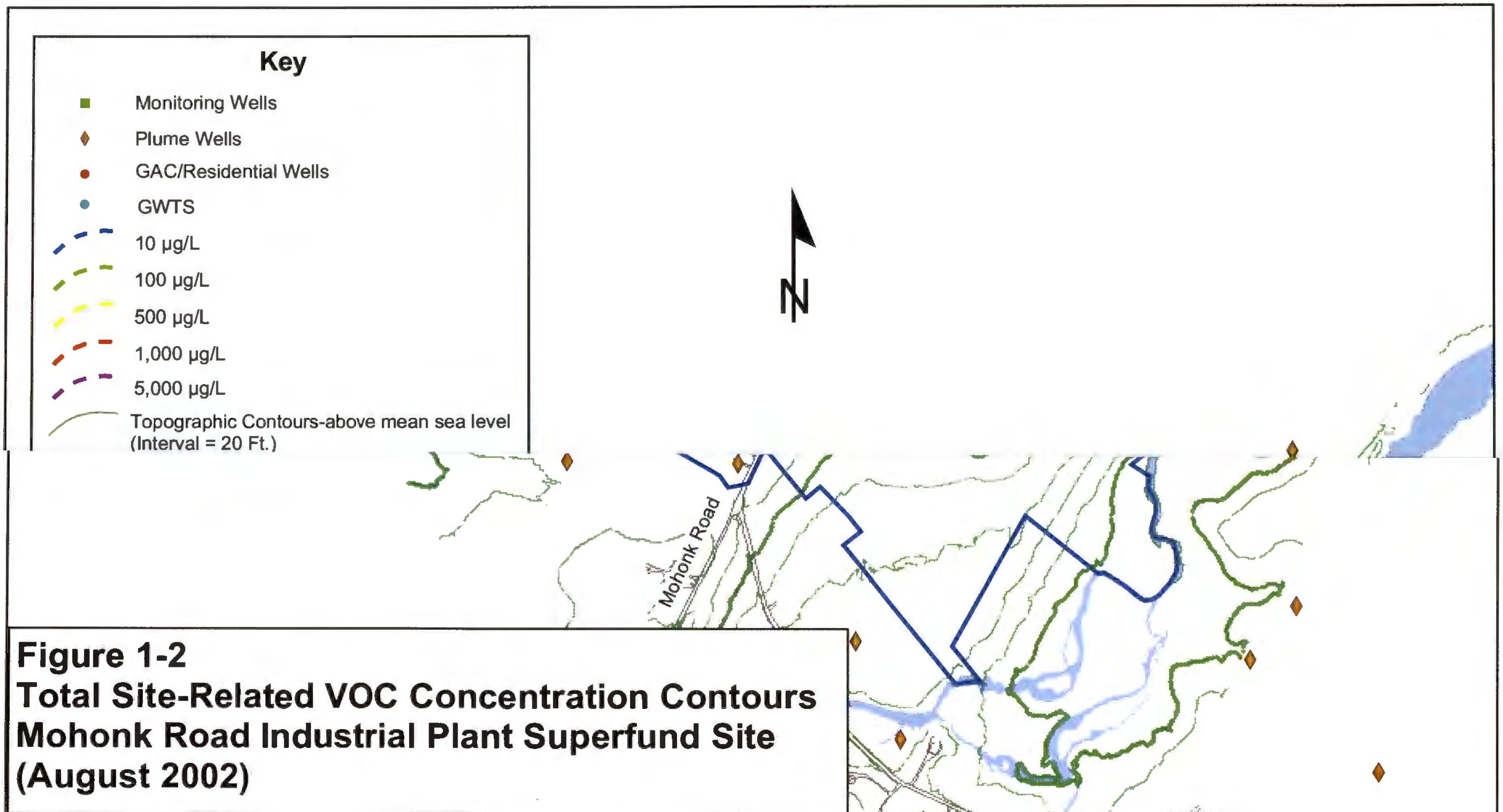


Figure 1-2
Total Site-Related VOC Concentration Contours
Mohonk Road Industrial Plant Superfund Site
(August 2002)

001002.UP02.05.04 - GIS 2/21/03
001515.UP02.04.01 - GIS 8/20/04
L:\Buffalo\Mohonk\mxds\VOC_Concentration_Contours.mxd

FIGURE 1-3
WATER SUPPLY STRUCTURES LOCATION MAP
HIGH FALLS, NEW YORK

groundwater response Alternative GR-3: Extraction and Ex Situ Treatment, and Source Control (contaminated soil) Alternative SC-3: Excavation and Off-site Disposal as the selected remedy for the MRIP Superfund Site.

Alternatives AWS-3 and AWS-4 are both technically feasible. A water district must be formed in the Proposed Water Service Area (PWSA) for Alternatives AWS-3 and AWS-4 to be implemented. The towns of Marbletown and Rosendale have prepared a draft intermunicipal agreement, as well as a plan, map, and report that describes the PWSA boundaries and per user cost estimates. The towns held a public hearing on district formation on March 16, 2000, and the High Falls Water District (HFWD) was formed. Alternative AWS-3 requires the construction of a water treatment plant (WTP), storage tower, and a water distribution system, and state and local approval of the design of the facilities. The recommended location for the WTP was the MRIP site. A water usage agreement is being reached between the HFWD and the NYCDEP for Alternative AWS-3.

Alternative AWS-3 was selected because it eliminates inhalation, ingestion, and dermal contact with contaminated groundwater associated with the site that does not meet the state or federal drinking water standards, and because it is considered to be the most reliable source of potable water over the long term.

In July 2000, the USEPA entered into an Interagency Agreement (IAG) with the United States Army Corps of Engineers (USACE) to prepare the Remedial Design (RD) of the potable water supply (Alternative AWS-3) and groundwater treatment systems for portion of the plume that extends beyond the MRIP property line. In October 2000, the USACE authorized Ecology and Environment Engineering, P.C. (EEEPC) to begin the design of the public water treatment and distribution systems (Alternative AWS-3).

Description of Existing Water Works

The hamlet of High Falls comprises parts of two towns, Marbletown and Rosendale. The area is primarily residential, and all homes and businesses presently use private groundwater wells as a drinking water supply (see Figure 1-2). Most wells in the area draw water from the bedrock aquifer, which has been designated as Class GA groundwater by NYSDEC. NYSDEC defines Class GA groundwater as follows: "the best use of Class GA waters is as a source of potable water supply. Class GA waters are fresh groundwaters found in the saturated zone of unconsolidated deposits and consolidated rock or bedrock." Groundwater near the MRIP Site will continue to be used as a supply of potable water until a public water supply system has been constructed. Since 1994, NYSDEC and USEPA have installed GAC filters at 74 homes and businesses with contaminated wells to provide water that meets state and federal MCLs.

The Catskill Aqueduct passes approximately 100 feet south of the MRIP property. The aqueduct is owned by New York City and is maintained by the New York City Department of Environmental Protection (NYCDEP). The aqueduct draws water from the Ashokan Reservoir and supplies the New York City Reservoir System via an underground tunnel. As it passes through the Rondout Valley in High Falls, the concrete-lined tunnel is 14.5 feet in diameter and about 500 feet below grade. The Rondout Dewatering Chamber (a siphon house) is located approximately 1,200 feet west of the MRIP property (see Figure 1-3).

Description of Existing Sewerage Systems

Individual homes, businesses, and industries currently use private septic tanks for sewerage. This is typical of a waterworks infrastructure consisting of private groundwater wells.

Identification of the Area Served

Following the RI/Feasibility Study (FS) for the MRIP, the town boards of Marbletown and Rosendale authorized the preparation of a Plan, Map, and Report for the creation of a municipal water district in the hamlet of High Falls (Brinnier & Larios, P.C., 2000). The HFWD includes all properties currently impacted or threatened by MRIP Site-related contamination in the towns of Marbletown and Rosendale (see Figure 1-1 and Appendix A).

Water District Contacts

The following official contacts for the HFWD are listed as required by *Recommended Standards for Waterworks* (Great Lakes 2003) (commonly referred to as *Ten State Standards for Waterworks*).

High Falls Water District
c/o Mr. Vincent C. Martello, Town Supervisor
Town of Marbletown
P.O. Box 217, Route 209
Stone Ridge, New York 12484

High Falls Water District
c/o Mr. Robert Gallagher, Town Supervisor
Town of Rosendale
P.O. Box 423, Main Street
Rosendale, New York 12472

2 Extent of Water Works System

Area to Be Served

The town boards of Marbletown and Rosendale have formed adjoining water districts known as the High Falls Water District (HFWD) in each town and agreed to operate them jointly for the benefit of the inhabitants of the districts and to contract with the city of New York for a reliable source of potable water. In September 1999, the town boards of Marbletown and Rosendale authorized the preparation of a plan, map, and report for the creation of a municipal water district in the hamlet of High Falls (Brinnier & Larios, P.C., 2000). RI sampling data, historical private well sampling data, and simulations from a groundwater flow model were used to determine the extent of contamination and in turn, establish the boundaries of the HFWD (USEPA 2000). The HFWD, which includes 224 distinct tax map parcels, encompasses the entire hamlet of High Falls and additional properties in the towns of Marbletown and Rosendale. Included within the HFWD are all properties currently impacted or threatened by site-related contamination, including all vacant agricultural, residential, public, commercial, and industrial properties within the HFWD that are impacted or threatened (see Figure 1-1 and Appendix A). Additional properties that could be impacted by water table drawdown due to the groundwater pump and treat project were also added to the HFWD. A legal description of the HFWD is presented in the Plan, Map, and Report (Brinnier & Larios, P.C. 2000) (refer to Appendix D of the Engineer's Report [EEEPC 2002]). A map of all the tax parcels in the HFWD is presented in Appendix A.

The entire HFWD will be served, as shown in the water distribution system drawings (EEEPC 2004).

Floodplain Assessment

The USACE (July 2004) conducted a floodplain assessment for the entire area to be serviced by the water districts. The waterline main and the drinking water treatment plant are not located within the 100-year and 500-year floodplains. The flood data was obtained from the Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA) - Publication Date: 1996, Title: Q3 Flood Data, Ulster County, New York.

Cultural and Archaeological Resources

The New York Archaeological Council (NYAC) has prepared *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (NYAC 1994), which has been adopted by the New York State Office of Parks, Recreation and Historic Preservation. These standards divide cultural resource assessments into two general phases. Phase I is intended to identify archaeologically sensitive areas, cultural/sacred areas, and standing structures at least 50 years old that may be affected by the proposed project. Phase I may be undertaken in two subphases, Phase IA and IB. Phase IA is an information-gathering phase, which consists of literature searches and an assessment of the archaeological sensitivity of the project area. The Phase 1A was completed for the project area in 1999. Phase IB consists of field investigations designed to collect additional information about cultural and archaeological resources in the project area.

John Milner Associates, Inc. (JMA), performed the Phase 1B investigation specifically for the areas where the waterline main is to be installed (JMA 2003). The report identified two historical resources. Plans and specifications have accounted for these areas to avoid potential disturbances to these resources.

JMA performed the Phase 1B investigation specifically for the water treatment plant site (JMA 2004). JMA did not identify any archeological sites within the 7.4-acre area where the WTP is to be constructed.

Provisions for Extending the Water Works System

The USEPA's primary intent in the formation of the HFWD is to protect human health from the existing MRIP site contamination. Therefore, there is no plan in place for extending the water works system beyond the HFWD. However, where the water distribution system reaches boundaries of the HFWD, the water line will be designed to allow for future expansion of the system by the HFWD. Although the system has been designed to extend the distribution system beyond the current boundary, additional demand would require additional hydraulic modeling and engineering studies. Approval from the NYCDEP would be required to extend the water distribution system. NYCDEP regulates the use of water used from the aqueduct and would need to be contacted to request permission to increase the volume of water withdrawn or to expand the service area.

Appraisal of Future Requirements for Service

All tax parcels in the HFWD, vacant or otherwise, will be served by the water works system. Under its legal authorities, USEPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. The HFWD was formed in accordance with this objective. Therefore, all tax parcels that are contaminated or threatened by contamination from the MRIP Site were appraised and included in the public water service.

3 Project Site

The High Falls WTP requires the construction of two main elements: a treatment plant including ancillary equipment, and a raw water withdrawal chamber.

The ROD (Alternative AWS-3) assumed that the treatment plant would be located at the MRIP Site. Alternative AWS-3 was selected because it eliminates inhalation, ingestion, and dermal contact with contaminated groundwater associated with the site that does not meet the state or federal drinking water standards, and because it is considered to be the most reliable source of potable water over the long term. During preliminary design phases, alternative siting locations for the WTP were investigated. After review of this evaluation by USEPA, USACE, and the HFWD, a decision was made to locate the WTP on the MRIP property. Therefore, the MRIP site will be the focus of this phase of the project for the WTP. The site for the WTP and the raw-water withdrawal chamber are described below.

Treatment Plant Site

The MRIP property is located in the southern portion of the HFWD, in the town of Marbletown, New York. The Catskill Aqueduct, a man-made underground tunnel supplying water to New York City, passes 100 feet south of the property. Industrial activities have taken place on the MRIP property since the early 1960s. Zoning at the MRIP site is a mix of residential and light industrial use, and the most reasonably anticipated future use for the MRIP property is light industrial. A detailed site description and history drafted by the USACE is presented in Appendix F of EEEPC 2002.

The MRIP property consists of approximately 14.5 acres of mostly wooded, undeveloped land with a 43,000-square-foot building located in the southern corner of the property. The government is currently acquiring approximately 7.4-acres to construct the drinking water treatment plant and access road for an access right-of-way. A groundwater extraction and treatment plant, constructed as non-time-critical removal action (NTCRA), is located west of the building.

The treatment system layout at the MRIP site includes a ground level raw-water storage tank, a treatment plant building for filtering and chemical additions to the water, an elevated finished water storage tank for storage of finished water and establishing a hydraulic head, sludge lagoons to settle solids from the filter backwash water, and a septic system needed for disposal of sanitary waste. The entire treatment system will be located west of the MRIP building. Access to the treatment plant area will be via a road constructed along the northern property line starting from Mohonk Road. Raw water will flow by gravity from the raw water tank to the treatment plant. Backwash water will be pumped from the treatment building to the sludge lagoons.

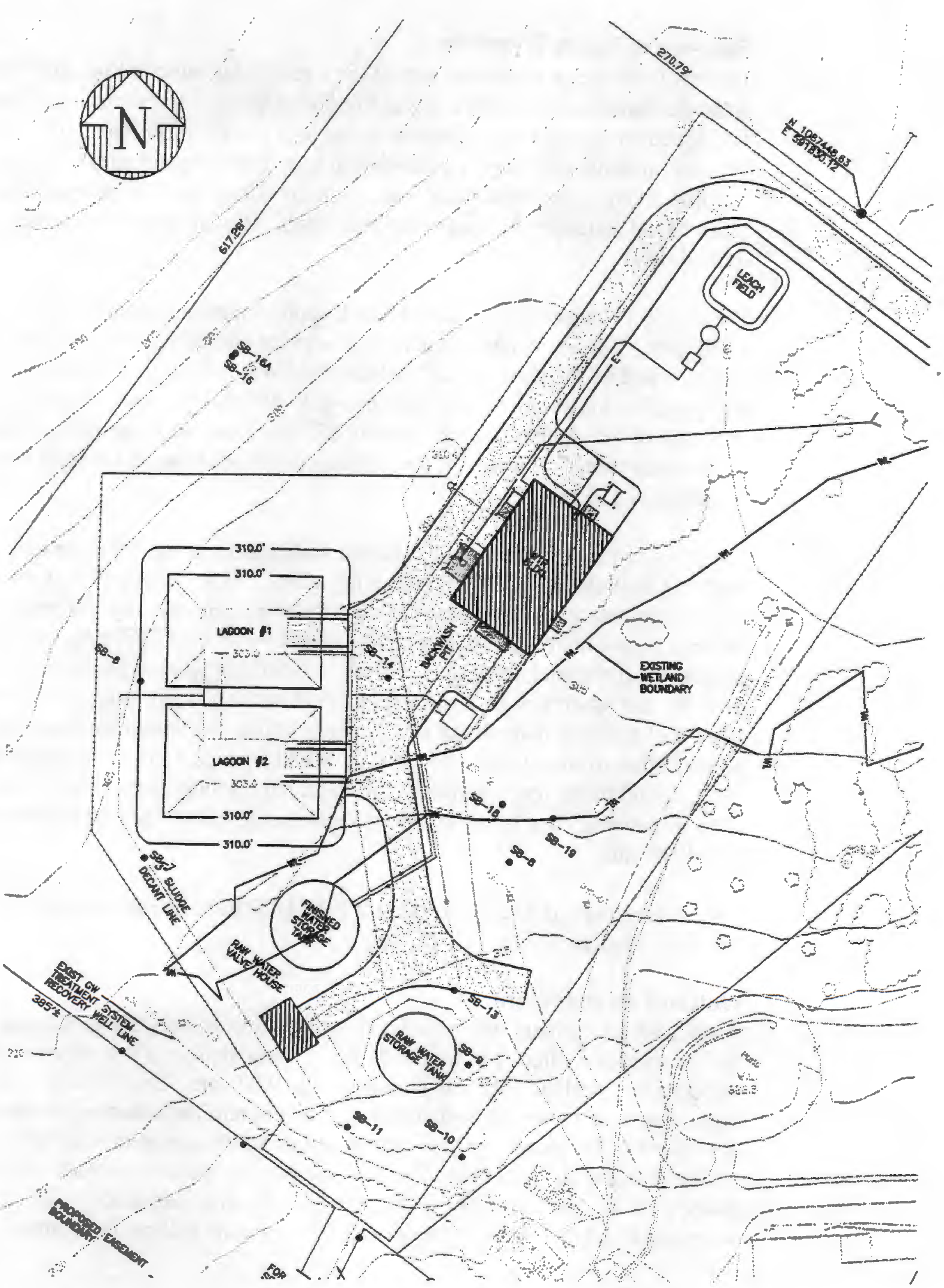
After filtration and chlorination, the water will be pumped to the finished water storage tank. The tank will store the finished water at a height of approximately 150 feet to pressurize the water system above 40 pounds per square inch (psi). Figure 3-1 and the drawings in Appendix B show the general layout of the drinking water treatment plant site. Technical memoranda providing WTP site design criteria are provided in Appendix C and in Appendices G and H of the Engineer's Report (EEEPC 2002).

Proximity of Residences and Industry

The WTP site is located in a primarily residential area. The site is bordered to the southeast by Mohonk Road, to the southwest by the Catskill Aqueduct, and to the northeast and northwest by residential properties on large wooded lots. The property immediately south of the WTP site is currently used to store machinery and trucks as part of a private paving company. There are approximately 150 households and 400 residents within a 1-mile radius of the site (USEPA 2000).

Potential Sources of Pollution on the Site

The main issue relevant to sources of pollution at the MRIP site is the groundwater contamination plume originating from the MRIP property. Existing data on the plume are discussed in Section 11 (Soil, Groundwater, and Contamination Characteristics). These data show that contamination is present in the bedrock at the site. Other data from monitoring well installations, piezometer installations, and preliminary site investigations provided limited information on contamination present in the soil at depths less than 20 feet. This information did not present any preliminary concerns. During recent subsurface investigations conducted in fall 2002, soil and groundwater samples were obtained and analyzed. Results from these analyses show that no contamination existed above action levels. Two of the four soil samples contained trichloroethene at low concentrations (6.71 micrograms per kilogram [μg/kg] and 14.3 μg/kg). The analytical results for the groundwater samples indicated the presence of VOCs at levels below 20 micrograms per liter (μg/L). These results are significantly lower than NYSDEC's recommended soil clean up objective of 700 μg/kg (TAGM 4046). However, due to the low VOC levels in the soil and groundwater, it is recommended that contractors performing excavation activities on the site be appropriately trained in 40-hour Occupational Safety and Health Administration (OSHA) health and safety practices.



ecology and environment engineering, p.c.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
SP GARDNER PE	SP GARDNER PE
DRAWN BY	APPROVED BY
JJ KOHLER	DJ MILLER PE

SITE LAYOUT
FIGURE 3-1

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.

Raw-water Tie-in Chamber

The raw water tie-in will be located at the Catskill Aqueduct's Rondout Valley drainage chamber, also known as the Rondout Siphon, located on Canal Road. The aqueduct inverts into a pressure tunnel as it passes under Rondout Creek. The siphon house structure is a substantial turn of the century stone masonry building above the aqueduct that was originally constructed for periodic maintenance of the aqueduct, but has never been used. The raw-water tie-in site is described below.

The siphon is located east of Canal Road, approximately one-half mile west of the MRIP Site. The site is approximately 20 acres of partially developed land currently owned by the New York City Bureau of Water Supply. The siphon building is used to maintain and store equipment to dewater the pressure tunnel. The elevation of the siphon is approximately 250 feet lower than that of the entrance to the pressure tunnel. Therefore, the pressure of the aqueduct at the siphon is approximately 115 psi.

The tie-in to the aqueduct will be located within an existing, below-grade concrete chamber containing aqueduct dewatering valves. New valves and custom made flange coupling adapters will be installed to replace the existing 100-year-old valves. A new below-grade, pay meter chamber with NYCDEP required metering equipment and associated piping, valves, and fittings necessary to monitor flowrate and usage will be also be installed at the site. Utilization of the residual 115 psi of pressure naturally available at the siphon will eliminate the need for a pump station to supply water to the Raw Water Storage Tank at the treatment plant. 2,600 linear feet (LF) of 6-inch pressurized supply piping will be installed along Mountain View Acres in a permanent easement between the roadway and the MRIP site.

A Final Engineering Design Report for NYCDEP Related Facilities was submitted under separate cover (EEEPC 2005).

Wetland Assessment

A wetlands assessment was conducted by the USACE (July 2004) for areas that will be impacted directly or indirectly by implementation of this remedy. One wet-meadow wetland area was present on the WTP site. Unavoidable construction impacts to the on-site wetlands have been minimized and considered during the review of the project. These impacts will require appropriate mitigation as indicated in the plans and specifications for erosion and soil controls. In accordance with Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), permits will not be required.

4 Water Use Data

Population Estimates and Trends

The HFWD includes all properties in the towns of Marbletown and Rosendale currently impacted by site-related contamination and properties with wells that may be impacted in the near future if the contaminated groundwater plume extends hydrogeologically downgradient.

Data for estimating the current and potentially affected population in the HFWD was obtained from county and town records, as well as information presented in the FS (LMS 1999). The HFWD encompasses the hamlet of High Falls and consists of 224 tax parcels—184 tax parcels in the town of Marbletown and 40 tax parcels in the town of Rosendale (Ulster County Information Services 2001). In the HFWD, there are 177 residential properties, two agricultural properties, 42 commercial properties, and three industrial properties. Of the 224 properties identified, 20 are currently vacant. Also, nine parcels are identified as owned by the Canal Historical Society and NYCDEP. Eight of these parcels will be deemed undevelopable. Therefore a total of 216 parcels in the towns of Marbletown and Rosendale will receive service connections to the waterline. Tax parcel information is summarized in Table 4-1.

The average number of residents per household in both Marbletown and Rosendale is 2.6, based on the 2000 Census (U.S. Census Bureau 2000). Therefore, the population of the HFWD was estimated by first determining the types of residential properties (i.e., single-family, two-family, three-family, and apartment) and then multiplying the number of households by 2.6. The current population of the HFWD is estimated to be 403 people (see Table 4-1). To plan for future growth in the HFWD, it was assumed that all vacant properties will be utilized as single-family residences in the future. Therefore, the estimated future population of the HFWD is 523 people. The High Falls WTP will be designed to supply the potential HFWD population of 523 people.

Table 4-1 Tax Parcel Data for High Falls Water District - Including All Parcels

	Marbletown	Rosendale	Total	Estimated Current Population	Estimated Future Population
Tax Parcels	**184**	**40**	**224**	**403**	**523**
Agricultural	**1**	**0**	**1**	**3**	**3**
Vacant	1	0	1	0	3
Residential	**109**	**30**	**139**	**400**	**400**
Single Family	101	27	128	333	–
Two Family	5	0	5	26	–
Three Family	1	3	4	31	–
Apartment	2	0	2	10	–
Vacant	32	6	38	0	99
Commercial	**26**	**2**	**28**	–	–
Hotels	1	1	2	–	–
Restaurants	3	0	3	–	–
Public Service	11	1	12	–	–
Converted Residence	5	0	5	–	–
Service Stations	3	0	3	–	–
Row type	3	0	3	–	–
Vacant	12	2	14	–	16
Industrial	**2**	**0**	**2**	–	–
Vacant	1	0	1	–	3
Total Used Land	**138**	**32**	**170**		
Total Vacant Land	**46**	**8**	**54**		
Bedrooms	**301**	**87**	**388**		
Baths	**165.5**	**45.5**	**211**		

Note: Parcels owned by the NYCDEP and the D. & H. Historical Society, Inc., will not be developed.

Present Water Consumption

Historical water usage records were not complete from the homeowners and business owners of High Falls, as not all private wells were metered. However, flow measurements were routinely taken from home and business owners with GAC filtration systems installed by NYSDEC as part of the GAC maintenance program and were made available by NYSDEC. The records report the flow through a GAC system for the lifetime of one GAC drum. The time the GAC drum was on line was also recorded. Therefore, the total flow divided by the number of days the GAC drum was on line gives a rough estimate of the average daily water usage in these households and businesses. In the FS, the average flow for the impacted community was determined to be 65 gallons per capita per day (gpcd)—47 gpcd for domestic use and 18 gpcd for commercial use (LMS 1999).

Projected Average and Maximum Daily Demands

Projected Average Daily Demand. The average and maximum daily and hourly water demands, including fire flow demand, were calculated for the design of the High Falls WTP and distribution system. As stated previously, limited historical water usage data was available for the HFWD. Therefore, to get the most accurate estimate, four estimating methods were used and the results compared to determine the average daily water demands for the HFWD (see Table 4-2). All water demand calculations and relevant references are presented in Appendix C.

In the FS (LMS 1999) and the *Plan, Map, and Report of the Proposed High Falls Water District* (Brinnier & Larios, P.C., 2000), the number of bedrooms in the HFWD was multiplied by a rate of 150 gallons per bedroom per day, which was obtained from the *New York State Rural Water Supply* (NYSDOH 1966). However, New York State Department of Health (NYSDOH) also recommends the use of 75 gpcd as an average daily water demand per person where service connections are metered (NYSDOH 1975). This method was also used in the FS. The estimated average daily flows for residential properties in the HFWD using these methods are presented in Table 4-2.

Table 4-2 Projected Average Daily Demand for the High Falls Water District

Method	Domestic Average Daily Demand (gpd)	Nonresidential Average Daily Demand (gpd)	Total Average Daily Demand (gpd)
NYSDEC Metered	24,581	9,414	33,995
NYSDOH (1966) 150 gpd/bedroom + nonresidential usage	75,300	10,146	85,446
NYSDOH (1975) 75 gpcd + nonresidential usage	38,225	10,146	48,371
Water Quality (1987) 160 gpcd total	83,680	included	83,680
High Falls Water District			**85,000**
Town of Marbletown			76,000
Town of Rosendale			9,000

Both NYSDOH methods calculate the average daily water demand for domestic purposes. For commercial and industrial properties, water usage was calculated using estimates specific to the type of business (LMS 1999). For example, the water usage for a restaurant was determined by multiplying the number of seats in the restaurant by the average water usage per seat to determine an average daily commercial demand. The number and types of nonresidential properties was obtained from the Ulster County Information Services 2001, and water usage information was obtained from *Water Quality* (Tchobanoglous and Schroeder 1987). The estimated average daily flows for nonresidential properties in the HFWD are presented in Table 4-2. The total average daily water demand can be estimated by adding the average daily water demand for residential properties to the average daily water demand of nonresidential properties. These values are also given in Table 4-2.

Another method, which is described in *Water Quality* (Tchobanoglous and Schroeder 1987) and used by EEEPC for flow estimations, combines both residential and nonresidential water usages to calculate average per capita daily water demand. According to *Water Quality* (Table 5-3), typical municipal water use for small communities ranges from 65 to 290 gpcd. Based on the table, the average daily flows for a new waterworks system, with minor system losses and leakage, is estimated to be 150 gpcd. As the waterworks system ages, unaccounted system losses and leakage will increase. Therefore, for future scenarios the average daily flow is estimated to be 160 gpcd. For this method, the population of the HFWD multiplied by the average daily water demand per capita yields an average daily demand flow for residential and nonresidential uses in gallons per day (gpd). The estimated average daily flows using this method are also given in Table 4-2 of this report.

The NYSDOH (1966) method and the *Water Quality* (1987) method yield similar results for average daily demand in the HFWD. Therefore, the projected average daily water demand, accounting for future growth and development within the HFWD, will be 85,000 gpd or 59 gallons per minute (gpm).

Projected Maximum Daily and Peak Hourly Demand. Flow-rate variations can be significant in small community waterworks such as the HFWD. Peak daily water use flows in small communities can range from 160% to 220% of the average daily demand (Tchobanoglous and Schroeder 1987). Due to the limited available historical water use data, NYSDOH recommends that the maximum daily demand be calculated as twice the average daily demand (NYSDOH 1975). This results in a maximum daily demand of 170,000 gpd, or 118 gpm, for the HFWD.

The peak hourly factor is used in sizing the water works distribution system and is generally taken as 1.5 times the maximum daily factor (Tchobanoglous, and Schroeder 1987). This results in a peak hourly demand of three times the average daily demand, or 255,000 gpd, (177 gpm) for the HFWD.

Fire Flow Demand. It is NYSDOH policy that new water supply system designs and installations include fire protection (to account for additional flow demand resulting from fire-fighting activities) (FS 1999). The community is currently serviced by the High Falls Fire Department, which uses Rondout Creek as its source for fire service water and pumper trucks and hoses as its equipment. The use of the pumper trucks will still be available after the public water system is online; however, the public water system will be designed to account for fire flow in the district. The design for fire flow is also required due to ordinances passed by the towns of Marbletown and Rosendale.

The additional water demand needed for fire-fighting activities was determined using the Insurance Services Office's (ISO's) *Guide for Determination of Needed Fire Flow* (2001), which is the preferred method of the National Fire Protection Association's (NFPA). The maximum needed fire flow (flow for fire-fighting purposes) in the High Falls Fire Department was determined to be 1,500 gpm, with a general design fire flow of 1,000 gpm.

The High Falls water system is designed for a fire flow duration of two hours, as required by the NFPA; therefore, the storage required to maintain the design fire flow is 120,000 gallons, which will be stored in the finished water storage tank.

Yield of the Catskill Aqueduct Water Supply

The New York City water supply system provides approximately 1.3 billion gallons of drinking water daily to nearly 8 million residents of New York City and approximately 1 million residents living in Westchester, Putnam, Ulster, and Orange counties. The water is supplied from a network of 19 reservoirs and three controlled lakes in a 1,969 square-mile watershed that extends 125 miles north of New York City. Approximately 90% of the total water comes from the Catskill/Delaware Aqueduct, which passes approximately 100 feet to the south of the MRIP Site (NYCDEP 2000). The aqueduct at this point is gravity fed from the Ashokan Reservoir. The capacity of the Catskill Aqueduct from the Ashokan Reservoir to the Kensico Reservoir is 610 million gpd.

Under the 1905 New York City Water Supply Act, New York City is required to provide water to municipalities within counties where its facilities are located up to the average annual per capita usage of New York City (NYCDEP 2001). The maximum daily quantity of New York City water that the HFWD is allowed to withdraw from its connection is calculated "by multiplying the number of inhabitants within the boundaries of each by the daily per capita consumption of water within the City [New York] as measured by the [NYC]DEP (Allowance Quantities)" as stated in the Draft Water Supply Agreement between the New York City Water Board and the HFWD (NYCDEP 2001). Since 1997, New York City's usage varied between approximately 140 to 170 gpcd (NYCDEP 2001).

Unusual Occurrences

Unusual occurrences are defined as periods of time when the Catskill Aqueduct is temporarily out of service for maintenance. In accordance with the Draft Water Supply Agreement, the Aqueduct could be down for three consecutive periods; each period consisting of five consecutive days, interrupted by a resumption of the connection for two consecutive days (NYCDEP 2001). Therefore, the High Falls WTP design must account for these periods of no water service. The HFWD plans to store five days' volume of average daily water demand, plus the fire flow in the system to account for the five-day down periods of the Catskill Reservoir. The hydraulic capacity will be capable of replenishing the required water demand from the reservoir in two days. The HFWD is allowed to exceed the "Allowance Quantity" of water withdrawn from the aqueduct as stated in the Draft Water Supply Agreement under these special circumstances of refilling the raw-water impoundment as a result of a shutdown.

As part of the draft agreement between the HFWD and the NYCDEP, restrictions may be imposed on the consumption of water during periods of aqueduct shutdown or drought. Should restrictions be imposed, the HFWD will be required to develop contingency plans prior to this event. Plans should be based on the type and length of the restriction.

5 Hydraulic Model

Purpose

Ten States' Standards (Great Lakes 2003) requires a hydraulic analysis to evaluate flow demands and pressure requirements. To meet this requirement and assist with design of the water distribution system, a model of the proposed HFWD's water distribution system was developed to simulate various operating scenarios in order to determine the effects of pipe sizing, initial chlorine dosage and resulting chlorine residuals, effects on pressure observations, and fire flows. The model was developed using WaterCad software, version 6.5, by Haestad Methods, Inc. (Haestad Methods 2001). Additional information regarding this software is provided in Appendix D.

Model Design and Data

The model of the water distribution system was based on the waterline layout and water treatment system with associated components such as the storage tanks, metering chamber, and raw water valve house submitted by EEEPC (EEEPC 2004).

Individual nodes, or water users, were assigned at each residence or commercial property expected to receive water. In addition, one node was assigned to each vacant parcel to account for increased demand due to future development. Each node was assigned an elevation based on the contours developed from an aerial survey obtained previously (3Di 2001). The average, peak, and fire flow demands used as inputs to the model are described in Section 4. The water distribution system was designed in accordance with Ten States' Standards (Great Lakes 2003) using cement mortar lined, ductile iron pipe. Ten States' Standards recommends pipes with a minimum 6-inch inside diameter (ID). However, both 6-inch and 8-inch ID pipes were modeled to evaluate their impacts on pressures and velocities.

Minimum normal working pressure requirements of 35 psi static pressure and 20 psi residual pressure during fire demand at each water user were obtained from Ten States' Standards (Great Lakes 2003). Surveys of individual residences, however, have revealed that existing pressures throughout the water district range from 34 to 64 psi. It is desirable to provide the same pressures that currently exist at each residence; a lower pressure may generate complaints, and a higher pressure may burst existing pipes within the residences. Therefore, the model accounted for existing pressures throughout the water district, and these values were used as the targets for the model.

Chlorine decay (bulk and wall) rates are typically determined empirically from field tests and samples. However, for this model, assumed rates based on discussions with other professionals experienced with chlorine modeling were used. For bulk decay rates (chlorine content dissipating due to time and water temperature), typical values range from -0.1 to -1.0 milligrams per liter (mg/L) per day; therefore, the bulk decay rate was assumed to be -0.5 mg/L per day. For wall decay, (chlorine content dissipating due to a reaction with the pipe walls), typical values range from -0.25 to -1.0 mg/L/ft/day; therefore, the wall decay rate was assumed to be -0.6 mg/L/ft/day.

Methods

In order to evaluate the drinking water supply and distribution system, a computer-generated model of the system was developed using WaterCad, Version 6.5, by Haestad Methods. WaterCad is a software program that facilitates the design and analysis of pressurized piping systems. WaterCad software can be used to:

- Lay out complex networks of pipes, tanks, pumps, and ancillary equipment;
- Perform steady-state analyses of water distribution systems with pumps, tanks, and control valves;
- Perform extended-period simulations to analyze a piping system's response to various supply and demand schedules;
- Perform water-quality simulations to determine water source and age, or track the growth or decay of a chemical constituent throughout the network;
- Perform fire-flow analyses on the system to determine how the system will behave under extreme conditions; and
- Develop scenarios to analyze combinations of "What if" conditions on the system.

Information regarding hydraulic parameters under normal operating conditions is easily obtained using WaterCad, which uses basic engineering principles to determine pressure drops, hydraulic grade changes, chlorine concentrations, velocities, etc. The program is based on the user's choice of friction-loss methods, including Manning's Equation, Darcy-Weisbach, and Hazen-Williams. The Hazen-Williams method, the equation generally used in the United States for these types of calculations, was chosen for this model. When a model is run, the program calculates all of these design parameters, allowing the user to see how a system will theoretically operate under similar conditions in real life.

Model Development

The model for the HFWD was developed based on the drawings developed by EEEPC for the water distribution system, the proposed layout of the WTP, and the Plan, Map, and Report for the proposed HFWD. Each pipe section was plotted, and nodes were established at each expected water user, residence, and business, as well as at vacant parcels. Based on the number of tax parcels, including homes, businesses, and vacant parcels, 216 nodes (water users) were plotted.

In addition to the 216 established nodes, the water source for the system, the raw water-metering chamber, the connection from the siphon house to the raw water valve house, raw water storage tank, clearwell, and finished water storage tank were plotted. The dimensions of the finished water storage tank, raw water storage tank, and treatment system building were entered into the model to simulate the proposed conditions for each of the tanks and clearwell. The elevations entered into the program for each of the model components were obtained from the same maps used to determine the elevations (in feet above mean sea level [AMSL]) of the nodes.

Pipe lengths between the siphon house, raw water tank, treatment plant, and finished tank were calculated and entered into the model. Pipe lengths throughout the distribution system were automatically calculated by WaterCad as the nodes were plotted. To account for the depth of cover over the pipe (provided for frost protection), an elevation value (measured in feet above AMSL) of 4 feet less than the top of grade was entered for each node. Since the addition of 4 feet between the top of the tank and the bottom of the pipe can provide about an additional 2 pounds of pressure, the depth of cover was accounted for to obtain a more hydraulically accurate model.

The sizes and configurations of the raw water tank, clearwell, and finished water storage tank were entered into the model. The required volume of the raw water tank is 340,000 gallons. This ground-level tank will be 46 feet in diameter. In order to provide operating pressure to the water treatment plant without the use of pumps, 120,000 gallons, or 10 feet of head, is added resulting in an approximate tank height of 38 feet. This has been increased to 40 feet to meet manufacturers' availability. Therefore, the raw water tank will have a total drinking water operating volume of 48,200 cubic feet (ft^3) (360,500 gallons) with a 1-foot top-of-tank clearance (39 feet of actual water height). The raw water tank will be modeled at this volume and height.

The clearwell requires an operating volume of 2,000 ft^3. The clearwell acts as the injection point for chlorine. A set-point chlorine level of 2.50 mg/L was established here, along with an initial chlorine level of 0.05 mg/L at each node. Because of this initial chlorine level, the model acts as if some residual chlorine was present in the system before the model started. When the model is run, the resulting chlorine residuals can be determined at each node throughout the system. The American Water Works Association (AWWA) requires that chlorine residual (any concentration above 0.0 mg/L) be maintained throughout the system (AWWA and ASCE 1998). Therefore, for acceptance, each model analysis required chlorine residual to be present at each node.

The finished water storage tank has a design volume of 40,107 ft^3 (300,000 gallons). The tank will be a 43-foot diameter cylindrical storage tank based on manufacturers' availability. In order to meet pressure requirements throughout the system, the particular tank characteristics result in a tank height of 151 feet. Drinking water operating elevation ranges of the tank will be approximately 441 feet and 459 feet. The maximum tank elevation will be 463 feet, which allows for 4 feet of headspace.

Raw water flow from the siphon house to the raw water tank will be provided by the current water pressure of 115 psi (equivalent to 266 feet of head) in the aqueduct system. The siphon house ground elevation is 215 feet. In order to simulate the hydraulic grade line (HGL) available at the siphon house of 266 feet, the siphon house elevation was set at 481 feet (266 feet of equivalent head and 215 feet actual elevation).

A metering chamber will be located after the siphon house and will contain a venturi meter and backflow prevention device. This will be added to the model as a backflow valve with appropriate headloss.

Prior to the raw water tank, a raw water valve house will contain a pressure-reducing valve (PRV) installed to reduce the pressure from the siphon house to meet the pressure required to adequately fill the raw water tank. The PRV is set at 16.88 psi, which limits the hydraulic grade to 359 feet (i.e., the maximum elevation of the raw water storage tank) when taking into account the elevation of the PRV.

Two flow control valves (FCVs) installed in parallel were modeled between the raw water storage tank and the clearwell. The FCVs were included to regulate the flow from the raw water storage tank to the clearwell and simulate the operating capacity of the treatment system (175 gpm). The output of each FCV was set at 170 gpm, 5 gpm lower than the treatment system capacity, to allow the model to simulate the system under a condition slightly lower than the actual capacity. This was done to obtain information regarding the system's ability to fill the tanks within the required time period under a worst-case scenario of empty tanks.

A pump was modeled between the clearwell and finished water tank. The pump was set with an initial discharge rate of 175 gpm to simulate the operating capacity of the treatment system. Various pump rates were analyzed to determine the impacts on tank levels and chlorine (see Scenario 1 below).

Two fill line configurations were modeled for the finished water storage tank. In the first configuration, the tank is bypassed by a line that first satisfies the demand for water in the distribution system. After and/or while the demand is met, any excess water is used to fill the tank. After the tank has been filled, demand is supplied from the tank, allowing the treatment system to be interrupted until demand exceeds the supply available from the finished storage tank.

In the second configuration, water is pumped through the finished storage tank and then to the distribution system. This alternative also satisfies the demand for water, as water is supplied from the tank to meet the demand. However, unlike the first analysis, water must first pass through the tank before supplying the demand. Excess water not needed to meet the demand is used to fill the tank until the tank is full. This option allows fresh, treated water, as well as the chlorine concentration, to be replenished in the tank until the tank is completely full. Operation of the treatment system is then interrupted while water is supplied from the full finished water storage tank.

Model Evaluation

The model can be run in either a steady-state or extended-period mode. The steady-state mode is a one-time run of the system and provides information regarding the operating behavior of the system under static conditions. Pressures, velocities, and hydraulic grades can be determined quickly by this method.

A fire-flow analysis can be performed in the steady-state mode. A minimum fire-flow requirement can be entered along with minimum system pressures to determine whether the system can provide the minimum fire flow at the minimum pressure at each node (i.e., water user). This allows the modeler to verify that enough water can be supplied to fight a fire without compromising the level of service to any other customers. As required by the ISO, a minimum fire flow of 1,000 gpm at a minimum residual pressure of 20 psi has been established for the new HFWD distribution system.

The other modeling mode, extended-period simulation (EPS), allows the model to be run over a designated time period. This analysis provides information about the system at each time frame, allowing the user to observe tank levels, regulating valve operation, pressures, and flow rates in response to varying demand conditions.

In the EPS mode, a chlorine analysis can be performed along with age and trace options. Chlorine analysis calculates the chlorine decay rate based on time (bulk decay) and rate of decay associated with each section of pipe (wall decay) and can determine the residual chlorine at each node in the system at a given time. The age option provides the age of a hypothetical parcel of water (i.e., its duration within the system) at any point in time as it flows within the system based on the demand. As the parcel of water flows through the system, the time that it takes to get from Point A to Point B can be determined by the model. This feature helps determine the water's path and the resulting effect on chlorine concentration over time. The trace option provides a view of the water flow throughout the system and can identify areas where water is potentially stagnant or mixing at intersections, which can result in reduced aesthetic qualities (e.g., cloudiness or disagreeable taste and odor).

Modeled Scenarios

Scenario 1: 6-inch-diameter Pipe Used throughout the System. Using the EPS mode, the first scenario evaluated the use of 6-inch ID ductile iron (DI) pipe within the entire system, including the raw water supply line. Using this diameter pipe between the siphon house and the raw water storage tank, the finished and raw water tanks fill within 28 hours under normal demand. This meets the NYCDEP requirement to be able to store a five-day water supply within 48 hours and provides a margin of approximately 40%.

A steady-state analysis indicated a low pressure of 48 psi near the corner of Mountain View Acres (a private road) and Mohonk Road and a high pressure of 137 psi at the end of Bruceville Road when the water elevation in the finished water storage tank is 441 feet. (For the model, this is the minimum elevation the water will reach in the tank, as the pump control is set to refill the tank when the water level drops to an elevation of 441 feet.) These pressures meet the minimum static pressure of 40 psi required by Ten States' Standards (Great Lakes 2003). When the finished water storage tank is full, the steady-state analysis indicated a low pressure of 53 psi near the corner of Mountain View Acres (a private road) and Mohonk Road and a high pressure of 146 psi at the end of Bruceville Road.

A fire-flow analysis indicated that 6-inch ID line in the distribution system would be unable to provide the required fire flow. The analysis indicated a low flow of 625 gpm, and many nodes were unable to obtain the required flow of 1,000 gpm. Most of the nodes capable of 1,000 gpm were located north of Route 213 at the lowest elevations relative to the treatment system.

Since 6-inch ID pipe within the distribution system would be unable provide the required fire flow, it was unnecessary to analyze the entire system using 6-inch ID pipe. However, the 6-inch ID raw water line was not eliminated at this time.

Scenario 2: 8-inch-diameter Pipe Used throughout the System. Using the EPS mode, this scenario evaluated the use of 8-inch ID DI pipe throughout the entire system. With a raw water supply line of this diameter, the finished and raw water tanks can be filled within 28 hours. This also meets the NYCDEP requirement to be able to store a five-day supply within two days. Therefore, use of this pipe remains an option.

A steady-state analysis provided results similar to those under Scenario 1, with a low pressure of 41 psi near the corner of Mountain View Acres (a private road) and Mohonk Road, and a high pressure of 132 psi at the end of Bruceville Road when the water level in the finished water storage tank is at its lowest water elevation of 429 feet. These pressures also meet the minimum static pressure requirement of 40 psi established by Ten States' Standards (Great Lakes 2003).

A fire-flow analysis also was run, and the 8-inch ID line in the distribution system was able to provide the required fire flow. The node with the lowest yield had a flow of 1,047 gpm, which surpasses the ISO requirement of at least 1,000 gpm.

Scenario 3: A 6-inch ID Raw Water Supply Line and an 8-inch ID Pipe in the Distribution System. The results of Scenario 1 (the use of 6-inch ID pipe throughout the system) indicated that the raw water supply line was able to fill the finished and raw water storage tanks within the time required by NYCDEP. Therefore, to minimize material costs, Scenario 3 evaluated the use of a 6-inch ID raw water supply line along with the use of 8-inch ID pipe in the distribution system. The results of this scenario indicated that the finished and raw water storage tanks filled within 28 hours, and the fire-flow analysis indicated that the minimum required flow of 1,000 gpm at each node can be achieved.

Scenario 4: A 6-inch ID Raw Water Supply Line and 6- and 8-inch ID Pipes in a Modified Distribution System. To further reduce material costs, a scenario was developed to analyze the effects of different pipe sizes at various locations throughout the distribution system. The goal was to utilize 6-inch ID pipe in place of 8-inch ID pipe where possible and still provide the required fire flows. Based on the results of this scenario, locations were identified where 6-inch ID pipe could be used in place of 8-inch ID pipe.

Based on the results of this scenario, pipe size was increased from 6 inches to 8 inches south of the MRIP along Mountain View Acres (a private road), down Mohonk Road, and to the top of School Hill Road. This combination of pipe diameters also provides sufficient tank fill times (29 hours). A list of pipes and their sizes is included at the end of this memo.

With the initial chlorine settings as discussed above, after running this scenario in EPS mode over a time period of 30 days, chlorine residual was maintained at each user node throughout the system, thereby meeting the AWWA requirement for a chlorine residual (i.e., any concentration above 0.0 mg/L). Nodes at the dead ends (at the east end of Route 213 and south end of Canal Road), chlorine residual drops to zero after approximately 200 hours indicating that a flushing program will be required to maintain chlorine residual throughout the system at all times. Since this is the scenario that will be considered, the chlorine residual was determined only for this scenario.

This scenario was ultimately designed to provide information regarding the minimum number of pipe sections that needed to be increased to 8 inches in order to meet minimum fire flow requirements. In addition to the sections mentioned above, pipe segments to the end of Bruceville Road, School Hill Road, and the south end of Canal Road were increased to 8 inches to provide for future flows outside the proposed water district. This provision was requested by USACE to facilitate potential expansion of the water district or provision of water services to surrounding communities.

The results of the above scenarios indicate that, under a normal, steady demand, a combination of 6- and 8-inch ID pipes will provide the required pressures, fire flows, and chlorine residuals at the lowest material cost. Therefore, further analysis regarding diurnal demand will be limited to this combination of pipe sizes.

Diurnal Demand Analysis

Using a combination of 6- and 8-inch ID pipes, normal, steady demands can be met while providing appropriate pressures and chlorine residuals. However, further analysis was required to determine whether pressures and residuals could still be supplied during diurnal demand periods. The diurnal demand pattern is the typical usage pattern during the day. Typically, a community's water usage varies throughout the day. Water usage is typically low at night during periods of low activity and increases during the early morning hours as activities involving water use increase. Usage typically decreases during the middle of the day and then increases during the evening, when people return home. However, there are different demand considerations for residential and commercial usage. Commercial usage typically starts mid-morning and peaks during the middle of the afternoon and drops early evening. The average daily demand of 85,000 gpd remains constant; only the rate of distribution over the day varies.

Diurnal demand analysis is used to determine the effects of diurnal demand on water and chlorine levels in the finished water storage tank, chlorine residuals at the nodes, and pressures throughout the system as low flow occurs throughout the night and as flow then gradually peaks during the day. This pattern was simulated over a one-month period. The analysis was begun assuming a finished water storage tank level of 15 feet (approximately half full) and a chlorine residual of 0.05 mg/L at all nodes. The results of this scenario indicate that after the first 24-hour period, the lowest chlorine residual at any node in the system is 0.01 mg/L, and the lowest pressure at any node is 55 psi. These pressures and residuals do not occur at all nodes; these are the low values within the system and do not necessarily occur at more than one node.

At half full, after the first 24 hours, the finished water storage tank has reached full capacity and begins to drain, and the distribution system is supplied directly from the finished water storage tank. At this point, the chlorine levels decrease as decay occurs within the finished water storage tank. Water is supplied from the finished water storage tank until 79 hours, at which time the tank begins to fill again. At 79 hours, the lowest chlorine residual at any node in the system was 0.007 mg/L, and the lowest pressure at any node in the system was 48 psi, thereby meeting both the low pressure and chlorine residual requirements. After 79 hours, the finished water storage tank refills, resulting in higher pressure and refreshed chlorine levels.

Conclusion

As indicated above, a combination of 6- and 8-inch ID pipes will provide the required pressures, fire flows, and chlorine residuals at the lowest material cost. In addition, the results of the diurnal demand analysis for this scenario indicate that adequate chlorine residuals are maintained at all nodes except the two dead ends, where the residuals approach 0.0 mg/L at approximately 200 hours. The two dead ends will require a flushing program to maintain safe chlorine levels. This program will be developed during the operational phase when actual chlorine levels can be measured. The HFWD will then need to maintain this program as part of their normal operation of the system.

Conclusion

[illegible] method [illegible] [illegible] [illegible] used [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] program [illegible] [illegible] [illegible] [illegible] program [illegible] their [illegible] of the program.

6 Alternative Plans

Alternatives

As a result of the RI, specific alternatives were developed to provide a permanent, safe water supply for all the private well owners impacted or threatened by contamination from the site. Alternative means to supply potable water to the HFWD included either maintaining the current point-of-use (POU) GAC treatment technology at each private well or creating a new water supply distribution system supplied with water from a reliable, uncontaminated source. All alternatives were described and evaluated in the FS for the Mohonk Superfund Site (LMS 1999).

Three alternatives were selected from the FS and considered in the ROD (2000). The first alternative included the installation of GAC systems for all the private well owners in the HFWD in addition to wells currently on GAC filtration systems (approximately 85 more systems for a total of approximately 155 systems). Operation and maintenance (O&M) of GAC filters would last for at least 30 years, or until the groundwater contamination levels have sufficiently decreased. The second alternative included the use of the Catskill Aqueduct as a new potable water supply source and the establishment of a water distribution system in the HFWD. The individual GAC filtration systems currently in use would be operated until the new public water supply system became operational and all water users were connected to the system. The third alternative included the installation of a well field to service the HFWD on a full-time basis and the establishment of a water distribution system. The individual GAC filtration systems currently in use would be operated until the new public water supply system became operational and all water users were connected to the system. The HFWD would be created to include residences whose private wells may be impacted by drawdown associated with the actively pumping well field.

A detailed comparative evaluation of the three alternatives was performed in the FS. A summary of that comparative analysis is presented in Table 6-1. Each alternative was assessed with regard to the following eight criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; cost; and state and community acceptance.

Table 6-1 Summary of the Comparative Evaluation of the Three Alternatives to Supply Potable Water to the High Falls Water District

Evaluation Criteria	GAC Filtration Systems	Catskill Aqueduct the Primary Water Supply	Public Well Fields as the Primary Water Supply
Protection of Human Health/Environment		√	√
Compliance with ARARs	√	√	√
Long-term Effectiveness		√	
Reduction of Toxicity		√	√
Short-term Effectiveness	√	√	√
Implementability	√	√	√
State and Community Acceptance		√	

Key: √ = Indicates that the alternative is effective in meeting the evaluation criteria.

All alternatives are technically feasible. The first alternative would require the installation and continued maintenance of at least 155 GAC filters, with the possibility of additional GAC filters being installed in the future. The second and third alternatives would require the construction of a water treatment plant, treated water storage tower, and a water distribution system. In addition, the second alternative would require a water usage agreement between the HFWD and NYCDEP. A draft Water Supply Agreement between the New York City Water Board and the HFWD was submitted to the USEPA in June 2001.

The capital costs, O&M costs, and present worth costs associated with each of the alternative water supply alternatives were estimated by NYSDEC for the FS and updated in the ROD. These cost estimates are presented in Table 6-2. Present worth costs were calculated over a 30-year period using 5 percent as the discount rate. It is important to note that these cost estimates were performed for the FS and are order-of-magnitude engineering cost estimates. An updated order-of-magnitude engineering cost estimate for the selected alternative is presented in Section 13.

Table 6-2 Initial Order-of-Magnitude Cost Estimates Performed in the FS and Updated in the ROD

Alternative Water Supply Alternative	Capital Costs	Annual O&M	Present Worth
GAC Filters (with 30 years O&M)	$406,000	$348,000	$5,749,000
Catskill Aqueduct	$8,342,000	$76,000	$9,510,000
Well Field	$7,662,000	$88,000	$9,015,000

Selection of the Catskill Aqueduct as the Public Water Supply

After a detailed evaluation of each alternative, the USEPA, with concurrence from NYSDEC, selected the construction of a public water supply system using the Catskill Aqueduct as the primary water source to provide potable water to the residences and businesses with impacted or threatened private water supply wells. The individual GAC filtration systems currently in use will be operated until the new public water supply system is operational. The USEPA and NYSDEC believe that selection of the Catskill Aqueduct as a public water supply will be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions to the maximum extent practicable. Community acceptance of the proposed remedy was assessed during the public comment period. The USEPA believes that the community generally supports this approach, and specific public responses are documented in the ROD (2000).

7 Sources of Water Supply

Catskill Aqueduct as the Primary Water Supply

The USEPA, with concurrence from NYSDEC, selected the construction of a public water supply system using the Catskill Aqueduct in the New York City water supply system as the primary water source to provide potable water to the residences and businesses with impacted or threatened private supply wells. The individual GAC filtration systems currently in use will be operated until the new public water supply system is operational. The USEPA and NYSDEC believe that the selected remedy of the Catskill Aqueduct as a public water supply will be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions to the maximum extent practicable. Community acceptance of the proposed remedy was assessed during the public comment period. USEPA believes that the community generally supports this approach.

Under the 1905 New York City Water Supply Act, New York City is required to provide water to other counties based on the following assumptions: (1) the city provides water to municipalities within the counties where its facilities are located; (2) the City provides water to municipalities at the price it costs the city to deliver water to that point, excluding costs associated with construction, operational expenses, maintenance, and additional charges related to distribution and delivery of the water with New York City; and (3) the City provides water up to the average annual per capita usage of New York City. Therefore, the aqueduct could be used by the High Falls community as a source of raw water.

The New York City water supply system provides approximately 1.2 billion gallons of potable water daily to nearly 8 million residents of New York City and approximately 1 million residents living in Westchester, Putnam, Ulster, and Orange counties. The water is supplied from a network of 19 reservoirs and three controlled lakes in a 1,972-square-mile watershed that extends 125 miles north of New York City (see Figure 7-1). Approximately 90% of that water comes from the Catskill/Delaware System located in Delaware, Greene, Schoharie, Sullivan, and Ulster counties (NYCDEP 2003). The entire water works system is owned by the city of New York and operated by NYCDEP.

Water from the Ashokan Reservoir generally flows through the aqueduct by gravity. However, as the aqueduct nears High Falls, the water draws into an inverted siphon approximately 500 feet underground to pass under Rondout Creek. The water supply connection to the Catskill Aqueduct is at the siphon house (see Figure 1-3). At this point the water in the Aqueduct is under approximately 115 psi pressure, which is sufficient to discharge the water to the raw-water storage tank without additional pumping.

The NYCDEP has been receptive to servicing the HFWD by supplying raw-water from the Catskill Aqueduct. A draft Water Supply Agreement between the New York City Water Board and the HFWD was submitted to the USEPA in June 2001.

Water from the aqueduct will require treatment under the Federal Surface Water Treatment Rule (SWTR) (40 CFR 2000), the requirements being defined by NYSDOH and UCHD. Raw water will require treatment to remove conventional contaminants such as particulates and microbes, and to control color, odor, and taste. In addition, the riser pipe that the High Falls system is connected to is lead-lined. Treatment for lead will be required. A conventional treatment scheme for a surface water supply, such as the aqueduct water, includes coagulation, flocculation, sedimentation, and filtration. A primary oxidant or disinfectant (e.g., chlorine) is used to control bacteria, algal growth, taste, and odor. After filtration, disinfectant is added to lower the microbe content in the distribution system. A similar treatment scheme is currently being used by the village of New Paltz to treat its water supply, part of which comes from the Catskill Aqueduct.

Hydrological Data

The capacity of the Catskill Aqueduct from the Ashokan Reservoir to the Kensico Reservoir is about 610 million gallons per day (NYCDEP 2000). The maximum daily quantity of New York City water that the HFWD would be allowed to withdraw from its connection is calculated "by multiplying the number of inhabitants within the boundaries of each [district] by the daily per capita consumption of water within the City as measured by the [NYC]DEP (Allowance Quantities)" as stated in the Draft Water Supply Agreement between the New York City Water Board and the HFWD (NYCDEP 2001). Under the 1905 New York City Water Supply Act, New York City is permitted to provide water to municipalities within counties where its facilities are located up to the average annual per capita usage of New York City. Since 1979, New York City's usage varied between approximately 136 to 208 gpcd. The average per capita water usage in the last 10 years was 165 gpcd. For this project, 160 gpcd was used for design of this system.

Safe Yield

Upon signing the Final Water Supply Agreement (NYCDEP 2001), NYCDEP will have determined that the HFWD has a consistent and safe water yield from the New York City water supply system.

L:\buffalo\mohonk\maps\figure_8-1_nycwater.mxd GIS

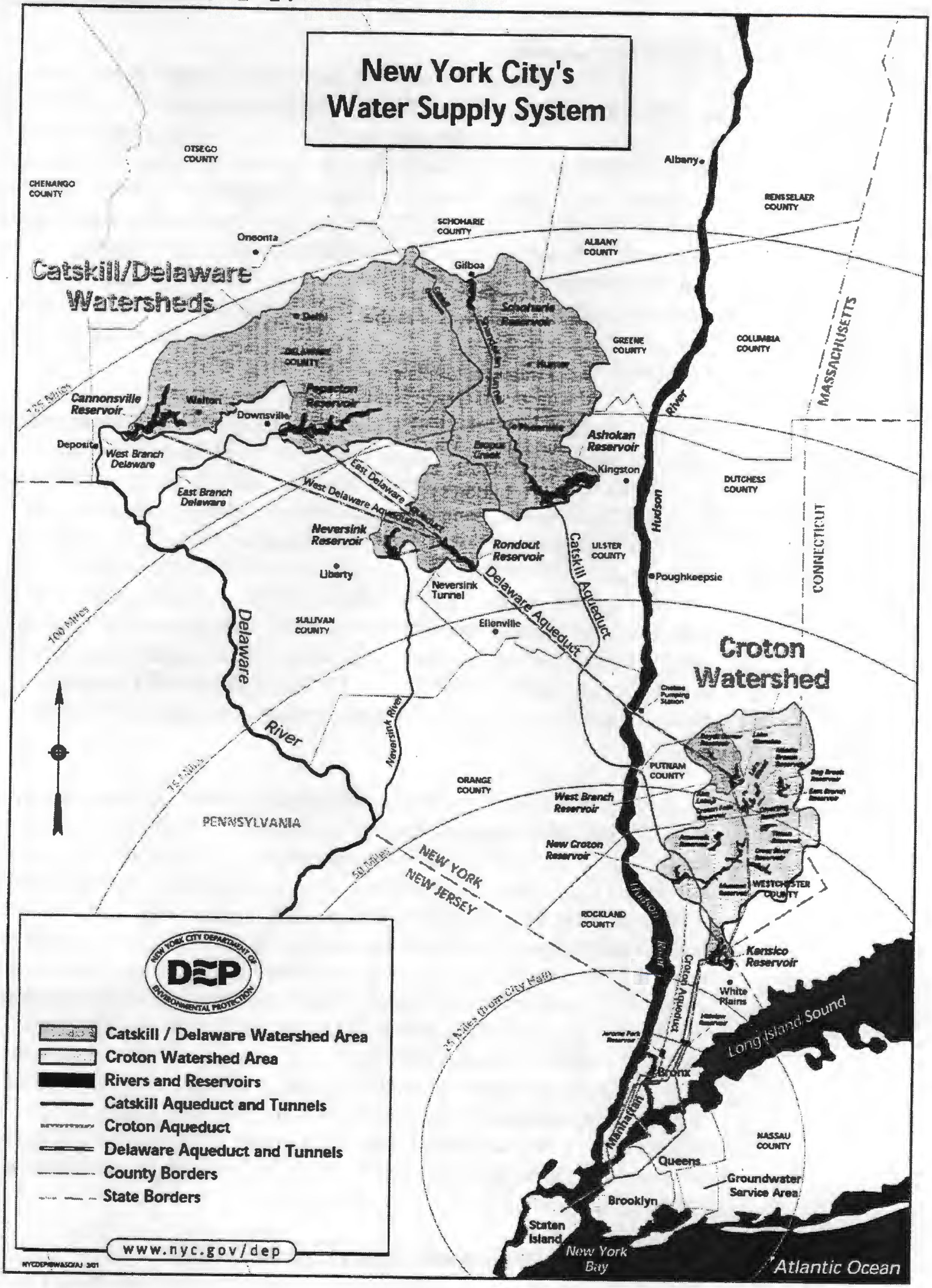


FIGURE 7-1
NEW YORK CITY'S WATER SYSTEM

Raw Water Quality

The NYCDEP monitors the quality of water in the aqueducts and in the upstate reservoirs and feeder streams. The NYCDEP conducts analyses for a broad spectrum of microbiological, chemical, and physical measures of quality and is responsible for water quality throughout the entire system, including the Catskill Aqueduct. According to the *New York City 2003 Drinking Water Supply and Quantity Report* (NYCDEP 2003), the quality of the drinking water remains high and meets all health-related state and federal drinking water standards. In 2003, as part of the routine sampling program developed by NYCDEP, 141 samples were collected from the Kensico Reservoir and analyzed for Giardia and Cryptosporidium oocysts. Of the 141 samples, 109 were positive for Giardia and 41 were positive for Cryptosporidium (NYCDEP 2003).

The quality of the raw water from the Catskill Aqueduct raw water often varies seasonally and can be more turbid with higher suspended solids content during summer months. Results of turbidity samples taken from the Ashokan Reservoir showing the minimum, maximum and average turbidity over a two year period (2000 to 2002) showed a maximum daily turbidity value of 36 nephelometric turbidity units (NTUs) with a daily average of 5 NTU. The manufacturer of the treatment system selected for the HFWD, USFilter Microfloc Systems (see description in Section 8), states that the selected package unit will respond automatically to turbidity spikes by increasing chemical feed and decreasing the time between clarifier flushes. New Paltz WTP, the High Falls WTP approved pilot plant, has not had problems with high turbidity (see Appendix E for the pilot study).

As the New Paltz WTP operates a similar package unit from the same manufacture, USFilter Microfloc Systems, with the same raw water source, Catskill Aqueduct, the New Paltz WTP has been approved as the High Falls WTP's pilot study (Appendix E). However, the connection to the aqueduct at the NYCDEP siphon house will be at the lead-lined riser pipe, resulting in varied total and dissolved lead concentrations in the raw water supply. In 2003, EEEPC sampled and analyzed the raw water from the lead-lined riser pipe mimicking anticipated WTP operation procedures. USFilter performed a raw water analysis and treatability bench scale testing on the raw water samples taken. Through the bench scale studies, USFilter determined that the selected treatment system can manage the anticipated concentrations of total and dissolved lead in the raw water under varying operating conditions. The raw water sampling plan, analytical results, testing reports and bench scale study results are attached in Appendix E. The NYSDOH has agreed to allow the High Falls WTP to demonstrate the effectiveness of lead removal during the WTP start-up period.

Source Water Protection Issues and Measures

To ensure high-quality water for today and in the future, New York City has developed a comprehensive long-range watershed protection program. Signed in January 1997, the Watershed Memorandum of Agreement unites the upstate watershed communities, New York City, New York State, the USEPA and environmentalists in support of an enhanced watershed protection program for the New York City water supply. The program incorporates a multifaceted strategy to protect and improve water quality. These efforts focus on three key programs: the acquisition of watershed lands; the enforcement of strengthened watershed regulations; and the expansion of partnership programs that target specific sources of pollution in the watershed.

Organizations and programs working for the protection of the New York City watershed are directed and funded by NYCDEP. Towns within the watershed, such as Marbletown and Rosendale, can work with NYCDEP and the Catskill Watershed Corporation (CWC) to implement source water protection measures.

Emergency Water Supply

The emergency source of water at the treatment plant will be the on-site groundwater treatment system discharge. The system is currently treating extracted water to Coxing Kill. Under certain circumstances, the NYCDEP aqueduct will not be available as a raw water source for extended periods. If the groundwater treatment system is needed, the capacity of the system will be evaluated to determine if additional extraction wells would need to be installed to provide the capacity to serve the High Falls area.

The USEPA, NYSDEC, NYSDOH, and the UCHD have agreed that a plan for an auxiliary or emergency backup supply will be developed should the NYCDEP Aqueduct source ever become unavailable for a relatively long-term duration of up to six months. Treated groundwater from the existing Groundwater Treatment System (GWTS) will be used as the emergency water supply. Prior to invoking the emergency supply, full Part 5 analysis will be required to demonstrate the water meets state and federal Standards.

[illegible] New York [illegible], the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] specific sources [illegible]

[illegible] of the New York City's [illegible] [illegible] [illegible] [illegible] [illegible] measures.

[illegible]

The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] New York [illegible]

The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

8 Treatment System

Pursuant to the SWTR (40 CFR Parts 141 and 142), raw water from the Catskill Aqueduct would require treatment to remove conventional contaminants such as particulates and microbes, and to control color, taste, and odor. A treatment system for a surface water supply such as the aqueduct water typically includes coagulation, flocculation, sedimentation, and filtration. After filtration, a disinfectant will be added to inactivate bacteria and other microbes and to control algae growth in the distribution system. A similar treatment system is currently used by the village of New Paltz to treat its water supply, the primary source of which is the Catskill Aqueduct. The New Paltz WTP was used as a pilot study in the design of the High Falls WTP, since High Falls will use a similar package unit and both use the aqueduct as their primary water supply.

The New Paltz WTP treats water by coagulation, up-flow adsorption filtration (clarification), mixed media filtration, and chlorination. The New Paltz system, a "package" system supplied by USFilter Microfloc Systems, was placed in operation in 1990. The High Falls WTP is designed to utilize the same USFilter Microfloc system, specifically the TR-105A USFilter Microfloc Trident packaged water treatment system.

Title 10, Part 5, of the New York State Health Rules and Regulations (NYCRR 2001) provides guidance on MCLs for drinking water supplies. Tables 1 through 7 of this Subpart lists the MCLs. (Copies of these tables are provided in the Appendix E.) This list of contaminants was confirmed with both the Ulster County Health Department and the NYSDOH to verify these as the only parameters and limits imposed on the High Falls WTP (UCHD 2001; NYSDOH 2001). In addition, NYSDOH stated that more-stringent limits would be imposed in the future for trihalo-methanes, halo-acetic acids, and arsenic (NYSDOH 2001).

A review of the Annual Drinking Water Quality Report for 2000 from the Village of New Paltz (Village of New Paltz 2001) indicates that water from the New Paltz WTP is meeting all standards set forth by Part 1.72 of the State Sanitary Code (NYCRR 2001). Water was tested for total coliform, turbidity, inorganic compounds, nitrate, nitrite, lead and copper, volatile organic compounds, total trihalomethanes (THMs), and synthetic organic compounds. Contaminants detected in the drinking water in 2000 were total coliform, barium, nitrate, lead, and THMs.

No other contaminants were detected, and of the detected parameters none were detected at levels above state MCLs or action levels.

High Falls Water District Pilot Study

EEEPC, with the approval of NYSDOH, used the New Paltz WTP as a pilot study for the use of the Trident treatment process, since both plants are of similar design and will require the same amount of treatment to meet water quality standards. A copy of the High Falls WTP pilot study report is presented in Appendix E. Based upon the findings of this report and the successful operation of the New Paltz WTP since 1990, it is expected that utilizing this same technology for the proposed High Falls WTP will be equally successful.

However, the NYSDOH has requested that the lead removal capability of the completed system, as described in Section 7, be verified. Therefore, during commissioning of the system, the treated water will be tested for lead in addition to other required parameters.

Treatment System Components

The criterion for sizing the High Falls WTP is the maximum daily flow, which has been calculated to be 170,000 gpd, or 118 gpm. The technology utilized at the New Paltz WTP is designed for a loading of 10 gpm/ft^2 at the adsorption clarifier and 5 gpm/ft^2 through the mixed media filter. The High Falls WTP is designed based on these parameters to ensure similar performance.

In accordance with NYSDOH and Ten States' Standard requirements, the design flow of a system is deemed to be the capacity of the treatment units with one filter out of service. Therefore, the equipment that will be used will allow for a second treatment train to accommodate this requirement. The High Falls WTP will consist of two TR-105A USFilter/Microfloc Trident packaged water treatment systems consisting of two 175-gpm adsorption clarifier/mixed media filter tanks, two influent flow-control loops, six chemical feed systems (with backup) with automatic controls, chemical monitoring at three points in the treatment train, and two air blowers (for flush and backwash). The automatic controls, chemical feed packages, and air blowers are shared between all filters. Process and control diagrams of the treatment system are shown on the design drawings.

Chemical Feed Systems

The USFilter Trident system includes equipment for the addition of caustic for pH adjustment, polyaluminum chloride (PAC) for coagulation, two different polymers, orthophosphate for corrosion control, and sodium hypochlorite for disinfection. It is anticipated that the polymer addition processes will not be used regularly, as the New Paltz WTP does not currently add polymer or orthophosphate to their raw water. Nonetheless, the polymer and orthophosphate addition processes will be provided in the High Falls WTP so they are available if needed. Chemicals will be delivered at the desired concentrations, precluding the need for mixing equipment. Positive displacement diaphragm-metering pumps will be used for chemical addition.

Tanks. The Trident system is constructed of welded steel tanks measuring 10 feet 1 inch long by 6 feet 11 inches wide by 8 feet 5 inches high. Each tank consists of two compartments, the clarifier and filter sections.

Adsorption Clarifier. The adsorption clarifier is an upflow process. It uses one-third of the total tank area (17.5 ft^2). The clarification media consists of irregularly shaped particles of chemically inert material and is placed in a bed approximately 4 feet deep. The clarifier media is suspended in the treatment tank under a media retention screen. As the raw water passes up through the media, solids are captured in the spaces between the media.

Mixed-media Filter. The mixed-media filter bed is made up of a progressively finer media, from coarse to fine in the direction of filtration, allowing true depth filtration, high solids storage, high flow rates, and high quality effluent. The media consists of 18 inches of anthracite coal, 9 inches of silica, and 3 inches of high-density sand for 35 ft^2 of area per tank.

Flow and Level Controls. The treatment system is designed to operate when the water level in the finished water tank drops below a set point. A pressure sensor will monitor the water level in the tank. When the level drops below the desired set point, the WTP control panel will start the treatment system. This will open the influent valve to allow water from the raw-water tank through the treatment system. When the water level in the finished water storage rises to the full level, the sensor will signal the WTP control panel to close the influent valve and stop the treatment process.

The system is designed to operate at a constant flow rate by means of two control loops. One loop will maintain a desired flow at the influent, the other will control the effluent valve to maintain proper water level in the filters. The influent control loop consists of an orifice plate with differential pressure monitor, electrically operated butterfly valve, and operator interface to set the desired influent flow set point. The effluent flow control loop consists of a level sensor in the filter tank and an electrically controlled butterfly valve on the discharge pipe.

Valves. The flow control valves used in the Trident system are wafer-type butterfly valves with electric-operated actuators. All backwash and discharge valves are equipped with speed controls to prevent rapid opening and closing of the valves.

Instrumentation and Controls. Trident systems use a Programmable Logic Controller- (PLC) based programmable controller for control functions. This controller is designed to maintain a constant flow rate through the system, initiate and control backwash and flush operations, and annunciate alarm conditions.

The chemistry of the water treatment process is controlled by a Microfloc Aquaritrol III system, incorporated into the PLC system. This microprocessor-based coagulant control system continuously optimizes the process of chemical addition based on raw-water quality analysis. See Section 9 for further details on the process instrumentation and controls.

Treatment Process

Raw water will be withdrawn from the Catskill Aqueduct at the High Falls siphon house located on Canal Road, as discussed in Section 7. The purpose of the siphon house is to allow access to a riser pipe on the inverted siphon beneath Rondout Creek.

The tie-in point for the raw water will be on the riser blow-off line to Rondout Creek. Three existing gate valves will be replaced with wafer-type butterfly valves and a new outlet will be installed in order to divert water to the High Falls WTP. A totalizing flow meter will be installed in an adjacent pay meter pit to allow NYCDEP personnel to determine water use by the HFWD. This chamber will also contain a rate of flow control valve for NYCDEP use to control the maximum rate of flow of water taken from the aqueduct.

A 6-inch diameter DI pipe will deliver water from the siphon house to the WTP site. Separate storage tanks will be constructed on the WTP site for raw water and finished water. A raw water valve house will be constructed upstream of the raw water storage tank to house an air/vacuum relief valve, two backflow prevention devices (BPDs) installed in parallel, and a throttling butterfly valve. The main purpose of the Raw Water Valve House is to control when and how much raw water is sent from the tie-in at the NYCDEP Siphon House to the raw water storage tank. A level sensor mounted in the raw water tank will monitor the water level in the tank, sending a signal to the PLC to determine when to water from the aqueduct. A butterfly valve will be actuated by the PLC system to open at a predetermined setting, filling the raw water tank. A separate room attached to the Raw Water Valve House will be dedicated to chlorine storage and pumps to chlorinate the raw water, if needed.

The two tanks will store a combined six days of average daily demand and the required fireflow. Because of this available storage volume, water will be treated on an as-needed basis by the automatic controls described in Section 9. The treatment process generally consists of chemical addition, filtration and disinfection by chlorine addition.

Chemical Addition. The chemicals that will be used at the High Falls WTP include sodium hypochlorite (NaOCl) for disinfection, PAC for flocculation, caustic for pH adjustment, two different polymers to augment flocculation, if needed, and orthophosphate for corrosion control, if necessary. The chemicals will be added during the treatment process by individual metering pumps. All chemical feed pumps will be controlled by the Aquaritrol III system, based on readings in the influent water.

Chemical injection will be completed by diaphragm pumps located adjacent to the storage drums. The pumps will draw chemical from day tanks, which will be filled manually by the operator. The feed pumps will start and stop based on signals from the main control panel.

Chemical Delivery, Handling and Storage. Chemicals required for the treatment process will be delivered as follows (chlorine is discussed in greater detail later in this section):

- **PAC.** The WTP will use approximately 1 to 3 gallons of PAC per day. Therefore, to meet the Ten States' Standards requirement of a minimum 30 days of chemical storage, the plant must have storage for at least 90 gallons of PAC on site. This will be accomplished by storage for two 55-gallon drums of PAC on site. One drum will be used as the primary source of PAC, while the other drum will be the backup. When the first drum is depleted, the second drum will be used and an order placed for a replacement drum. At the estimated usage rate of 3 gallons per day, it is expected that one drum will be delivered every two weeks.

- **Caustic.** The WTP will use approximately 0.3 gallon of caustic per day. Therefore, the minimum 30-day storage volume is 9 gallons. Since the shelf life of caustic is at least one year (Environmental Consultants 2002), it will be feasible to store a 55-gallon drum of caustic on site. At the expected usage rate, the drum will last approximately six months, at which time a replacement drum will be delivered.

- **Polymer**. It is not anticipated that the treatment system will require the addition of polymer, since the New Paltz WTP does not use any and that plant uses the same treatment process and draws from the same raw water source. However, space in the chemical storage and feed room will be allocated for the storage of two 55-gallon drums of polymer. Injection points for polymer will be both at the head of the treatment process and directly into the mixed media filter. It is expected that any polymer delivered to the WTP will be in containers not larger than 55 gallons, and most likely smaller.

- **Orthophosphate**. Orthophosphates are used to protect the water distribution system from corrosion. It is not anticipated that the treatment system will require the addition of orthophosphate, since the New Paltz WTP does not use any and that plant uses the same treatment process and draws from the same raw water source. However, space in the chemical storage and feed room will be allocated for the storage a 55-gallon drum of orthophosphate. The injection point for orthophosphate will be the clearwell. It is expected that orthophosphate delivered to the WTP will be in a 55-gallon barrel.

The 55-gallon drums will most likely be delivered by a "box" truck equipped with a lift gate or ramp on the back. The truck will be positioned over a spill containment pad in front of the chemical/chlorine storage room doors, and the delivery company will bring the drums into the plant on a two-wheeled dolly. When chemicals are delivered, the delivery company will also remove the empty storage containers and dispose of or reuse them.

Treatment plant personnel will then move the drums into their final position and transfer chemicals to the day tanks, as necessary. Also, personnel may have reason to move the drums around the site, since the raw water and/or finished water tanks may require the addition of hypochlorite. For these reasons, it is recommended that the treatment plant have access to a handcart made for the handling and transport of drums.

To satisfy New York State regulations (6 New York Codes, Rules, and Regulations [NYCRR] part 599), the design for the High Falls WTP includes secondary containment areas for each chemical stored on site and a chemical transfer station located outside the chemical/chlorine storage rooms. The containment system also will provide a means of monitoring leakage at the bottom of the drums. The following is a list of some of the major design points of the chemical delivery system:

- Chemical drums will be stored in the containers shipped from the supplier with the label clearly visible.
- Chemical drums will rest on fiber-reinforced plastic (FRP) grates in the chemical/chlorine feed rooms over containment sumps. One sump will be located under each chemical being stored. The sumps will be sized to contain 110% of one 55-gallon drum (61 gallons). The grates will be sized to cover an area large enough to hold two 55-gallon drums (approximately 3 feet by 6 feet). Each chemical stored will have its own containment grate and sump: three each in the chemical feed room for PAC, caustic, and polymer, and one in the chlorine feed room for sodium hypochlorite.
- The floors in the chlorine room will be sloped toward the containment sumps. The slope will be 3 inches per 10 feet (2.5%).
- The area outside of the building and immediately in front of the chemical/chlorine rooms (measuring approximately 20 feet by 15 feet) will drain to a catch basin designed to contain potential spills. This area will be sloped to the catch basin and cover the area where delivery trucks will stop to off-load the storage drums.
- A gate valve outside the containment area will control flow from the catch basin. The valve will normally be open, except when deliveries are made. Dur-

ing deliveries, the valve will be closed to contain potential spills. If no spill occurs during delivery, the valve will be returned to the open position. If a spill occurs, the catch basin will contain at least 110% of the volume of one 55-gallon drum (61 gallons).

- A safety shower/eye wash station will be located in both the chemical storage room and the chlorine storage room.

- Instructions for unloading of chemicals will be posted in a weatherproof placard.

Filtration. The system will operate at approximately 100 gpm under normal operating conditions, with a maximum flow rate of approximately 175 gpm. The influent will enter the side of the clarifier tank through a diffuser pipe located near the bottom of the tank. The diffuser pipe evenly disperses the flow into the clarifier tank. As the influent fills the clarifier tank, it flows up through a layer of adsorption clarifier media, which is held in place by a media retention screen. After the influent passes through the media layer, it overflows a trough, which directs the flow to the mixed media filter. The influent overflows the sides of the trough on the filter side of the tank and drops onto the filter. It then flows through the mixed media layers. The mixed media layers contains three layers of filter: 3 inches of garnet, 9 inches of silica sand, and 18 inches of anthracite. The influent flows through the filter and media via gravity. After the influent has been filtered, it exits the tank through the Triton Underdrain System, a proprietary system from USFilter. The Triton Underdrain System is a series of perforated header pipes partially encased in concrete on the bottom of the filter side of the tank. The filter media rests directly on the Triton Underdrain and the encasing concrete.

Finished water is then sent to the clearwell, located beneath the filter room. The clearwell will have a working volume of 25,000 gallons. A pair of vertical turbine pumps will transfer finished water in the clearwell outside to the finished water storage tank. The clearwell pumps must be capable of pumping treated water to the finished water tank at a rate at least as fast as the treatment system. Therefore, the pumps for the finished water clearwell will be designed to pump at a flow rate of 175 gpm each.

Chlorination. The High Falls WTP will use liquid NaOCl as a disinfectant. Using a sodium hypochlorite solution as the primary disinfectant and oxidizer is economical and safe and is therefore suggested for use in small WTPs (AWWA and ASCE 1998). In addition, sodium hypochlorite is the disinfectant used at the New Paltz WTP, which was approved as the pilot study for the High Falls WTP.

Surface water treatment plants are required to provide injection points at four locations (Great Lakes 2003), and EEEPC proposes the following locations:

- The raw water storage tank (prechlorination),

- In-line mixer before the filter units (intermediate chlorination),
- Immediately prior to the clearwell (post-chlorination), and
- At the outlet from the finished water storage tank, at the beginning of the distribution system (rechlorination).

Prechlorination is the addition of chlorine to the water prior to any of the other plant processes. If prechlorination is deemed necessary, it will take place in the raw water storage tank. The general purposes are to oxidize inorganics when inorganic concentrations are high and to start disinfection when turbidity levels are high (an indication of potential microbial contamination). Prechlorination is generally used when chlorine demand is higher than normal. For example, it may be beneficial to prechlorinate to oxidize inorganics such as soluble iron, manganese, and sulfides. The oxidized iron, manganese, and sulfides form insoluble compounds and will settle out in the raw water tank or be filtered out in the treatment units. However, in the presence of organics, prechlorination could lead to THM formation. Source water must be sampled for concentrations of inorganics and organics to determine whether prechlorination is appropriate.

Intermediate chlorination is the addition of chlorine at intermediate points along the treatment process train. Intermediate chlorination is required when chlorine demand is high (e.g., due to high turbidity) or to help inhibit biological growth on treatment unit components. Chlorine may be added on an intermittent, as needed, or continuous basis (continuous chlorination can cause additional disinfection by-product (DBP) formation due to increased contact time). Chlorine added before the filters help inhibit biological growth on the filter beds. At the High Falls WTP, intermediate chlorination should be performed as needed based on the results of chlorine residual tests.

Post-chlorination is the addition of sodium hypochlorite just prior to the clearwell and after filtration. Primary oxidation and disinfection will occur at this location. Sodium hypochlorite will be added here for primary disinfection and to provide the minimum 0.2 mg/L of free chlorine residual mandated by NYCRR. Post-chlorination also precludes the formation of THM, as the precursors to THM are filtered out prior to this stage of the treatment process. The capacity of the clearwell is designed to meet the C x T value required by NYCRR 10 (EEEPC 2002a).

Rechlorination will take place at the outlet from the finished water storage tank and the start of the distribution system. Rechlorination is used to maintain a free chlorine residual of 0.2 mg/L during periods of low demand. However, during normal system operation, primary disinfection at the clearwell alone is adequate to maintain free chlorine residual throughout the system (EEEPC 2002b).

The amount of chlorine required to treat water is determined by a chlorine demand test (APHA, AWWA, and WEF 1995). The chlorine demand of water to be treated can sometimes be estimated by analyzing the constituents in the water and then calculating the demand. The chlorine demand is more easily estimated if the constituents are primarily dissolved materials such as iron, manganese, and sulfides. However, if the constituents include organics, as is generally the case in surface waters, it may not be possible to accurately estimate the required dosage, and the chlorine demand of the water must be determined by either amperometric titration or the N,N-diethyl-p-phenylenediamine (DPD) test. THM formation potential should be evaluated concurrently with the demand test.

The Surface Water Treatment Rule (USEPA, 40 CFR Part 141) dictates the continuous measurement of chlorine residual in the water; however, periodic sampling may be satisfactory for small utilities. At the New Paltz WTP, chlorine residual is manually tested periodically throughout the day (Environmental Consultants 2002b).

The chlorine residual at the High Falls WTP will be monitored continuously at the filter effluents using colorimetric chemistry. The analyzers send a signal to a controller, which paces the sodium hypochlorite feeder. The most common analyzers are either amperometric or colorimetric

Chlorine Delivery, Handling and Storage. The WTP will use approximately 1.5 gallons of sodium hypochlorite per day, at a 12.5% solution. One 55-gallon drum of chlorine will be delivered each month to meet average demand and keep a 30-day volume of chlorine in storage. It is expected that up to three drums of chlorine will be kept in the chlorine feed room, one for use, one for backup, and potentially one for emergency dosage at the raw or finished water tanks.

Containers used for shipping and storage of sodium hypochlorite are composed of mainly polyethylene (PE), polyvinyl chloride (PVC), and chlorinated polyvinyl chloride (CPVC), as sodium hypochlorite is corrosive. PE tanks are commonly shipped in 5-, 15-, or 55- gallon capacities, and all such containers are equipped with pressure relief devices. Containers of sodium hypochlorite need to be stored away from heat and light (i.e., inside) to prevent decay.

All piping materials for the disinfection system should have sufficient chemical resistance and mechanical strength. Piping is generally constructed of PVC, but lined steel pipe (lined with rubber, PE, and PVC) can be used. Valves, gauges, and pressure switches also must be made of or protected by compatible materials, including PVC, CPVC, and polypropylene (PP).

The wet end of the chemical feed pumps must be made of suitable materials. Pump suction intake is above the day tank bottom to avoid feeding any sediment into the pump. Barrels delivered to the site will have a vent to prevent pressurization. In addition, a vent is required to prevent the creation of a vacuum during liquid removal and to permit exhaust during filling operations. A level sensor will be located in the barrel, detecting when the level of chlorine in the barrel is near the bottom requiring a barrel exchange.

OSHA, state, and local safety regulations require all chlorine storage and use areas to be equipped with gas detectors that are sensitive to a range of gases (in this case only chlorine gas) at maximum allowable concentrations (MACs). The recommended safety level for chlorine gas is 1 ppm/volume of room air. Gas detectors will be installed in the chlorine storage rooms in the WTP and the raw water valve house.

Facility requirements include (from Ten States' Standards):

- A minimum of two feeders shall be provided (one for standby) - At the High Falls WTP, three feeders will be required, two for primary supply and one for standby.
- When booster pumps are used, a standby pump shall be provided.
- Separate feeders shall be used for each chemical provided.
- Automatic controls, when provided, shall have a manual override.
- Feeders shall have an electric interlock with the service pump.
- Chemical feed rates shall be proportional to flow.
- Liquid chemical feeders shall have anti-siphon protection.
- Water supply feeders shall have cross-connection protection.
- Day tanks for all chemicals will be installed. Chemicals will be transferred from the storage drum to the day tank manually by the operator. Chemical feed pumps will be connected to the day tanks.
- Chemical feed equipment shall be located in rooms separate from the rest of the facility.
- Space should be provided for 30 days of chemical storage.
- Ammonia solution to neutralize chlorine leaks shall be provided.
- When a leak detector is provided, it shall have both an audible alarm and a warning light.

- Protective equipment consisting of rubber gloves, an apron, or similar clothing; goggles or face mask; a deluge shower; and an eye-washing device shall be provided.

- Sodium hypochlorite storage rooms shall be enclosed and separate from other rooms, and be provided with a shatterproof inspection window, doors that have external exits only, and doors equipped with panic hardware.

- Sodium hypochlorite rooms shall have ventilating fans with a capacity of one complete air change per minute, air inlets shall include louvers near the floor, and air discharge shall be above grade, not near walkways, doors or fresh-air intakes.

- Sodium hypochlorite rooms shall be heated to 60° Fahrenheit.

- Sodium hypochlorite rooms shall not be below grade.

- All local, county, and state fire codes must be adhered to when designing chlorination systems and storage.

Backwash Process. The purpose of the backwash operation is to purge the clarifier and mixed media of particles that have accumulated during normal operation. Backwashing consists of two different cycles, "clarifier flush," which flushes only the adsorption clarifier media with raw, untreated water; and "filter backwash," which flushes the mixed media filter with treated potable water. Clarifier flushing is a 7-step process that occurs between filter backwash events. Filter backwashing with air scour is a 5-step process that occurs either automatically based on operating conditions or when manually initiated.

Water will be taken from the finished water tank for backwashing the filter. A 6-inch diameter pipe will be brought into the WTP from the main distribution line. Pressure reducing valves will be installed on the line inside the WTP to decrease the water pressure from the elevated storage tank to that required for backwashing. The raw water line from the raw water tank will be used to provide flow for flushing the clarifier. Raw water is passed through the clarifier in the reverse direction. The reverse flow flushes trapped particles from the clarifier and the water is discharged to the backwash pump station.

Flow required for backwashing the filters varies throughout the 5-step process. The flow rate required is determined by the WTP control panel and regulated by a series of throttling valves located on 6-inch and 2-inch pipes, providing backwash water to the filter. When a lower flow rate is required (i.e. during air scour), the valve will close the larger 6-inch diameter pipe off and allow backwash water to flow through the 2-inch diameter low flow branch. This small diameter branch has a manual valve that is adjusted during startup to achieve the required flow. When a higher flow rate is required for the backwash, the actuated valve is opened and water is allowed to flow through both the 2- and 6-inch pipes to achieve the required flow rate.

Conservative, worst-case estimates of the volume of clarifier flush and backwash wastewater is 18,600 gallons per day with approximately 12,000 gallons estimated to be from clarifier flushes and approximately 6,000 gallons from backwashes. However, US Filter estimates that an average volume of 6,000 gallons per day will be encountered with approximately 2,000 gallons from clarifier flushes and 4,000 gallons from backwashes. Backwash wastewater will be sent to a lagoon to settle out solids before final disposal/discharge. Because gravity flow directly to a settling lagoon is not possible, backwash wastewater from the filters will be discharged by gravity into a temporary waste sump inside the WTP. Backwash wastewater will then flow by gravity to a larger exterior wastewater pumping station capable of holding all the backwash wastewater produced in an entire day. The backwash wastewater will be pumped from the exterior wastewater pumping station to one of two lagoons to allow solids to settle out. Refer to Section 10 for details on the lagoons.

Decant water in the lagoons will flow by gravity out of the lagoons to a common pump station between the two lagoons at the southwest corner of the property. The pump station will pump the decant water to a surface water discharge location, which will discharge into Rondout Creek. The surface water discharge system requires a State Pollutant Discharge Elimination System (SPDES) permit prior to discharge. There have been preliminary discussions with NYSDEC and NYSDOH concerning an SPDES permit, but a permit has not been finalized.

Water Storage

As mentioned above, two tanks will be constructed on the WTP site. The tanks will be constructed in a manner consistent with the AWWA Standard D100-96, "Standard for Welded Steel Tanks for Water Storage" (AWWA 1996) and all other relevant industry standards, including those by the American Society for Testing and Materials (ASTM) and the National Association of Corrosion Engineers (NACE). Both tanks will be painted with a high quality coating and have cathodic protection installed to prevent/reduce corrosion.

Raw Water Tank. A cylindrical, ground storage tank will be constructed on the WTP site for raw water. The tank will be sized to hold a working volume of 340,000 gallons to accommodate four days of average daily demand. The overall volume of the tank will be approximately 460,000 gallons, which includes additional storage capacity to meet minimum head requirements at the WTP. The tank will be approximately 46 feet in diameter and 40 feet tall.

Raw Water Valve House. A Raw Water Valve House will be provided to house an air/vacuum relief valve, two BPDs, and a throttling butterfly valve on the raw water line, before entering the raw water storage tank. A separate room attached to the Raw Water Valve House will be dedicated to chlorine storage and feed.

The main purpose of the Raw Water Valve House is to control the flow of raw water from the tie-in at the NYCDEP's siphon house to the raw water storage tank. The valve house will also house a station for addition of chlorine, which will be added if deemed necessary by the WTP operator.

The appropriate BPD for this application is a reduced pressure zone (RPZ) BPD assembly. Based on good engineering practice, two RPZs should be installed above grade to facilitate access for testing and maintenance and to prevent potential reverse flows to the siphon house. The RPZs will be installed in accordance with local and national plumbing codes, and they will be installed in parallel so that one will be in place in the event that the other needs to be taken out of service for maintenance purposes. An air/vacuum relief valve will be installed upstream of the RPZs to relieve any air or vacuum that may develop in the line from the raw water source tie-in at the Catskill Aqueduct siphon house due to fluctuating pressures.

A throttling altitude valve will be installed downstream of the RPZs and upstream of the chlorine room to reduce the water pressure from the aqueduct, maintain constant downstream pressure, and prevent the raw water storage tank from overflowing. The throttling altitude valve will be used to control the rate of flow into the raw water tank, which will approximate the rate of withdrawal from the tank to maintain a constant water level in the raw water tank.

Finished Water Tank. Treated water will be stored on the WTP site in an elevated storage tank. The county and state departments of health both have requirements regarding the recommended volume of finished water that must be stored in the water distribution system. The recommended volume is equal to the maximum day demand at the WTP, plus the required fire flow. The maximum day demand is equal to twice the average daily demand or 170,000 gallons. The required fire flow is 120,000 gallons. Therefore, a volume of 290,000 gallons is recommended. The nearest size standard tank that satisfies the volume requirement is a 300,000-gallon tank. Therefore, a 300,000-gallon tank has been included on the site plans. The tank will be a multi-column tank approximately 151 feet tall. It will utilize separate inlet and outlet pipes and an eductor or jet nozzle on the inlet to promote mixing within the tank.

Emergency Water Supply. The emergency source of water at the treatment plant will be the on-site groundwater treatment system discharge. This source will be used during extended periods when the NYCDEP aqueduct system will not be available. The connection to the groundwater treatment system discharge pipe will be made inside the groundwater treatment system building downstream of the liquid phase GAC vessels. At the connection inside the groundwater treatment building, valves will be inserted to direct the flow to either the raw water valve house (i.e., to use as the emergency water source) or to Coxing Kill, the normal receiving stream. The connection to the WTP will be made inside the raw water valve house upstream of the raw water chlorination injection point and downstream of the raw water tank fill valve (LCV 27-5). A check valve will be installed on the emergency water supply pipe to prevent water from the raw water valve house from entering the groundwater treatment system. Operation of all valves for the emergency water supply will be manual.

The WTP operator will be required to close the butterfly valve inside the raw water valve house and the valve on the Coxing Kill discharge pipe in the groundwater treatment system building and open the emergency water supply pipe valves in both the raw water valve house and the groundwater treatment system building. When the raw water storage tank is full, the WTP operator would then close the emergency water supply pipe valve and open the discharge pipe valve to Coxing Kill in the groundwater treatment system building.

9 Automation

The treatment system will be designed to operate by automatic controls that will bring the water from the aqueduct, treat it, and pump it up to the finished water storage tank. Separate control loops to activate the raw-water tie-in, start the treatment system, operate the treatment system, and initiate backwash procedures will be included. Each control loop will be handled from the treatment building at the WTP.

The USFilter process controls for the proposed High Falls WTP will function through the different phases of the WTP's operation. During normal operating conditions, these process controls will control three basic functions: filter raw water into potable water; backwash operations; and clarifier flush operations. The backwash operation purges the filter and mixed media of particles that have accumulated during normal operation, and the clarifier flush operation flushes the adsorption clarifier media of particles that accumulate from the influent flow through the clarifier media. The process and instrumentation diagrams for these process controls are included in design drawings I-1 through I-8.

The design of the treatment system was completed to allow the greatest flexibility in operations. The operator will have the ability to allow the treatment system to treat water unattended or to run only when the operator is present. Tank controls can be adjusted to allow the operator to manually open valves (by hand switch) to fill the tanks, or to allow the treatment system to respond automatically. The operator will determine the method of control used. However the discussions in the following process control description describe the automatic operation. The control systems can also be operated manually.

9.1 Overview of WTP Automation Process

The finished water storage tank will control the production of treated water. A submersible level transducer will be located in the tank to provide a constant monitor of the water level in the finished water tank. The level signal will be sent back to a control panel that will operate the finished water pumping system in the clearwell. The level in the finished water tank will be subject to demand in the distribution system.

The finished water pumping system will use the input from the finished water storage tank to determine if the system needs to pump. If the tank level is low enough, the transducer will send a signal to the finished water pumping system that calls the pumps to run. These pumps will also receive a signal from the WTP control panel indicating the water level in the clearwell that determines if there is enough water in the clearwell for the finished water pumps to run. The finished pumps will run only if both signals call the pumps to run. If not, the pumps will wait for both signals to agree.

The level transducer in the clearwell will also send a signal to the USFilter control panel. This signal will tell the USFilter control panel if more treated water is needed. The USFilter system will also receive a signal from the pressure transducer in the raw water storage tank to determine if enough water is available in the raw water tank to treat. Both signals will be required to call the USFilter system to run. If there is not enough water in the raw water tank, the system will wait until there is adequate water.

A throttling butterfly valve at the raw water valve house will control level of the raw water tank. The valve will open and close, allowing the raw water tank to fill, based on the level in the raw water tank. The valve will open to a set position (percent open) as determined by the operator at the WTP control panel.

In addition to the process piping, the waste systems will also operate on an automated system. The USFilter system utilizes actuated valves to control the backwash process via the main control panel. The valves will turn on at timed intervals (as determined by the operator) or more frequently according to the differential pressure signals provided by the USFilter system. Backwash water will be taken from the finished water tank as discussed in Section 8. The main control panel will also receive an input from the finished water tank level transducer to determine if adequate treated water exists to initiate a backwash cycle. Positive agreement from both the USFilter system and the finished water tank level transducer will be required for backwashing to occur.

After backwashing, the backwash wastewater is discharged by gravity out of the WTP building to the backwash wastewater pump station. The backwash wastewater pump station will be controlled by a series of level sensors. The sensors will call the backwash pump station pumps to pump wastewater to the lagoons. Pumps in this pump station will operate on a lead-lag system. The design of the pumps is based on one pump providing the design flow of 50 gpm. The lag pump is used as a standby unit.

The lagoons will receive water from the pump station and discharge water by gravity into the lagoon pump station. No electronic controls are necessary to operate the lagoons.

The lagoon pump station will be filled from the discharge of the lagoons. When the level in the wet well reaches maximum, level sensors will call the pump station to run. The station will continue to run until the level drops to the minimum, where a float will turn the pumps off. Pumps in this pump station will operate on a lead-lag system. The design of the pumps is based on one pump providing the design flow of 35 gpm. The lag pump is used as a standby unit.

9.2 Trident System Overview

9.2.1 Treatment Process

The Trident system utilizes a treatment process configured for use in a prefabricated steel tank structure, featuring an upflow adsorption clarifier, followed by a downflow filter. The adsorption clarifier process combines the functions of mixing, contact flocculation, and turbidity removal to provide a well conditioned water to the filter for final polishing. The adsorption clarification process is accomplished by introducing chemically coagulated water beneath a packed bed of buoyant adsorption media which provides a high surface area for adsorption of the coagulated solids. Flow through the media is in an upflow pattern, entering the bottom of the bed and exiting from the top. Flocculation is enhanced by contact with previously attached solids and by the hydraulic shear which develops in the packed bed. The adsorption clarifier provides excellent pretreatment, which is most often better than the performance achievable with complete flocculation and settling processes. Turbidity removal in this stage ranges up to 95%.

The filter media design in this plant utilizes mixed media. The filter media is supported on the USFilter Trident direct underdrain system. Filtered water is collected by the Trident underdrain, and the backwash water is uniformly distributed by the Trident underdrain without the need for gravel.

9.2.2 Equipment Description

The installation at this plant consists of two identical clarifier/filter modules to process the total design flow of 175 gpm each. Operation of the clarifiers and filters is automatic or semiautomatic with separate flush and backwash cycles. Raw water will be gravity fed from the raw water storage tank to the treatment plant. Processed water will be discharged into a clearwell for distribution to users via the finished water storage tank.

9.2.3 Operation Overview

The following is an overview of general control concepts.

9.2.3.1 Clarifiers

Normal Operation

Flow into each clarifier will be controlled by an automatic rate-of-flow control loop. The flow control loop ensures that the flow remains at the set point regardless of pressure variations in the supply system or pressure drop across the clarifier media.

Flow will enter the lower portion of the clarifier compartment through a perforated distribution header, passes up through the media bed and retainer screen, and will be collected in the longitudinal troughs at the top of the clarifier compartment. From the troughs the clarifier effluent enters the transfer piping for passage into the filters.

Flushing

Flushing of excess solids from the adsorption clarifier will be accomplished in a simple, effective manner. Fluidization and scouring of the particles will be achieved by bubbling air into the bottom of the clarifier compartment through a distribution header/lateral system beneath the media. This causes an immediate downward expansion of the adsorption media and a vigorous scrubbing action to take place. Solids are then hydraulically flushed out the top of the clarifier to a waste tank. Since raw, untreated water is used for this process, there is no unnecessary wasting of finished product water.

The Trident clarifier air scour system allows the functions of fluidization and solids flushing to be totally independent. Therefore, the cleaning process is not sensitive to hydraulic loading. The degree of solids flushing is dependent only on total wash volume, so that it can be completed at any hydraulic rate (within limitations) with only the duration of the wash being adjusted for various influent flow rates. Also, the rate or duration need not be altered due to changing water temperature.

Flushing of the adsorption clarifier is normally required one or more times during a filter operation. Controls allow the flush to be initiated by an adjustable timer, a pre-set pressure switch, or by manual initiate. Typical frequency is one flush approximately every 8 hours of operation. However, bench scale tests conducted by USFilter indicate that this duration will likely be 24 hours, based on the quality of the raw water at this plant. Complete cleaning is not required; the majority of solids are removed in the first few minutes of the flush cycle. The residual solids in the bed are conducive to rapid resumption of full efficiency.

During flushing the adsorption clarifier retention system allows passage of waste solids, but keeps the adsorption media in place. The retainer is scoured during each flush cycle, thus preventing clogging; and is easily removed to allow access to the adsorption clarifier compartment if required.

9.2.3.2 Filters

Normal Operation

Flow enters the filter compartment through the trough at the top of the clarifier. Flow through the filter is down, through the three media layers, collecting in the underdrain system. From the underdrain, flow is out into the filter effluent piping leading to the clearwell.

Effluent flow from the filters is individually controlled by a modulating effluent flow control loop on the effluent line out of each filter. The set point for the flow control loop is determined by the flow through the clarifiers through a level-sensing transmitter in the filters compartment. Filter flow rates will follow the clarifier's flow.

Backwashing

Filter backwashing is accomplished by reversing the flow through the filter, flowing from bottom to top, at an increased rate to flush the accumulated solids out of the bed. Air scouring of the particles is achieved by bubbling air into the bottom of the filter compartment through a distribution header/lateral system beneath the media. This causes an immediate expansion of the filter media and a vigorous scrubbing action to take place. Solids are then hydraulically flushed out the top of the filter to waste. Data obtained from the system vendor indicates that the time between backwash cycles will be approximately 48 hours, based on the quality of the raw water from the aqueduct. The aqueduct raw water varies in clarity, ranging from very clear (turbidity below drinking water standards) to very turbid for brief periods. During periods of high aqueduct turbidity, filter run length will likely be reduced.

The reverse flow, utilizing water from the finished water storage tank at a rate three to four times higher than normal flow, expands and fluidizes the bed, "opening up" the spaces between the media grains, and releases the trapped solids.

The wastewater discharging from the filter carries the released solids out of the filter to the backwash receiving pit. From the pit, wastewater flows by gravity to the backwash wastewater pump station where pumps send the waste flow to the sludge settling lagoons. The same wastewater handling facilities treat the clarifier flush wastewater.

9.2.3.3 Chemical Feed

Treatment chemicals for the Trident process will be either PAC or polymer as a coagulant, sodium hydroxide (caustic) for pH adjustment, sodium hypochlorite (liquid chlorine) for disinfection, and orthophosphate for corrosion control. All chemical feed systems will be controlled by the Trident system.

Chemical feed systems can be controlled either on the basis of coagulation requirements from the AQUARITROL III chemical process control logic's response to effluent turbidity (either filter or clarifier), or by flow pacing from the total plant influent flow. Chemical feed pumps will be furnished by USFilter for the chemicals listed above. All feed systems are paced or controlled by the main filter control panel.

9.3 Description of Trident System

9.3.1 Control Sequence

The following sections discuss the operation of major control loops in the system control.

9.3.2 System Operation

For the system to operate, at least one treatment unit must be available and called to run, and the clarifier must not be in high pressure shutdown.

Individual clarifier flows are established using the individual Clarifier Influent Flow Loops. Control loops are implemented in the programmable controller logic. Operation monitoring and setpoint entry is performed through an Operator Interface Unit (OIU) on the face of the Main Control Panel.

Flow out of the clarifiers establishes the filter flow rate. Any change in the clarifier flow, either up or down, will change the water level in the filter compartment. An increase in clarifier flow will cause an increase in the level, while a decrease in clarifier flow will lower the level. A level transmitter mounted in the filter tank, functions to position the filter effluent valve to maintain the flow in the filter at the same rate as in the clarifier.

9.3.3 Flow Controls

9.3.3.1 Influent Flow

Each clarifier influent line will be equipped with a rate of flow control loop to regulate the flow in the line regardless of supply pressure or demand variations.

Each treatment unit has a control and status display indicating flow parameters on the face of the Filter Control Panel. The Flow Control Loop will compare the actual flow, as measured by the line's orifice plate and transmitter, to the set point the operator enters through the OIU. The flow controller logic will send a corrective position signal to the modulating butterfly valve in the influent line to maintain the flow at the operator entered set point. The flow rate will be adjusted automatically to the flush cycle flow rate during flush cycles.

9.3.3.2 Effluent Flow

Over the length of the filter run, the pressure in the filter effluent line will gradually drop as the headloss through the filter media increases. If the effluent valve remained in a fixed position, the flow through the filter would gradually decrease. With the gradual decrease in flow, the filter level begins to rise. The increase in level is detected by the filter tank level control loop, which then opens the effluent valve slightly to bring the level back to the set-point, causing the filter flow to match the clarifier influent flow.

A similar response takes place in the clarifier inlet flow controls, which are affected both by pressure loss through the clarifier media and by pressure fluctuations in the raw water supply line.

The same butterfly valve which serves to modulate the flow in the lines will also be used for shut-off service. To override the flow control loop and drive the valve closed in response to unit on/off or cleaning operations, the output signal from the flow control loop is forced to zero by the PLC. The valves are configured to close on loss of instrument signal. With no signal from the flow controller, the valve will close completely, stopping all flow in the line.

9.3.4 Clarifier Pressure

The pressure in the area beneath the media in each clarifier is monitored by a pressure gauge and two pressure switches. As solids accumulate in the clarifier media, more pressure is required to pass a given flow rate. This increase in pressure is used as a measure of the solids loading in the clarifier media.

An automatic flush cycle is initiated in a clarifier when its influent pressure reaches about 4 feet of water (first pressure switch). Normal clean media headloss in the clarifier is approximately 1 foot at 10 gpm/sq.ft.

A clarifier is shut down when the pressure reaches about 6 feet of water pressure (second pressure switch) to protect the retaining screens from damage. Once shut down on overpressure, the fault must be manually reset to restart the clarifier. The shutdown trip point is adjustable at the pressure switch.

9.3.5 Filter Headloss

Pressure drop through the filter media will be monitored by a pressure gauge and pressure switch sensing pressure in the effluent line exiting the filter. With a relatively constant water level in the filter, an increase in the headloss through the media due to the accumulation of solids will result in a decrease in the pressure in the effluent line. Starting headloss in the media following backwash is approximately 2 to 3 feet at 5 gpm/sq.ft.

When the pressure loss in the effluent approaches 8 feet of water pressure headloss, (adjustable at the pressure switch), a backwash initiate signal will be generated within the PLC. Should the filter continue to run without backwashing it will shut down on high filter headloss after a time delay set in the PLC.

9.3.6 Filter Effluent Turbidity

Each filter's effluent turbidity will be monitored by a continuously reading analyzer receiving a sample stream from the filter effluent line. The analyzer output is sent to the Main Control Panel PLC and to the plant monitoring display panel. High and High-High alarm conditions are transmitted to the plant's automated dialer system.

9.3.7 Clarifier Flush Cycle

The flush cycle of a clarifier can be initiated either manually, by elapsed run time on the clarifier, or by increasing pressure loss through the clarifier media. Interlocks are provided to prevent flush initiate if the unit is not on-line (either switched off or in high pressure shutdown), if another unit is in flush, or if a filter is in backwash. Once initiated, the cycle is the same regardless of the method of initiation.

9.3.7.1 The Clarifier Flush Cycle Sequence

1. Stop influent flow, "Fluidize" media with air: 2 to 4 minutes.
2. "Flush" media with air and influent flow: 4 to 6 minutes.
3. "Level" the media with air w/o influent flow: 1 minute.
4. "Settle" the media w/o air or influent flow: 1 minute.
5. "Rinse" the media with influent flow, discharge to waste: 6 to 10 minutes.
6. Let waste troughs drain.
7. Return the clarifier to service.

The cycle sequence is advanced through the steps by a sequence of timers within the PLC. There is no valve position report-back to the PLC.

The same timers are used for each unit to insure that each clarifier receives an identical flush cycle. The times listed in the above cycle are adjustable by the operator through the OIU.

9.3.7.2 Flush Cycle Events

1. Close clarifier influent valve FCV 9-1/2 (set output to zero).
2. Close filter effluent valve LCV 11-1A/2A.
3. Open waste gate LCV 19-1/2.
4. Start air blower. Verify discharge pressure.
5. Open clarifier air isolation valve FCV 17-1/2.
6. Timing: Air only. "Fluidization."
7. Open clarifier influent valve FCV 9-1/2 (flow setpoint=clarifier flush rate).
8. Timing: Air and water. "Flush."
9. Close clarifier influent valve FCV 9-1/2.
10. Timing: Air only. "Bed Leveling."
11. Close clarifier air isolation valve FCV 17-1/2.
12. Stop air blower.
13. Timing: no air or water. "Bed Settle."
14. Open clarifier influent valve FCV 9-1/2.
15. Timing: Water only "Rinse."
16. Close influent valve FCV 9-1/2.
17. Timing: Allow trough to drain.
18. Close waste gate LCV 19-1/2 (Flush cycle complete).
19. End of flush cycle. All timers are reset.

9.3.7.3 Filter/Clarifier Valve Loop Numbers

Table 9-1 lists valves and associated filter/clarifiers.

Table 9-1 Filter/Clarifier Valve Loop Numbers

Valve Description	Clarifier No. 1	Clarifier No. 2
Clarifier Influent	FCV 9-1	FCV 9-2
Clarifier Air Isolation	FCV 17-1	FCV 17-2
Filter Effluent to Clearwell	LCV 11-1A On, 11-1B Off	LCV 11-2A On, 11-2B Off
Filter Draindown	HV 20-1	HV 20-2
Waste Gate	LCV 19-1	LCV 19-2
Filter Air Isolation Valve	FCV 18-1	FCV 18-2
Filter Backwash Inlet	FCV 16-1A	FCV 16-1B
Filter to Waste	LCV 11-1B	LCV 11-2B

Common to all: Air Blower No. 1 or No. 2.

9.3.8 Filter Backwash Cycle

Backwash of a filter can be initiated either manually, by elapsed run time on the filter, or by high pressure drop (headless) across the filter media (PS 12-1/2). Once initiated, the cycle is the same regardless of the initiation method.

9.3.8.1 The Filter Backwash Sequence

1. Stop influent flow.
2. Drain down the filter to clearwell.
3. Start air blower, verify discharge pressure.
4. Open filter air isolation valve.
5. Open waste gate to overflow trough.
6. Low rate backwash, refill and air scour.
7. Low rate backwash only, no air.
8. High rate backwash only.
9. Stop backwash flow.
10. Allow trough to drain.
11. Close waste gate.
12. Filter effluent out to waste: 10 minutes.
13. Effluent to waste ends, effluent to clearwell opens.
14. Filter is returned to service.

9.3.8.2 Interlocks

Interlocks are provided to prevent backwash if the filter is off-line, if a clarifier flush is in progress, if another filter is in backwash, or if the associated clarifier is in a high pressure shutdown. The interlocks are effective for all automatic initiate modes and for manual initiate. The interlock also prevents a backwash from being initiated if there is not sufficient water in the finished water storage tank.

The cycle sequence is advanced through the steps by a sequence of timers within the PLC. There is no valve position report-back to the PLC.

9.3.8.3 Backwash Cycle Events

The following backwash step sequence is written for Filter No. 1 (A), the same sequence is used for each filter, only the valve numbers will change. The same timers are used for each unit to insure that each filter receives an identical backwash cycle. The timer settings are established in the PLC registers.

1. Close filter inlet valve (FCV 9-1/2).
2. Open filter effluent valve (LCV 11-1A/2A).
3. Close filter effluent valve (LCV 11-1A/2A).
4. Open waste gate (LCV 19-1/2).
5. Start air blower (B 33-1/2). Verify discharge pressure (PI 33-1).
6. Open filter air isolation valve (FCV 18-1/2).
7. Timing: air scour.
8. Open filter backwash valve (FCV 16-1A/1B).
9. Timing: air scour and low rate backwash refill.
10. Close filter air isolation valve (FCV 18-1/2).
11. Stop air blower.
12. Timing: low rate backwash refill only.
13. Open high rate backwash valve (FCV 16-1) and flow control.
14. Timing: high rate backwash only.
15. Close filter backwash valve (FCV 16-1A/1B).
16. Close high rate backwash valve (FCV 16-1).
17. Timing: allow trough to drain.
18. Close waste gate (LCV 19-1/2).
19. Open filter inlet valve (FCV 9-1/2).
20. Increase clarifier influent flow back to normal.
21. Open filter-to-waste valve (FCV 11-1B/2B).
22. Timing: "Filter To Waste."
23. Close filter-to-waste valve (LCV 11-1B/2B).
24. Open filter effluent valve (LCV 11-1A/2A) if filter is being called to service.
25. End of backwash cycle. All timers are reset.

9.3.8.4 Filter Valve Loop Numbers

Valve Description	Filter No. 1	Filter No. 2
Clarifier Influent	FCV9-1	FCV 9-2
Clarifier Air Isolation	FCV 17-1	FCV 17-2
Filter Effluent to Clearwell	LCV 11-1A On, LCV 11-1B Off	LCV 11-2A On, LCV 11-2B Off
Filter Draindown	HV 20-1	HV 20-2
Waste Gate	LCV 19-1	LCV 19-2
Filter Air Isolation Valve	FCV 18-1	FCV 18-2
Filter Backwash Inlet	FCV 16-1A	FCV 16-1B
Filter to Waste	LCV 11-1B	LCV 11-2B

Common to all filters: backwash pump, low rate and high rate backwash valves.

9.4 Coagulant Process Control

The coagulant process uses logic in the PLC to regulate the coagulant chemicals to maintain the selected effluent turbidity at a preset operator-entered value. The AQUARITROL III coagulant control loop, receives inputs from process analyzers and generates an outputs to adjust the rate of the coagulant metering pumps.

9.4.1 Coagulant Loop Inputs

1. Raw water turbidity (selectable: either streaming current or raw water turbidity, depending on control strategy).
2. Filter effluent turbidity.
3. Total influent flow.

9.4.2 Signal Selection

The selection of which filter's effluent turbidity is to be monitored by the coagulant control is determined by "Last-to-Backwash" logic in the PLC. The filter most recently backwashed is monitored after a short time delay following backwash to "season" the filter.

9.4.3 Coagulant Pumps Pacing Mode

The coagulant pumps are paced from the main control panel. The primary input is the rate of flow of the raw water to the filters. The flow rate (raw water composite flow) is determined by adding the influent flows of each operating treatment unit. The influent flow is fed to the feed forward input of the control loop providing a base dosing rate.

A. The Raw Water Turbidity or Coagulated Water Streaming Current may be optionally used to adjust the dosing rate according to measured conditions in the treated water. Alternately, the filter effluent turbidity may be selected as the control parameter for coagulant dosing.

B. The Raw Water Turbidity may be manually selected for use in modifying the flow pacing signal, to provide a response proportional to the total amount of turbidity that exist in the raw water. When on, the measure turbidity is multiplied by the flow rate and a proportioning constant to increase the dosing signal as the raw water turbidity increases.

To enable turbidity, turn the "Raw Water Signal" selection on the coagulant control screen to ON.

C. Automatic control modes are manually selected from the OIU. Two mode may be selected, the Effluent Water Turbidity or the Streaming Current Signal for control of the dosing rate. The output is summed with the flow pacing signal to provide a total pacing signal.

1. Streaming Current. In streaming current mode, the PLC logic will control the coagulant feed to maintain a pre-determined streaming current value in the coagulated water. The streaming current value to use is operator entered via the OIU.
2. Filter Effluent Turbidity. With the "Filter Signal" selector switch on the Filter Control Panel OIU in the "Filter" position, the PLC logic will adjust the coagulant dosage to maintain the preset effluent turbidity from the filters.

9.4.4 Chlorine Feed Pumps Pacing Mode

The sodium hypochlorite (liquid chlorine) pumps are paced from the main control panel. The primary input is the rate of flow of the raw water to the filters. The flow rate (raw water composite flow) is determined by adding the influent flows of each operating treatment unit. The influent flow is fed to the feed forward input of the control loop providing a base dosing rate.

Only one filter is monitored at a time, with the signal selection being rotated through the on-line units on a "last-to-backwash" basis. The monitoring rotation skips over a filter that is not on-line.

9.5 Operating Procedures

Manual control of some valves will be accomplished by initiating a manual override via the OIU on the Filter Control Panel. The valve is placed in the OVERRIDE position and pressing the OPEN/CLOSE function key.

9.5.1 Filling the Filters

The first step to bringing the plant on-line will be to fill the filters, bringing water in from underneath the media using the backwash piping system. The filter must be under manual control during the initial filling operations. Only fill one filter at a time so the flow rate can be carefully regulated.

1. Manually "Close" all valves.
2. Place all pump and blower switches to "Off" at the MCC.

3. Visually verify that all valves are closed, including the backwash high rate valve, and that all pumps are stopped.
4. Slowly open the backwash inlet valve of the filter to be filled until a flow of about 70 gpm is indicated. Hold the fill rate to 70 gpm (2 gpm per sq. ft. of filter area) until the water level is above the media surface. The low rate is required to gently release the air from the filter media.
5. Once the media is covered, slowly increase the rate and continue flow until the water spills into the Backwash collection trough. Once the level is at the trough, close the backwash inlet valve.

Repeat steps 4 and 5 for both filters.

It is recommended that any filter which has the media installed be kept full of water at all times, whether or not it is actually operating, to protect the media from drying out or from debris falling into the filter. Any time a filter is drained to below the media level it should be refilled using the filling procedure just described.

9.5.2 Filling the Clarifiers

Do not fill the clarifiers until after the filters have been filled. This precaution is to prevent raw water from the clarifiers from being accidentally introduced into the filter while the media is dry.

1. Manually "Close" all valves.
2. Place all pump and blower switches to "Off" at the MCC.
3. Visually verify that all valves are closed, and that all pumps are stopped. Transfer the clarifier influent flow controller to "Manual" and drive the output down to zero.
4. Open any manual isolation valves on the influent line into the plant.
5. Slowly increase the output of the influent flow controller until a flow of about 35 gpm is reached. Hold the flow at 35 gpm until the water level covers the retainer screens and has just about reached the clarifier effluent trough lip.
6. Decrease the flow controller output until the valve has closed.

Both clarifiers can be filled at the same time if desired. Similar to the filters, it is best to keep the clarifier full of water at all times unless draining is required for inspection or maintenance.

9.5.3 Clarifier Flush Manual Initiate

To manually initiate a flush cycle on a clarifier at the Filter Control Panel, select the desired treatment unit to be flushed, via the treatment unit select for manual initiate selector switch and press the Clarifier Flush cycle manual initiate pushbutton. If all the interlocks are satisfied, the respective treatment unit call pilot light will toggle on and off, the flush cycle manual intake pushbutton will illuminate and the flush cycle will begin. If the cycle will not start, one or more of the following conditions is preventing it:

- Another unit is in flush.
- A filter is in backwash.
- The unit is in a shutdown mode.
- The raw water tank level is low.
- No air blowers available.

Should one or more of the above interlocks not be satisfied the respective treatment unit call pilot light and the flush cycle manual initiate pushbutton will toggle on and off. The flush cycle will not start until all the interlocks are satisfied.

9.5.4 Filter Backwash Manual Initiate

To manually initiate a filter backwash at the Filter Control Panel, select the desired treatment unit to be backwashed, via the treatment select for manual initiate selector switch and press the backwash cycle manual initiate pushbutton. If all the interlocks are satisfied the respective treatment unit call pilot light will toggle on and off, the backwash cycle manual initiate pushbutton will illuminate and the backwash cycle will begin. If the cycle will not start, one or more of the following conditions will be preventing it:

- Another filter is in backwash;
- A clarifier is in flush;
- The unit is in a shutdown condition;
- The raw water tank level is low;
- The associated clarifier is in high pressure shutdown;
- No air blowers available; and
- The finished water tank level is low (below the backwash inhibit level).

Should one or more of the above interlocks not be satisfied the respective treatment unit call pilot and the backwash cycle manual intake pushbutton will toggle on and off. The backwash cycle will not start until all the interlocks are satisfied.

9.5.5 Finished Water Storage Tank Level Controls for Backwash

Two levels in the finished water storage tank are monitored by the PLC for interlocking the backwash cycle. The upper level setpoint, called the backwash enable level, is used to signal the PLC when the water level in the finished water storage tank is sufficient to initiate a backwash cycle. The lower level setpoint is used to notify the PLC of a low water level condition and will inhibit a backwash cycle from starting. A backwash cycle will not be able to be initiated either manually or automatically until the finished water storage tank level rises to a level at or above the enable point.

9.5.6 Flush and Backwash Cycle Times

Each of the time periods programmed into the PLC can be changed using the keypad on the "Operator Interface Station". Select the desired setpoint, press the "INS"ert button and enter a new setpoint value using the numeric keypad, followed by the "ENTER" key. Press "CLR" to clear incorrect numbers.

9.5.7 Filter-to-Waste

The filter effluent will be sent to the waste lagoon following each occurrence of closing the filter's effluent valve. Closing the effluent valve causes the "filter-to-waste" timer to reset. This occurs when the treatment unit is shut off or is backwashed. When the filter's effluent valve reopens, the effluent water will be sent through the waste line for the "Filter-to-Waste" delay time. Then after timed filtering-to-waste, the effluent flow will be redirected to the clearwell. Filtering to waste is indicated by the "call" light will either be steady on (call to run) or flashing (backwash cycle) and the green "run" light is OFF. When the "filter-to-waste" timer has timed out and the effluent water is directed to the clearwell, the green "run" be ON. This is referred to being "on-line," filtering-to-clearwell. Anytime the green "run" light is OFF, the effluent valve is directed to the waste line.

9.5.8 Treatment Unit Starting and Stopping

The Treatment Units are brought on-line as needed based on the water level in the clearwell. The OIU on the Filter Control Panel door will provide a screen for displaying the clearwell level and the associated setpoints as listed below:

- High level alarm;
- All Treatment Units "OFF" level;
- Lead Treatment Unit "ON" level;
- Lag Treatment Unit "ON" level;
- Low level alarm;
- Normal flow setpoint; and
- Flush flow setpoint.

The OIU will have an integral keypad to be used for changing setpoints.

As the level in the clearwell drops below the "Lead Treatment Unit ON" setpoint, the "Lead" Treatment Unit, as selected by the sequence selector switch, will come on-line and start filtering at the "Normal Flow Setpoint" as set by the operator on the OIU. If the level in the clearwell continues to rise above the "All Treatment Units OFF" level setpoint, then the "Lead" Treatment Unit will stop filtering and go off-line. However, if the level in the clearwell continues to drop below the "Lag" Treatment Unit "ON" level setpoint, then the "Lag" Treatment Unit as selected by the sequence selector switch, will come on-line and start filtering at the "Normal Flow Setpoint" as set by the operator on the OIU. If the clearwell level continues to rise above the "All Treatment Units OFF" level setpoint both the "Lead" and the "Lag" Treatment Units will stop filtering and go off-line.

The "High" and "Low" level alarm setpoints are used for local annunciation on the panel and are available for the actuation of the telephone dialer.

9.5.9 Treatment Unit Automatic Control

<u>Automatic Treatment Unit Starting/Stopping control only applies to treatment units in the "AUTO" mode</u>. The PLC provides the on/off and sequencing control for the Treatment Units based on the water level in the clearwell. Leaving all available Treatment Units in the "AUTO" position ensures proper "Automatic Sequence Alternation" and "Automatic Backup" operation.

9.5.10 Treatment Unit Manual Control

<u>Manual Treatment Unit Starting/Stopping control only applies to treatment units in the "MAN" mode.</u> When a treatment unit is placed in the "MAN" position, it will start up, filtering-to-waste, then come on-line (filter-to-clearwell) and filter at the flow rate governed by the influent flow rate controller (see Section 9.3.3). All treatment units in the "MAN" mode will remain on-line and continue to filter water until placed in the "OFF" position, <u>regardless of the level in the clearwell (excluding a Clearwell High Level).</u> Returning the mode selector switch to the "AUTO" position will return control to the PLC for on/off control.

9.5.11 Treatment Unit Selection

The "Treatment Unit Sequence" selector switch will have three positions and offers the following sequences:

- pos 0 = Automatic Alternation;
- pos 1 = 1-2; and
- pos 2 = 2-1.

If the selector switch is placed in position 0 (Auto Alternation), then the PLC will automatically alternate the sequence each time all Treatment Units have shut off. This is the preferred position when all Treatment Units are available since it will insure equal run time on each Treatment Unit. Also, the PLC will automatically advance to the next sequence if the "Lead" Treatment Unit is called to run and is unavailable. Alternation of the lead treatment unit when a backwash occurs may be optionally selected. When selected the backwashing filter becomes unavailable and causes the alternation logic to search for a replacement unit that is available.

9.5.12 Treatment Unit Availability

A treatment unit is considered "available" when its control mode selector switch is placed in the "MAN" or "AUTO" (preferred) position and it is not in a shutdown condition. When a treatment unit is placed in the "OFF" position, or is locked out on a shutdown, it will not be called to run until the "reset" button is pressed and then placed in the "MAN" or "AUTO" position.

9.5.13 Treatment Unit Failure

If a treatment unit fails to perform a clarifier flush cycle and the pressure in the clarifier reaches a dangerous level, the treatment unit will automatically shutdown on a "Clarifier Over Pressure Shutdown. The red "fail" light will turn on and the treatment unit will be locked out from operating in both the "MAN" and "AUTO" modes until reset. To restore the treatment unit, place the mode selector switch in the "OFF" position, press the "reset" button until the "fail" light shuts off, then quickly select this clarifier unit to flush, and press the manual initiate push-button to start a flush cycle. Keep the mode selector switch to the "AUTO" position to resume automatic control.

9.5.14 Treatment Unit Status Lights

When a treatment unit is called to run automatically by the PLC, the amber "call" light will turn on and remain steady on for as long as the PLC is calling the treatment unit. When the PLC wants the treatment unit to stop filtering, the "call" light will shut off and the treatment unit will shutdown. During a filter backwash cycle, the amber "call" light will blink at the rate of 1/2 second "ON" and 1/2 second "OFF", if currently not being called to run. This makes it easy to identify the treatment unit backwashing. If the "call" light is steady on and the green "run" light is not on, then the treatment unit is filtering-to-waste. As soon as the green "run" light comes on, then the treatment unit is filtering-to-clearwell. Each time the effluent valve opens, the "filter-to-waste" timer is reset, and the green "run" light will not turn on until this timer has expired (see Section 7.3.7, Filter-to-Waste for more details).

9.5.15 Run Time Metering

Each Treatment Unit clarifier and filter has an elapsed run time hour meter. The meter will be used to control time initiated flush and backwash cycles. It will also be utilized in determining treatment unit effluent turbidity to be used in the coagulant control algorithm.

9.5.16 Changing Setpoints

The Treatment Units are brought on-line as needed based on the water level in the clearwell. An OIU will be provided on the panel door for displaying the underground reservoir level and the associated setpoints as listed below:

- High level alarm;
- All Treatment Units "OFF" level;
- Lead Treatment Unit "ON" level;
- Lag Treatment Unit "ON" level;
- Low level alarm;
- Low Flow Setpoint; and
- High Flow Setpoint.

The operator will have the option of changing all setpoints programmed into the system. The OIU will have programmed into it a screen for modifying setpoints. The operator can change one or all setpoints programmed into the PLC.

9.5.17 Influent Flow Rate

Each treatment unit will have an influent flow rate controller. These flow controllers will be implemented in the programmable controller and their operating parameters are displayed on the OIU located on the Main Control Panel door. The flow rate input signal comes from the differential pressure transmitter piped across an orifice plate in the treatment unit influent line, just ahead of the influent flow control valve. Using a square root extractor, the analog 4-20 mAdc signal from the transmitter becomes a linear representation of the influent flow (4-20 mAdc=0-500 gpm). The desired influent flow rate (in gpm) will be entered using the keypad on the OIU. The controller will use its preset tuning constants to perform positioning control on the modulating influent butterfly valve to reach the desired flow rate smoothly, and without oscillation. The output from the controller is an analog 4-20 mAdc signal that is fed into the PLC to determine if the influent valve requires an adjustment. If more flow is desired, the "open influent valve" contact will engage, adjusting the influent valve open slightly. If less flow is desired, the "close influent valve" contact will engage, adjusting the influent valve closed slightly. Because, the influent flow rate is not expected to change rapidly, a delay is placed on the output signal to prevent the system from oscillating. Using the keypad on the OIU, the influent flow rate controller parameters may be observed and adjusted. The parameters include the desired flow setpoint, the measured flow rate, the output signal (0 to 100 % meaning fully closed-to-fully open), and the operating mode (Automatic or Manual). The controller, when placed in manual mode, allows direct positioning of the influent butterfly valve manually, using the keypad on the OIU.

9.6 Finished Water Pump Operation

Treated water will be discharged from the treatment units into the finished water wetwell (Clearwell). Water in the clearwell will be pumped into the elevated storage tank as a function of tank levels, to maintain the amount of water stored within operating limits. The Tank level is telemetered to the Filter Control Panel via hard wire from the tank.

The demand for finished water pumps is determined by the operating levels in the Storage tank. Finished water pumps are brought on-line as needed based on the water level in the Tank. An OIU on the Main Control Panel door provides a screen for displaying the clearwell level and the associated setpoints.

The finished water pump flow rate will be a constant rate, determined by the head at the finished water pump. The finished water pumps are also interlocked with levels in the clearwell, allowing pumping only when sufficient water is available in the clearwell.

- Effluent Pump "Enable" level; and
- Effluent Pump "Inhibit" level.

As the level in the Tank drops below the "Lead Effluent Pump ON" setpoint, the "Lead" Effluent Pump, as selected by the sequence selected, will come on-line and start pumping to storage. If the level in the tank rises above the "All Effluent Pumps OFF" level setpoint, then the "Lead" Effluent Pump will stop and go off-line. However, if the level in the tank continues to drop below the "Lag" Effluent Pump "ON" level setpoint, then the "Lag" Effluent Pump will come on-line and start pumping water to the tank. Both the "Lead" and the "Lag" Effluent Pumps will continue to pump water until the tank level rises above the "All Effluent Pumps OFF" level setpoint and both the "Lead" and the "Lag" Effluent Pumps will stop pumping and go off-line. The "High" and "Low" level alarm setpoints are used for local annunciation on the panel and are available for the actuation of the telephone dialer.

9.6.1 Effluent Pump Automatic Control

Automatic Effluent Pump Starting/Stopping control only applies to Effluent Pumps in the "AUTO" mode. The PLC provides the on/off and sequencing control for the Effluent Pumps based on the water level in the tank and clearwell. Leaving all available Effluent Pumps in the "AUTO" position ensures proper "Automatic Sequence Alternation" and "Automatic Backup" operation.

9.6.2 Effluent Pump Manual Control

Manual Effluent Pump Starting/Stopping control only applies to Effluent Pumps in the "MAN" mode. When a Effluent Pump is placed in the "MAN" position, it will start up, and pump at the flow rate governed by the VFD. All Effluent Pumps in the "MAN" mode will remain on-line and continue to pump water until placed in the "OFF" position. Returning the mode selector switch to the "AUTO" position will return control to the PLC for on/off control.

9.6.3 Effluent Pump Selection

The "Effluent Pump Sequence" selector is entered on the OIU. The selector has three positions and offers the following sequences:

- pos 0 = Automatic Alternation;
- pos 1 = 1-2; and
- pos 2 = 2-1.

If the selector switch is placed in position 0 (Auto Alternation), then the PLC will automatically alternate the sequence each time all Effluent Pumps have shut off. This is the preferred position when all Effluent Pumps are available since it will insure equal run time on each Effluent Pumps. Pump failover is automatic, selecting the lag pump upon un-availability of the lead pump.

9.6.4 Effluent Pump Availability

An Effluent Pump is considered "available" when its control mode selector switch is placed in the "MAN" or "AUTO" (preferred) position and it is not in a shutdown condition. When a Effluent Pump is placed in the "OFF" position, or is locked out on a shutdown, it will not be called to run until the "reset" button is pressed and then placed in the "MAN" or "AUTO" position.

9.6.5 Effluent Pump Failure

If a Effluent Pump fails to run or receives a fault input from the variable frequency drive, the red "fail" light will turn on and the Effluent Pump will be locked out from operating in both the "MAN" and "AUTO" modes until reset. To restore the Effluent Pump, place the mode selector switch in the "OFF" position, press the "reset" key on the OIU until the "fail" light shuts off.

9.6.6 Effluent Pump Status Lights

When an Effluent Pump is called to run automatically by the PLC, the "call" light will turn on and remain steady on for as long as the PLC is calling the Effluent Pump. When the PLC wants the Effluent Pump to stop filtering, the "call" light will shut off and the Effluent Pump will shutdown.

9.6.7 Run Time Metering

Each Effluent Pump will have an elapsed run time hour meter. The meter will be used to record operating usage. The elapsed run time is displayed on the OIU.

9.6.8 Changing Setpoints

The Effluent Pumps are brought on-line as needed based on the water level in the tank. An OIU will be provided on the panel door for displaying the tank level and the associated setpoints as listed below:

- Tank Levels;
- High level alarm;
- All Effluent Pumps "OFF" level;
- Lead Effluent Pump "ON" level;
- Lag 1 Effluent Pump "ON" level;
- Low level alarm;
- Single Pump Flow Setpoint;
- Two Pump Flow Setpoint;
- Clearwell levels;
- Effluent Pump "Disable" level; and
- Effluent Pump "Enable" level.

9.7 Filter Backwash Cycle

A filter backwash cycle will initiate with any of the following conditions, depending on the position of the "Backwash Initiate - MAN/AUTO" Selector Switch.

- High lead-loss pressure in filter (AUTO only);
- High effluent turbidity (AUTO only);
- Accumulated filtering time since last backwash (AUTO only); or
- Manually pressing the initiate push-button (AUTO and MAN).

If the "Backwash - Initiate - MAN/AUTO" Selector Switch is in the MAN position, then all automatic initiates will be disabled and the unit must be manually selected using the "Flush/Backwash Manual Initiate" Unit selector switch to select the Treatment Unit, and pressing the "Backwash Cycle Manual Initiate" push button. If the initiate selector switch is in the AUTO position, then all automatic initiates will be enabled and the unit will start a backwash cycle for all of the above conditions.

The backwash cycle starts with the "filter backwashing" indicating light flashing, making a request for a backwash. If no other treatment unit is in a backwash cycle, and the required devices to complete a backwash cycle are available, then a backwash cycle will. If another treatment unit is in a backwash cycle or the required devices continue to flash until the init is switched to the "off" position, or a backwash cycle initiates.

First the waste gate will open, then the "filter discharge" valve will open and drain the water from the filter until the drainage timer expires or the "low level" float switch is reached (stage 1). The "filter discharge" valve will close, the air blower will start and when the air blower discharge has reached adequate pressure, the filter air inlet valve will open and air will be injected into the filter compartment (stage 2). The "low rate" backwash valve will open followed by the filter compartment backwash valve. The filter will refill at the "low rate" until the refill timer expires or the "high level" float switch is reached (stage 3). Once the water level in the filter has reached the high level float, the air blower will stop, the filter air inlet valve will close, and the filter will continue to backwash at the "low rate" (stage 4). Next, the supply valve will open and the filter will backwash at the "high rate" after a short valve-opening delay for air purging (stage 5). Next, both the "high rate" backwash valve and the filter compartment backwash valve will close. The waste trough will be allowed to drain before closing the waste gate (stage 6). At this time, the filter backwash cycle is complete and the treatment unit is ready for use.

A clarifier flush cycle can be requested each time a filter backwash is requested by setting this option using the OIU on Main Control Panel. Since the flush cycle requires an air blower through stage 3 of the flush cycle and the backwash cycle needs an air blower from stage 2 through stage 3 of the backwash cycle, a slight overlap of stages might occur - depending on the stage timer preset values. Therefore, if the backwash cycle needs the blower before the flush cycle is done with it, the backwash cycle will simply continue in its current stage and wait until the air blower is available before advancing.

To terminate a backwash cycle, simply place the "filter control" selector switch in the "off" position. However, if the head loss pressure is still at the "filter high head loss, (backwash requested)" set point when the "filter control" selector switch is returned to the "on" or "Auto" position, then the "filter backwashing" indicating light will start to flash again and a new backwash cycle request will be made.

9.8 Air Blower Operation

The Air Blower will be used during a Clarifier flush Cycle (see Section 9.2.7, Clarifier Flush Cycle) and during the filter backwash cycle. One air blower operates during flush sequences and two blowers operate during backwash air cycles.

The air blower operating mode is controlled from the Backash Screen of the OIU. Manual, Automatic and Off modes are selectable.

9.8.1 Air Blower Automatic Control

Automatic Air Blower Starting/Stopping control only applies when the Air Blower is in the "AUTO" mode. The PLC provides on/off control of the Air Blower during a Clarifier flush or filter backwash cycle. When a treatment unit requires the Air Blower(s) during a Flush or Backwash cycle, the blower(s) will start and run for as long as needed. If no Air Blowers are available, then the Flush or Backwash cycle will not be allowed to be initiated (see Section 9.7.3, Air Blower Availability). For automatic plant operation at least one Air Blower must be available at all times. For proper backwash operation, both blowers must be available.

9.8.2 Air Blower Manual Control

Manual Air Blower Starting/Stopping control only applies when the Air Blower is in the "MAN" mode. When the Air Blower is placed in the "MAN" mode, it will start up immediately and continue to run until placed in the "OFF" position, regardless of the Flush or Backwash Cycle. Returning the mode selection to the "AUTO" position will return control to the PLC for on/off control during a Flush or Backwash Cycle only. It is critical to leave the Air Blower in the "AUTO" position when unattended.

9.8.3 Air Blower Availability

The Air Blower is considered "available" when its control mode selector switch is placed in "MAN" position and is running, or placed in the "AUTO" (preferred) position and the fault light is not on. When the Air Blower is placed in the "OFF" position, or is locked out due to a blower failure, it will not be available for automatic control until "reset" (see Section 9.7.4, Air Blower Failure for details on how to reset this blower).

9.8.4 Air Blower Failure

The Air Blower will fail and be locked out from automatic control under the following conditions.

- Motor starter thermal overload trips.
- Called to run but fails to start within 60 seconds.
- Blower discharge pressure switch (PSH-2) does not close within a predetermined amount of time

When the Air Blower fails, its alarm status will be logged on the OIU and the common alarm light will illuminate and it will be locked out from operating in the "AUTO" mode only, until reset. To reset the Air Blower, place its mode selector switch to the "OFF" position, press the "reset" pushbutton until the "fail" light shuts off, then return the mode selector switch to the "AUTO" position to resume automatic control.

9.8.5 Air Blower Status

When the Air Blower is called to run automatically by the PLC, a relay will energize to start the selected blower. Placing the Air Blower in the "MAN" position will immediately start the blower. As soon as the motor starter pulls in, the "run" status on the OIU will turn on for run verification.

9.9 Chemical Feed Pump Operation

All chemical feed pumps (and feed solenoid valves) are 120 VAC powered and provide variable pumping rate control using a 4-20 mAdc current signal. Both the on/off and variable rate (speed) controls will be provided by the Main Control Panel as shown in Table 9-2. Refer to the chemical feed pump owner's manual for more details.

Table 9-2 Chemical Feed Pump Speed Controls

Device	Operation	Speed Signal Source
Primary Coagulant Feed Pump	Anytime an influent orifice plate is sensing flow to a treatment unit.	PLC logic Coagulant Feed Controller (4-20 mAdc=0-100%)
Corrosion Control Feed	Anytime a Treatment Unit's Influent valve is open, separate pump for each treatment unit	Total plant Effluent flow (4-20 mAdc = 0-350 GPM)
Treatment Unit Polymer (Filter Aid) feed Pumps	Anytime a Treatment Unit's Influent valve is open, separate pump for each treatment unit	Total plant Effluent flow (4-20 mAdc = 0-350 GPM)
Primary Chlorination	Anytime an influent orifice plate is sensing flow to a treatment unit.	Total plant Influent flow (4-20 mAdc=0-350 GPM)
Pre-Chlorination Feed Pump	Anytime an influent orifice plate is sensing flow to a treatment unit and pre-chlorination is called for by the operator.	Total plant Influent flow (4-20 mAdc=0-350 GPM)
Post-Chlorination Feed Pumps	Anytime an influent orifice plate is sensing flow to a treatment unit and post-chlorination is called for by the operator.	total plant Effluent flow (4-20 mAdc=0-350 GPM)

9.10 WTP Operator

The High Falls WTP is a pre-engineered water treatment plant that is designed to operate without an operator's direct supervision. The USFilter system is designed to operate remotely by use of the dialer/telephone. A policy statement on pre-engineered water treatment plants published by Recommended Standards For Water Works requires oversight by a full-time operator except where the reviewing authority has approved an automation plan. Since the plant is located in New York, the reviewing authority would be the NYSDOH. Although the plant is designed to operate 24 hours a day without continuous supervision, it is anticipated that operating the plant 8 hours per day 5 to 7 days per week will be sufficient for the required potable water production. If the NYSDOH does not approve the plant as an automated facility, then one full-time operator and one part-time operator would be necessary for the plant's operation. The full-time operator would supervise the plant five days a week and the part-time operator would supervise the plant three days a week overlapping one day with the full-time operator and also fill in when the full time operator is not available. The overlapping day will allow communication between the two operators of the plants operations and any potential problems that might be evident. Two operators will also permit any maintenance that requires more than one person to be performed on the overlapping day, such as changing the media in the USFilter system.

It has been determined that the WTP can efficiently run automatically without an operator. The policy on automated/unattended operation of surface water treatment plants explains that a certified operator must be on "standby duty" status at all times with remote operational capability and located within a reasonable response time of the treatment plant. The dialer system is the remote capability of the plant and will provide the operator control of the treatment system from a remote location. Only one operator would be necessary for "standby duty", but he would still have to check on the plant everyday and perform the duties of sampling, monitoring, and other maintenance required by the operator. Once the duties are complete and the plant is running properly, the operator would not be required to stay. He would be required by NYSDOH to be within one hour of traveling distance from the treatment plant at any time the plant is in operation.

The WTP operator will be required to perform periodic checks on the system to ensure it is running properly. In addition, the operator will be required to attend to the rest of the equipment at the water treatment plant and distribution system. The operator's duties will likely include daily inspections, water quality monitoring, distribution system maintenance, meter reading, billing, and property maintenance.

9.11 Daily Inspections

The operator will perform various duties that will ensure water quality and performance of the water treatment plant. The operator will be required to perform daily inspections that will include checking and recording influent/effluent water pressures, air blower pressures, water levels in the clearwell, finished and raw water tanks, and verifying that the chemical mixing system, filtering system, lagoon and all pumping systems are operating correctly. Any signs of damage, vandalism, leaks, and any other problems or potential problems will be noted and corrective measures will be taken. It is estimated that the daily inspection should take approximately two hours. This estimate is based on discussions with WTP operators in NYS and with the treatment system vendor, and takes into account the inspection of the ancillary systems such as the raw water valve house, sludge lagoons, and water tanks.

9.12 Water Quality Monitoring

The operator will also perform daily water quality monitoring of pH, temperature, turbidity, and chlorine residual of the effluent water. The operator will perform this monitoring at the laboratory at the water treatment plant. Lead and copper samples will be taken by the operator on a frequency that will depend on the analytical results of the initial lead and copper samples of the water treatment plant. These samples will be collected by the operator and sent to an independent analytical testing laboratory. If lead and copper levels exceed their action levels the operator will also be responsible for monitoring alkalinity, calcium, orthophosphate, conductivity, and silica. Once a year the operator will be responsible for obtaining the samples and sending them to an independent laboratory for testing for the water treatment plants annual report. The sampling and monitoring should account for approximately 1 hour of the operator's time each day.

9.13 Distribution System

Distribution system maintenance will be the operator's duty. The distribution system will not require any day-to-day tasks, but will require tasks to be performed throughout each year. At least once a year and whenever deemed necessary the operator should perform main line valve exercising to prevent valves from sticking open, air release valve inspections, and pressure monitoring. The operator will also be responsible for the required chlorine residual testing of the distribution system, which will be performed on site. The operator is also in charge of reading all the users meters every quarter and billing each user their water usage every quarter.

9.14 Property Maintenance

The operator will be responsible for the treatment plant's property maintenance. The responsibilities include keeping the treatment plant building clean and functioning properly (e.g., lights are all functioning, toilet and sinks work), snowplowing the road and parking lot during winter months, mowing the lawn, and any other task that may require maintenance on the property.

9.15 WTP Operator Certification Requirements

The treatment system is designed to run automatically, but an operator will supervise operation, as required by NYSDOH Public Health Law, section 225, Subpart 5-4.2, which requires the owner of a water system to place direct supervision of the water system, including each treatment plant and/or the distribution system, under the responsible charge of a water treatment operator(s) holding a valid certification equal to or greater than that required for the classification of the treatment plant and/or distribution system.

The level of certification required by operators is determined by the size and complexity of the WTP the operator is working at. NYCRR lists guidelines in Subpart 5-4, Table 5.4-2, for determining the type of required certification based on the category of the WTP. The High Falls WTP can be classified under two categories according to Section 5-4.2: (1) WTP with facilities for filtration which is designed to treat 2.5 MGD or less or (2) WTP that is designed to serve 1,000 people or less. Section 5-4.2 states that, in accordance with Sections 5-1.22 and 5.130 of Part 5, the NYSDOH will classify the WTP upon approval of the final design.

A WTP that is classified under the first definition (facilities treating 2.5 MGD or less than) is designated a Grade IIA system, which requires that both the operator and the assistant operator must hold a Grade IIA certification. Grade IIA certification requires one year of operating experience at a WTP with facilities for filtration, a minimum of a high school diploma or New York State Equivalency diploma, a Grade A course, and Grade IIA examination.

A WTP that is classified under the second definition (facilities serving less than 1,000 people) is designated a Grade C system, which requires that only the operator must hold a Grade C certification. Grade C certification requires six months of operating experience at a minimum Grade C WTP, a minimum of a high school diploma or New York State Equivalency diploma, a Grade C course, and Grade C examination. An assistant operator at a Grade C WTP does not require certification.

The final classification of the High Falls WTP will be determined by NYSDOH upon approval of the final WTP design. To be conservative in estimating operations costs, it is assumed that two Grade IIA operators will be required to operate the High Falls WTP, and this assumption will be used in the O&M cost estimate.

[illegible] system.

The [illegible] in the type and form [illegible] WTP [illegible] guidelines in Singapore [illegible] conventional [illegible] the High Purity WTP [illegible] and 3.3 show that [illegible] design.

[illegible] the conventional [illegible] the system [illegible] conventional [illegible].

[illegible]

The [illegible] WTP [illegible].

10 Waste Disposal

Wastewater produced as by-products of the treatment plant operation will result from two locations—the backwash and flushing of the filters and the sanitary waste at the treatment plant building. The backwash and flush waters used for the filters will be separated by settling in sludge lagoons into liquid and solid wastes. The sanitary waste at the treatment building will be treated by an on-site septic system. Solid waste will also be generated at the treatment plant and will be disposed of through appropriate collection methods.

Filter Process Wastewater

The package treatment system will require frequent flushes and periodic backwashes to clean the filter media. Data obtained from the system vendor indicates that the total backwash cycle time will vary from 24 to 96 hours, depending on the quality of the raw water from the aqueduct. The aqueduct raw water varies in clarity, ranging from very clear (turbidity below drinking water standards) to very turbid for brief periods. For conservative estimates, it is assumed that the system will backwash once per day. During that time, the adsorption clarifiers will flush three times, discharging approximately 4,200 gallons per flush, or 12,600 gpd. The mixed media filter will also be backwashed once per day. The backwash uses both air and water to clean the media. The water portion of the backwash will be approximately 6,040 gallons. Therefore, the total wastewater will be approximately 18,640 gpd.

Lagoons

Sizing. The backwash and flush wastewater will be piped to two settling lagoons to allow the solids in the wastewater to settle out, creating sludge. The design size of the lagoons is based on the required settling capability and sludge-holding capacity. The settling capability is determined by the length of time required for particles to settle to the bottom of the lagoon and form sludge.

Worst-case 8,000 gallons of sludge may be generated annually. Therefore, using worst case as a conservative measure, 1.2 feet of the bottom of the lagoon (900 ft^2) is allocated for sludge accumulation, with the remainder of the lagoon volume available for solids settling. Assuming a 3:1 side slope on an earthen lagoon, a lagoon depth of 5 feet, and 2 feet of freeboard, the lagoons will be 7 feet high and measure 87 feet by 62 feet at the top. The lagoons will be adjacent to each other with a maintenance road between them. The total area required will be approximately 117 feet by 169 feet plus area for the lagoons' outer side slopes. The outer side slopes will also be checked with calculations to verify slope stability. The total volume of each lagoon will be 81,000 gallons.

Based on previous projects and standard guidance values (Metcalf and Eddy 1991), the sludge lagoons at the High Falls WTP were sized with a total water depth of 5 feet, the bottom 1 foot of which would be covered by sludge after one year. These dimensions maximize sludge accumulation and removal efficiency. Stoke's Law was used to verify that the designed lagoon size would provide the necessary settling time of particles from the supernatant flow. The time for particles to settle to the bottom of the lagoon is 2.42 days, and the lagoons' design allows for 4.35 days. Therefore, the lagoons have been properly designed to accommodate the settling requirements of the sludge.

Liner. The lagoons will be lined with a geosynthetic clay liner (GCL) to prevent infiltration of the lagoon influent flow into the surrounding soil. The GCL is a very low permeability environmental liner that has high-performance self-sealing properties and freeze-thaw resistance. It will be anchored on top of the slope, beneath the access road. On the side slopes, 12 inches of cover soil will be placed over the GCL to provide confining stress on the GCL and to protect it against the elements. The bottom of the lagoon and the side slopes will be covered by the following four layers (from bottom to top): the GCL, 6 inches of cover soil, a biaxial geogrid, and 6 inches of crushed stone. The biaxial geogrid will be installed on the cover soil prior to installation of the crushed stone to prevent lateral displacement of the stone cover when it is under stress. A biaxial geogrid will also be installed within the access road into the lagoon. Crushed stone will be placed on the lagoon bottom to protect it from damage by heavy equipment loads and to reduce the likelihood of the lagoon bottom being removed during sludge removal (an exposed soil cover may have characteristics similar to sludge and mistakenly be removed).

Slope Stability. The sides of the lagoon were designed with a 3H:1V slope as per the GCL manufacturer's recommendation. This side slope recommendation is based on the shear strength of the GCL and the need to ensure slope stability. A slope stability analysis performed by the liner manufacturer and repeated by EEEPC with our intended cover soil verified the stability of a 3H:1V side slope.

The GCL manufacturer also recommended construction of an access road into the lagoon, which would be used by trucks and heavy equipment for potential maintenance. The manufacturer recommended a 5H:1V slope for the access road. A slope stability analysis was performed on the top slope of the access road using a large crane/front-end loader (assumed weight of 15 tons). Under the dynamic force of braking, the slope proved stable and the force did not exceed the GCL's strength. The manufacturer's recommendation for a safety factor greater than 1.5

was achieved for the slope stability analyses of the side slopes and the access road slope.

Operation. The lagoons are designed to be capable of operating simultaneously. However, if one lagoon requires emergency maintenance, the other must be able to handle the wastewater flow of the plant. This is a conservative measure for which the lagoon design accounts for.

Operated dry, the lagoons will be cycled annually; one lagoon receiving backwash water, the other drying the sludge received the previous year. Sludge will accumulate in the bottom of the lagoon until the year is complete. At that time, the flow will be routed to the other lagoon. The sludge remaining in the lagoon will freeze over the winter and dry, forming a cake in the spring. The sludge material will be removed by mechanical methods (e.g., a bulldozer and/or a front-end loader) and transported to an appropriate solids handling facility. The cycle will then repeat itself with the flow routed to the emptied lagoon and the other lagoon taken off line to be dried and emptied.

Operated wet the lagoons can be used simultaneously, but will be designed with only one lagoon operating. This is a conservative measure in case one lagoon needs maintenance; the other lagoon is designed to handle the wastewater flow of the plant. With only one lagoon operating, sludge will be removed annually. At the end of one year of operation the lagoon will have the supernatant drained off and the sludge will be removed and taken to an appropriate solids handling facility. This process can be done in less than a week, therefore reducing the down time of the lagoon. If the lagoons are operated simultaneously, only one lagoon can have sludge removed at a time because the other lagoon has to handle the wastewater flow of the plant. The benefit of using two lagoons simultaneously would be the reduced maintenance needed because the wastewater flow would be distributed to both lagoons instead of one therefore reducing the sludge in each lagoon to half. This would allow the ability to have sludge removal every two years rather than annually.

The wastewater flow created by the High Falls WTP will flow into each lagoon through two 3-inch ID pipes at an intermittent flow rate of 50 gpm. The wastewater flow rate will be influenced by the daily performance of backwashes and clarifier flushes. In addition, sludge is expected to accumulate at the bottom of the raw water storage tank. It is anticipated that any sludge buildup in the tank will be removed periodically by partially draining the tank to the lagoons. The sludge from the raw water tank will flow into the lagoon through its own pipe separate from the WTP waste water flow. The two discharge pipes will be located in opposite corners from each other and at the opposite end of the discharge structure to minimize short-circuiting to the discharge structure. The outlets of each pipe will have a 90-degree elbow on the end to direct the flow straight down into a 2-foot-square concrete block, which will diffuse the energy of the flow to avoid any scouring of the lagoon bottom.

The discharge structure, a box culvert measuring 10 feet wide by 10 feet long, will be situated between the two lagoons. A vertical outlet pipe will be set near the discharge structure and discharge into the box culvert. The pipe will control the water depth in that lagoon. When wastewater is discharged into the lagoon, the water level will increase to the height of the top of pipe. As it exceeds the top of the weir (but no higher than 6 inches above the weir), supernatant will overflow into the pipe and discharge out of the lagoon. On average, the supernatant will remain in the lagoon approximately 4.35 days from the time it enters the lagoon until discharge over the weir. This detention time will allow for particles the size of silt and larger to settle onto the bottom of the lagoon, forming the layer of sludge. After one year of operation, the layer of sludge will be approximately 1 foot deep and have a volume of approximately 1,000 ft^3.

Two 35-gpm pumps will be located in the middle of the 30-foot-long discharge structure. Four level probes controlling the pumps are designed to maintain a low set point of 2 feet and a high set point of 3.5 feet. The first (lowest) switch will turn off the pumps when the water level drops to 2 feet; the second switch will turn on the first pump when the water level rises to 3 feet; the third switch will turn on the second pump when the water level rises to 4 feet; and the fourth switch will activate an alarm and shut down the entire system when the water level rises 4.5 feet.

The discharge pipes from each pump will be equipped with a gate valve and check valve. The valves will be located above the pumps in the box culvert. The discharge pipe will be located at a depth of 4.5 feet below ground surface to avoiding potential freezing during the winter months. A 4-foot by 5-foot by 6-foot chamber will be set adjacent to the box culvert, containing a meter for the discharge. The pit and the discharge structure will both have access doors. The discharge structure, valve pit, and access doors will all be designed for H-20 loading because they are located in the access road between the two lagoons.

The discharge from the lagoon will be piped to either the raw water tank and a surface discharge. The raw water tank pipe can be utilized to return lagoon supernatant to the head of the treatment plant. However, during periods of potentially high turbidity, the surface discharge pipe can be used. (USACE will coordinate with NYSDEC to gain approval to discharge the clarified supernatant to surface discharge.)

Disposal. Based on sludge generation rates at the New Paltz WTP, it is anticipated that the High Falls WTP will produce, at the most, 8,000 gallons of sludge annually. It is assumed that the sludge will consist primarily of silts and sand from the Catskill Aqueduct raw water and will be non-hazardous. Therefore, sludge may be disposed of at an appropriate sanitary landfill capable of accepting the sludge. New York State law requires that the sludge must be dewatered to 20% solids with no free liquid to be disposed of at a landfill (6 NYCRR Part 360-

2.17). If the sludge is removed from the lagoons wet, the sludge may be transported offsite to a Publicly Owned Treatment Works (POTW) for dewatering and final disposal. As a third alternative, the Water District may elect to apply to NYSDEC for a permit to land dispose the sludge on site or elsewhere.

Based on the fact that there will be lead in the source water, it is anticipated that there will be lead in the sludge. It is estimated that approximately 0.13 pound of lead will be pumped to the lagoons each year. The landfill may require testing prior to accepting the sludge for disposal.

Sanitary Waste. The sanitary waste that will be generated at the treatment plant building is estimated to be 25 gallons per employee per day. Assuming three employees, the volume is 75 gallons per day. In addition, some wastewater may be generated through use of the laboratory facility. The only wastewater anticipated to be generated in the lab is the periodic samples of drinking water and rinsing of sample containers. Hazardous materials are not expected to be used at the laboratory. For preliminary design purposes, it will be assumed that 100 gallons per day will be used in the cleaning of sample containers and processing of water samples. The leach field will be sized based on 175 gallons per day. A septic system and leach field will be designed adjacent to the WTP to receive wastewater from the treatment building. Initial tests at the site indicate that the percolation rate of site soils is inadequate for a leach field. Therefore, a raised bed system must be designed and constructed using imported soils.

Other Solid Waste. Other solid wastes generated by HFWD personnel will be collected and disposed of at an appropriate solids handling facility or recycled where applicable. Solid waste volumes should be minimal, based on office and bathroom use.

11 Soil, Groundwater, and Contamination Characteristics

11.1 Soil Conditions at the MRIP Site

11.1.1 Bearing Capacity and Foundations

Monitoring wells were installed for the January 1997 Immediate Investigation Work Assignment (IIWA) (LMS 1997) to provide a means for sampling the groundwater and monitoring potential contamination at the MRIP Site. During the design phase, these soil-boring logs were used to gather preliminary information to proceed with layout of the treatment plant and associated structures. Review of soil types, bedrock depths, groundwater levels, and potential contamination revealed the area west of the existing MRIP building (see Figure 11-1) as the most appropriate location.

After initial design and layout, a soils exploration program was developed to perform soil borings, collect samples, and perform analysis to determine the soil characteristics at each of the WTP component locations. This program was performed during the period of September 30 to October 9, 2002. A total of 21 borings (see Figure 11-2) were performed, and split-spoon soil samples were collected at each boring. Soil and groundwater samples were also collected by representatives of EEEPC from random locations and submitted to EEEPC's Services Center analytical laboratory for VOC analysis.

Based on the 21 soil borings, the subsurface profile consists of topsoil over firm silts and sands followed by a compact to dense silty till, then bedrock. Some of the soils below the topsoil were described as containing a trace to some clay. Typical soil samples had moisture contents ranging from 5.1 to 17.8%. Final laboratory analysis classified the material as a silty sand or sandy silt with gravel and clay.

Auger refusal, likely on bedrock, was noted at various depths (ranging from 3.5 feet to 17.2 feet) at the soil borings. Rock cores were taken at four of the test borings. Through laboratory analysis, the bedrock was classified as a very hard, massively bedded quartzite (16,470 psi).

In general, the areas where test borings were conducted exhibit an allowable bearing pressure in the 2,000 to 3,000 pound per square foot range on the native soils and 6 to 10 tons per square inch on the bedrock. Typical spread footing foundations bearing on new structural fill, undisturbed natural soil or bedrock can be accomplished for the water treatment building. The raw water tank can be supported on a built-up concrete foundation or on bedrock. The finished water tank will be supported on bedrock.

Although the original soil boring locations were based on the proposed site layout established during preliminary phases of design, the site characteristics are such that the structural design are based on the originally determined soil properties. The specifications are written to include that soil conditions uncharacteristic of the soil investigation be conveyed to the engineer for review and acceptance with the design.

11.1.2 Groundwater and Soil Contamination

Given the nature of this site, contamination is the primary concern. Prior to the soils exploration performed for soil structural characteristics, preliminary information available for groundwater conditions from the IIWAs performed by Lawler, Matusky, and Skelley Enginers, LLP in January and September 1997 at the MRIP Site was used. In addition, technical memorandums submitted to the EPA by Roy F. Weston, Inc., (December 1998 to June 1998) and Lockheed Martin Technology Services Group (August 1999 and October 1999) provided further subsurface information and identified levels of contamination at the site.

Sampling from the wells developed during the IIWAs were taken from groundwater coming predominantly from bedrock at depths of between 25 and 40 feet deep. The results of sampling performed during the IIWAs indicated the presence of VOCs within the property, surrounding the MRIP building, and leading north and west from the building. In June 2001, groundwater samples were analyzed. The results of this sampling indicated that bedrock contamination still existed north and west of the MRIP Site. Figure 11-1 shows exaggerated VOC contours, based on the June 2001 sampling rounds, which extend south of the MRIP Site. Additional samples were collected in October 2001, and the results of that sampling indicate that the bedrock contamination contours also extend south of the MRIP building, leaving only the area surrounding monitoring well 1B (MW-1B) uncontaminated.

Information regarding groundwater in the overburden is limited. The majority of the monitoring wells at the site are either bedrock wells (100 to 200 feet deep) or interface wells, collecting water from both the overburden and bedrock. Monitoring well 4 (MW-4) is the only current well that collects groundwater from overburden. MW-4 is located north of the MRIP building, near an underground tank that was removed in 1997. The results for samples collected in 1997 and 1998 indicate VOCs levels between 15 and 20 ppm. There also exist data from monitoring well 5, which is an interface well northeast of MW-4. The results for samples collected from this well indicate low levels of VOC contamination.

C

Technical Memoranda

High Falls Water Treatment Plant

Table of Contents – Technical Memoranda

Mohonk Water Treatment Plant

Calculating Average Daily Flow Demand for the High Falls Water District

MRG 9/27/01

Revised 11/19/01, 12/14/01

Purpose

To summarize the different methods and discussions related to determining to the average daily demand for the High Falls Water District to date.

Data

All property and classification information for the Towns of Marbletown and Rosendale, included in the High Falls Water District, is available on CD from Ulster County Information Services. The High Falls Water District was mapped out with GIS. The information obtained from the CD included the number of tax parcels in each town, property types (agricultural, residential, commercial, industrial, and vacant), and property details (type of resident, number of bedrooms and bathrooms). All this information is summarized in Table 1 of the attached excel spreadsheet.

Methods

The following is a chronological summary of methods and discussions in determining the average daily demand.

9/27/01

Ecology & Environment, Inc. used two separate methods to calculate the average daily flow demand. The first method calculates the average daily flow from the total number of bedrooms in the High Falls Water District. This is the method utilized by Brinnier and Larios, P.C. in the *Plan, Map, and Report for the Proposed High Falls Water District*, January 2000, referenced in the *Record of Decision* by the USEPA, March 2000, and described in the *Feasibility Study* by Lawler, Matusky, and Skelly Engineers LLP, March 1999. The second method uses typical daily water usage flows for residential, commercial and industrial, public services, and unaccounted losses for an estimated population of the High Falls Water District, which includes parts of the Towns of Marbletown and Rosendale. Each method was used to determine both present and predicted future average daily flow demand (gpd).

E&E counted the tax parcels in the HFWD coming up with 224 parcels (Memo, Additional Tax parcels). Of these 224 parcels, 8 are either owned by the NYCDEP for watershed protection or aqueduct right of way or by the Town Historical Society. It is assumed that these eight parcels will remain undeveloped. Therefore there are a total of 46 vacant lots (38 are residential, 8 are industrial or commercial) that can be developed in the future.

<u>Method 1 (NYSDOH 1966):</u> Verification of the average daily flow calculated by Brinnier and Larios, P.C. from the total number of bedrooms in the High Falls Water District. All information is up-to-date and taken from the CD.

Brinnier and Larios, P.C. used a New York State Department of Health (1966) method sited in the *FS* (1999) to calculate the average daily demand from residences on the basis of 150 gallons per bedroom per day. The average daily demand from commercial properties was calculated using a different technique. For each type of business, the water usage was calculated using estimates specific to the certain type of business (such as number of seats in a restaurant, or customers in a retail store). Following this calculation we estimate the *present* average daily flow demand:

Number of bedrooms in the High Falls Water District = 388
Number of commercial and industrial users = 30

(388 bedrooms) x (150 gallons/bedroom/day) = 58,200 gpd
(30 commercial and industrial users) x (specific flow rates as described in the *FS*) = 8000 gpd
Total estimated average daily flow = 58,200 gpd + 8000 gpd = 66,200 gpd or 46 gpm (present)

Following this same calculation, including vacant lands with the potential for *future* development we can estimate the future average daily flow demand:

Assuming 3 bedrooms per residence (which is the average number of bedrooms per residence according to the tax parcel data), and that all vacant residential parcels will be utilized as single family residences in the future.

Number of vacant residential parcels = 38
Number of vacant commercial and industrial parcels = 8

(388 bedrooms + (38 parcels * 3 bedrooms/parcel)) x (150 gallons/bedroom/day) = 75,300 gpd
(30 + 8 commercial and industrial users) x (267 gpd/user) = 10,146 gpd
Total estimated average daily flow = 75,300 gpd + 10,146 gpd = 85,446 gpd or 59 gpm (future)

Method 2A (Water Quality, 1987): This method is adopted from *Water Quality* by Tchobanoglous, George and Edward Schroeder (1987). Using this method average daily flow demand is estimated per capita using average daily water usage rates for a small community such as the High Falls Water District. According to *Water Quality* typical municipal water use ranges from 65-290 gallons per capita per day.

Water Use	Flow Range (gpcd)	Average Flow (gpcd)
Domestic	40-130	60
Commercial and Industrial	10-100	70
Public Service	5-20	10
Unaccounted system losses and leakage	10-40	25
Total	65-290	165 gpcd

The population of the High Falls Water District is estimated by assuming an average occupancy of 2.6 residents per home. This is the average number of residents per household according to the Town Clerk in both Marbletown and Rosendale based on the 1990 census (*FS* 1999) and also prescribed in Metcalf and Eddy (1991). By multiplying the population by the average flow per capita, the average daily flow for the High Falls Water District can be determined.

From Table 1, the *present* population of the High Falls Water District is estimated at 403. We will assume that at the present the water distribution system will be new and will therefore have less unaccounted system losses, approximately 10 gpd/capita (Metcalf and Eddy, 1991 who referenced Water Quality, 1987). Using this information the average daily flow demand is calculated as follows:

Present estimated population of the High Falls Water District = 403
Average daily flow/capita on the new distribution system = (60 + 70 + 10 + 10) = 150 gpd/capita

(403 people) x (150gpd/person) = 60,450 gpd or 42 gpm (present)

To estimate for *future* demands we will again assume that all vacant parcels will be developed into single family residences (with 2.6 people/residence). Also as the water distribution system gets older, the amount of unaccounted system losses will increase. We will assume the average of 20 gpd/capita in unaccounted losses (Metcalf and Eddy, 1991 who referenced Water Quality, 1987.

Future estimated population of the High Falls Water District = 403 + (46 parcels x 2.6 people/parcel) = 523 people
Average daily flow/capita on the new distribution system = (60 + 70 + 10 + 20) = 160 gpd/capita
(523 people) x (160 gpd/person) = 83,680 gpd or 58 gpm (future)

Method 2B (NYSDOH 1975): The average daily water demand was also calculated in the *FS* (1999) using a similar method based on population estimates. The method uses recommended values of daily water use as developed by the NYSDOH of 75 gallons per capita per day where service connections are metered (NYSDOH 1975). Water use from commercial properties were again estimated based on specific commercial and industrial businesses (*Water Quality* by Tchobanoglous and Schroeder). Using this method the average daily water demand is calculated as follows:

(403 people) x (75gpd/person) = 30,225 gpd or 21 gpm (present)
Commercial demand (from the *FS*) = 8000 gpd
Average daily demand = 38,225 or 27 gpm (present)

(523 people) x (75gpd/person) = 39,225 gpd or 27 gpm (future)
Commercial demand (from the *FS*)= 10,146 gpd
Average daily demand = 49,371 or 34 gpm (future)

For the design of the water treatment plant we will use Method 2A (*Water Quality*), based on population estimates, to determine average daily flow demand for the High Falls Water District. It is important to note that Method 1 and Method 2A are very similar (Method 1 is the method used in the *FS* and referenced in the *ROD*). The population estimate method (of 75gallons per capita per day) was *not* used in the *FS*, as the more conservative estimated used by Method 1 (bedroom count) was deemed a more reasonable estimate of average daily water demand.

Planning for future demands the water treatment plant for the High Falls Water District will be designed for an average daily flow of 85,000 gpd.

10/30/01
Upon further review of the FS and the Draft Water Supply Agreement between the NYCDEP and the HFWD it was discovered that according to the 1905 New York City Water Act the NYCDEP could provide the district with water up to the average annual per capita usage of NYC. The average daily per capita demand was 160 gpcd in 1999 (include all water usages: domestic, commercial, public, losses…) (11/19/01 Contact Report w/ DEP). The average water usage in NYC ranges from 145 to 195 gpcd.

Average daily demand was then calculated by multiplying the population of the High Falls Water District by the maximum allowable water usage of 160 gpcd.

(403 people) x (160gpd/person) = 64,480 gpd or 45 gpm (current)
(523 people) x (160 gpd/person) = 83,680 gpd or 58 gpm (future)

However, the FS explicitly states that future population growth should not be considered, as the EPA won't fund it. This issue was raised to the USACE and EPA along with all the average daily demand calculations from E&E, the Plan, Map, and Report, and the FS. All demands are summarized in the following table.

	Feasibility Study (1999)	Plan, Map, and Report (2000)	E&E (2001) Current Demand	**E&E (2001) Future Demand**
Tax Parcels	174	225	224	**224**
Population	364	403	403	**523**
Average Per Capita Daily Demand (gpcd)	173	182	160	**160**
Average Daily Demand (gpd)	63,050	73,400	64,480	**83,620**

Therefore the final design average daily demand will be 85,000 gpd.

References

Brinnier and Larios, P.C., *Plan, Map, and Report of the Proposed High Falls Water District*, January 2000

Lawler, Matusky, and Skelly Engineers LLP, *Feasibility Study Report* Mohonk Road Industrial Superfund Site, March 1999

NYSDOH, New York State Department of Health, *Rural Water Supply*, 1966

NYSDOH New York State Department of Health, *Designing Community Water Systems*, 1975

Tchobanoglous, George and Franklin Burton, *Wastewater Engineering Treatment, Disposal, and Reuse*, Metcalf and Eddy, Inc., 1991

Tchobanoglous, George and Edward Schroeder, *Water Quality* 1987

Ulster County Information Services, *CD-Rom of Tax Data for the Towns of Marbletown and Rosendale*, 25 S. Manor Ave., Kingston, New York 12401, February-May 2001

USEPA Region II, *Record of Decision* Mohonk Road Industrial Superfund Site, March 2000

NYC Water Board, Draft Water Supply Agreement between the NYCDEP and the High Falls Water District, 2001

Table 5-1: Tax Parcel Data for High Falls Water District

Tax Parcels	Marbletown	Rosendale	Total	Estimated Population
	184	**40**	**224**	**403**
Agricultural	**1**	**0**	**1**	**3**
Vacant	1	0	1	0
Residential	**109**	**30**	**139**	**400**
Single Family	101	27	128	333
Two-Family	5	0	5	26
Three-Family	1	3	4	31
Apartment	2	0	2	10
Vacant	32	6	38	0
Commercial	**26**	**2**	**28**	
Hotels	1	1	2	
Restaurants	3	0	3	
Public Service	11	1	12	
Converted Residence	5	0	5	
Service Stations	3	0	3	
Row type	3	0	3	
Vacant	12	2	14	
Industrial	**2**	**0**	**2**	
Vacant	1	0	1	
Total Used Land	138	32	**170**	
Total Vacant Land	46	8	**54**	
Bedrooms	301	87	**388**	
Baths	165.5	45.5	**211**	

**There are 8 parcels (included in this count) owned by the DEP and Historical Society that will not be developed

References:

Ulster County Information Services, CD-Rom of Tax Data for the Towns of Marbeltown and Rosendale, February-May 2001

Table 2: Method 1, Determining Average Daily Flow by the No. of Bedrooms

	Marbletown	Rosendale	High Falls Water District
Number of Bedrooms (Present)[2]	301	87	388
Water Usage (gal/bedroom*day)[3]	150	150	150
Average Daily Flow (gpd) (Present)	45150	13050	58200
Vacant Parcels[2]	32	6	38
Number of Bedrooms (Future)[2]	397	105	502
Water Usage (gal/bedroom*day)[3]	150	150	150
Average Daily Flow (gpd) (Future)	59550	15750	75300

Table 2 (continued): Method 1, Average Daily Flow of Commercial Parcels

	Marbletown	Rosendale	High Falls Water District
Number of Commercial Parcels[2]	28	2	30
Water Usage (gal/parcel*day)[1]	266	266	266
Average Daily Flow (gpd) (Present)	7448	532	8000
Number of Commercial Parcels (Future)[2]	30	2	32
Water Usage (gal/parcel*day)[1]	267	267	267
Average Daily Flow (gpd) (Future)	8010	534	8544

Table 2 (continued): Method 1, Total Present and Future Average Daily Flows

	Marbletown	Rosendale	High Falls Water District
Average Daily Flow (gpd) (Present)	52598	13582	66200
Average Daily Flow (gpd) (Future)	67560	16284	83844

References:

1 Lawler, Matusky, and Skelly Engineers LLP, Feasibility Study Report Mohonk Road Industrial Superfund Site, March 1999 (Commercial parcel water usage)

2 Ulster County Information Services, CD-Rom of Tax Data for the Towns of Marbeltown and Rosendale, February-May 2001

3 NYSDOH Rural Water Supply, 1966

Table 3: Method 2A, Average Daily Flow (gpd) by Population Estimate (Present)				
Use	Range of Flow (gal/capita*day)[1]	Average Flow (gal/capita*day)[1]	Estimated Population[4]	Flow (gpd)
Domestic	40-130	60	403	24180
Commercial/Industrial	10-100	70	0	0
Public Service	5-20	10	0	0
Unaccounted	10-40	10	403	4030
Total		**150**	**403**	**60450**

Table 3 (Continued): Method 2A, Average Daily Flow (gpd) by Population Estimate (Future)				
Use	Range of Flow (gal/capita*day)[1]	Average Flow (gal/capita*day)[1]	Estimated Population**	Flow (gpd)
Domestic	40-130	60	510	30576
Commercial/Industrial	10-100	70	0	0
Public Service	5-20	10	0	0
Unaccounted	10-40	25	510	12740
Total		**165**	**510**	**84084**

** assuming 38 single family parcels (2.6people/family) [2 and 3]

References:

[1] Tchobanoglous, George and Edward Schroeder, Water Quality 1987 (Range of flows)

[2] Lawler, Matusky, and Skelly Engineers LLP, Feasibility Study Report Mohonk Road Industrial Superfund Site, March 1999 (2.6 people/family)

[3] Tchobanoglous, George and Franklin Burton, Wastewater Engineering Treatment,Metcalf and Eddy, Inc., 1991 (2.6 people/family)

[4] Ulster County Information Services, CD-Rom of Tax Data for the Towns of Marbeltown and Rosendale, February-May 2001(Population estimates)

☞ CONTACT REPORT ☜	
☎ Telephone <✔ > ☺ Conference < > ✉ Other < >	
CONTACT:	NYCDEP
TO:	D. Miller, J.Fazzolari, T. Lewandowski, S. Gardner
FROM:	M. Gifford
DATE:	11/19/01
SUBJECT:	"Allowable Quantity" of water from DEP to HFWD
CC:	

COMMENTS:

I called the NYCDEP to find out the average annual per capita water usage in NYC for the year 2000. This is important in determining the maximum allowable quantity of water that the HFWD can withdraw from the Catskill Aqueduct as per the 1905 New York City Water Supply Act and the Draft Water Supply Agreement. The average per capita water usage in 1999 was 160 gpcd according to the Feasibility Study.

I called both DEP Public Affairs (718-595-6600) and DEP Education Offices (718-595-3483, 718-595-3523 (Doreen Bater, Director)). Both offices stated that that figure was not readily available, and they did not know where to go for that information. Doreen Bater did say that NYC, surrounding boroughs and upstate counties use an average of 1.3 billion gallons daily from the water supply. I asked if the figure of 160 gpcd, from the 1999 FS, sounded reasonable. She did not refute that number.

According to the NYC 2000 Drinking Water Supply and Quality Report, the water supply systems provides 1.3 billion gallons daily to over 9 million people, plus tourists. This is approximately 145 gpcd.

☞ CONTACT REPORT ☎	
☎ Telephone <✔> ☺ Conference < > ⌁ Other < >	
CONTACT:	Hafez Erfani NYC DEP (845) 742-2067
TO:	Bob Pender, Pat Hamblin
FROM:	Don Miller
DATE:	12/10/01
SUBJECT:	Allowable Population Determination for water district
CC:	John Fazzolari, Shawn Gardner, Maureen Gifford

DRAFT

COMMENTS:

I called Hafez, as Joe Boek of the NYC DEP suggested, to discuss which method the DEP will accept for water district population determination.

Hafez stated that normally, the DEP will accept the most recent census figures for a political subdivision (eg a Town or City) if a water district's boundaries coincide with that political subdivision's boundaries. He stated that a legal issue might arise at the DEP due to the fact that the water district consists of parts of two Towns. (However, he did say the DEP legal group would discuss that issue.) Since the High Falls Water District boundaries do not coincide with a political subdivision's boundaries, the County Planning Board must get involved. The Water District, E&E, the EPA, the ACE or any others cannot accomplish this determination without the County Planning Board who must certify that the population is "x". The population must be from census figures. If a person gives their permanent address elsewhere, they cannot be included in the population determination regardless of how much time they would spend living within the water district. Going door to door performing another census will not be acceptable. The population can be adjusted in the future when the population changes.

Hafez agreed that the capacity of the water treatment and distribution facilities should be designed for the worst case. That issue is not relevant to the DEP. The only issues that would be relevant to the DEP would be the certified population and the average DEP daily per capita water use figure.

The method used by the DEP for determining the cost of raw water was explained as follows:

- The DEP will take the previous month's water use and divide by the number of days in the month and by the number of people served by the DEP. This will provide an average DEP daily per capita water use figure.
- The average water use per person in the area served by the DEP is normally 145 gpcd to 195 gpcd.

- The approved population figure previously certified by the County Planning Board would then be divided into the total water use by the water district along with the number of days in that previous month.
- For all water used by the water district less than or equal to the average DEP daily per capita water use figure, the lower price would apply.
- For all water used by the water district in excess of the average DEP daily per capita water use figure, the higher price would apply.
- He said he thought there would be a clause in the agreement that this average DEP daily per capita water use figure could be doubled for 1 day. This would cover the increased demand due to fire demand.
- He did not say how many days the average DEP daily per capita water use figure could be exceeded without penalty. This should be negotiated between the water district's and DEP's legal groups.

The information that must be submitted to the DEP will include the certified census data, a water district map and a description of the water district. This information should be sent to Ms. Roberta Pederson, the DEP's legal dept. head?

Don Miller

NEW YORK STATE SUPERFUND CONTRACT

Feasibility Study Report

Mohonk Road Industrial Plant Site
Remedial Investigation/Feasibility Study

Site No. 356023

Work Assignment No. D002676-25.3

DATE: March 1999

DEPARTMENT OF ENVIRONMENTAL CONSERVATION • NEW YORK STATE •

Prepared for:

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233
John Cahill, *Commissioner*

Division of Environmental Remediation
Michael J. O'Toole, Jr., P.E., *Director*

By:

Lawler, Matusky & Skelly Engineers LLP

EPA Guidance Document for Providing Alternate Water Supplies (EPA/540/G-87/006) provides guidance for sites that do not require a time-critical removal action but do require an alternate water supply. The ability to implement alternative water supplies as non-time-critical removal actions depends on the site conditions and available resources. The conditions at the MRIP site are non-time-critical because action is not required within six months.

EPA Guidance on Remedial Action for Contaminated Groundwater at Superfund Sites (EPA/540/G-88/003) provides guidance for making key decisions in developing, evaluating, and selecting groundwater remedial action at Superfund sites. This document focuses on policy issues and the decision-making approach and highlights key considerations that should be addressed during the remedy selection process.

Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds in Soils (EPA/540/F-93/048) recommends certain preferred remedies for sites where VOCs are present in the soil and treatment is warranted. Utilizing a presumptive remedy would expedite the remedy selection for the remediation of soils that are contaminated with VOCs.

EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA/540/G-89/004) establishes the methodology that the Superfund program has set up for characterizing the nature and extent of the risks posed by uncontrolled hazardous waste sites and for evaluating potential remedial options. This guidance would apply if the MRIP site were to become a site on the National Priorities List (NPL).

NYSDEC Selection of Remedial Actions at Inactive Hazardous Waste Sites as presented in TAGM HWR-90-4030 establishes a hierarchy of remedial technologies for inactive hazardous waste sites in New York State and describes the preliminary screening and detailed analysis of remedial alternatives.

10.3 POTENTIAL WATER SERVICE AREAS

Data for estimating the current, and potentially, affected population were obtained from interviews and town records. For those potable wells sampled in this study, the number of people in each household was determined through interviews with residents and business owners held during May 1997. For developed lots where wells were not sampled or for whom an interview was not conducted, information was obtained from the Town Clerk of Marbletown. According to the Town Clerk, the average number of residents per household in both Marbletown and Rosendale is 2.6 based on the 1990 census.

A potential public water service area (PWSA) was developed based on the private wells of homes and businesses that have been impacted and those that may be impacted in the future (Figure 10-1). Population estimates were developed for the potential water supply service area based on the extent of current and possible future groundwater contamination. The potential PWSA includes properties with wells that may be impacted in the near future if the contaminant plume continues to spread hydrogeologically downgradient. The population estimate, summarized in Table 10-2, includes only the properties that are currently occupied; for vacant properties (i.e., no buildings), the population was assumed to be zero. In keeping with EPA FS guidance, future population growth was not considered in these estimates (EPA 1988a).

Water supply alternatives for the potential PWSA will be pursued in this FS. Based on the hydrogeological information gathered to date, areas outside the potential PWSA are not considered threatened now or in the future by the groundwater contamination.

10.3.1 Water Demand

The average and maximum daily water demands were calculated for use in the conceptual design of a water supply alternative. Limited historical water usage records were available from the homeowners and business owners of the High Falls area. Therefore, recommended values of daily water use were used as developed by the New York State Department of Health (NYSDOH). In one reference NYSDOH recommends the use of 75 gallons per capita per day (gpcd) as an average daily water demand per person where service connections are metered (NYSDOH 1975). For this method, the population of an area multiplied by the average daily water demand per capita yields an average daily demand flow in gallons per day (gpd) for the proposed service area.

The second NYSDOH method calculates the average daily demand from residences on the basis of 150 gallons per bedroom per day (NYSDOH 1966). In this method the number of bedrooms in the proposed service area is multiplied by the rate per bedroom.

The NYSDOH recommended value of 75 gpcd was compared to the actual flow measurement taken from the home and business owners' GAC filtration systems. Flow through these systems is routinely measured and recorded by NYSDEC as part of the GAC maintenance program. Historical records made available by NYSDEC indicate the flow through a GAC system from the time a new GAC drum was installed to the time the same GAC drum was spent. The time the GAC drum was on line was also provided in these records. Therefore, the total flow divided by the number of days the drum was on line yields a rough estimate of the average daily flow for each household or business on a GAC system. Average flow for the impacted community was calculated using these historical records and was determined to be 65 gpcd (see Table 10-3). The average daily water demand calculated using the actual rate of 65 gpcd and based on a population estimate of 364 is 23,660 gpd. Using the higher rate of 75 gpcd yields a rate of 27,300 gpd.

The second method of calculating the average flow based on the number of bedrooms was also done. The number of bedrooms per household was obtained from the tax assessors office (see Table 10-4). The number of bedrooms in the PWSA (367) was then multiplied by 150 gallons per day per bedroom. This calculation results in an average daily demand of 55,050 gpd.

Despite the actual metered rate giving a lower average daily demand than using the NYSDOH value based on the number of bedrooms, the NYSDOH recommended value of 150 gallons per bedroom per day is used as a conservative estimate of the potable water flow requirements of the potential PWSA.

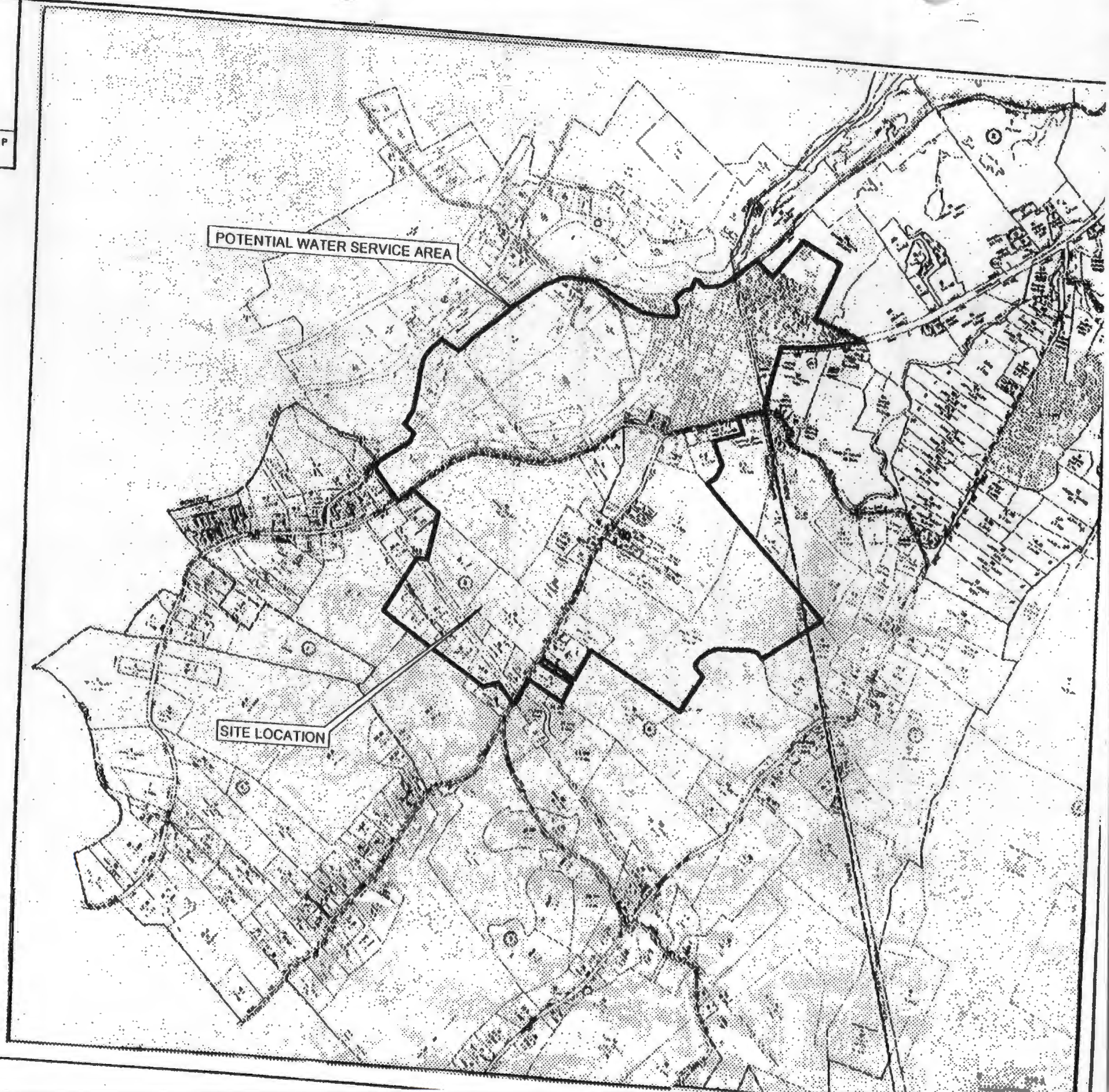
Table 10-5 summarizes the demand flow of the potential PWSA based on both the population and the current number of bedrooms in the service area. The average daily demand flow for a commercial property, such as a restaurant, was calculated using a different technique. The water usage for a restaurant was determined by multiplying the number of seats in the restaurant by the average water usage per seat to determine an average daily demand. For other businesses, the water usage was calculated using estimates specific to the type of business. For example, for retail stores in the High Falls area the average number of customers per day was estimated and then multiplied by the typical daily water usage of a customer in a store. The estimated average daily flows for these businesses and nonresidential properties in the potential PWSA are also presented in Table 10-5. A detailed breakdown of the formulas and references used to calculate the commercial property flow rates is provided in Appendix A.

Figure 10-1

Location of Potential Service Area

MOHONK ROAD INDUSTRIAL PLANT
NYSDEC I.D. No. 356023

LAWLER, MATUSKY & SKELLY ENGINEERS LLP
Pearl River, New York



0 2000 ft

APPROX. SCALE IN FEET

\650\MOHONK\service districts map.dsf

TABLE 10-2

POPULATION AND PROPERTY TYPES
Mohonk Road Industrial Plant

PARAMETER	Marbletown	Rosendale	Potential Water Service Area
Estimated Population	293	71	364
No. of Residential/Mobile Home Lots	99	23	122
No. of Commerical Lots	20	1	21
No. of Vacant Lots	28	3	31
Total Lots	**147**	**27**	**174**

+Disk No. \\Lms-srvr1\data\HazWaste\JOBS\600\650-254\mohonk1999/finalfs/PWSA information.xls Total PWSA 1/26/99 2:36:29 PM+

TABLE 10-3

WATER USAGE OF HIGH FALLS' RESIDENTS ON GAC FILTERS

Mohonk Road Industrial Plant Site

	Average flow (gal/unit/day)*
Residential Households	47
Commerical Properties	18

* - For residential households, unit refers to a person
- For commerical properties, unit depends on the type of commerical establishment (e.g., units for a restaurant is a seat)

TABLE 10-4

BEDROOM COUNT FOR PROPOSED HIGH FALLS PUBLIC WATER SERVICE AREA
Mohonk Road Industrial Plant Site

Tax Parcels S/B	Total Lots	Developed Residential Lots	Mobile Home Lots	Vacant Lots	Other[a]	Number of Bedrooms
			Marbletown			
70.003-3	15	9	0	4	2	30
70.003-6	23	17	0	5	1	45
70.009-2	21	15	1	3	2	49
70.046-1	23	13	1	6	3	44
70.046-2	31	15	0	7	9	52
70.046-3	34	28	0	3	3	76
			Rosendale			
70.009-1	27	21	2	3	1	71
			TOTAL			
TOTAL	174	118	4	31	21	367

[a]Other indicates developed lots with municiapl, manufacturing, restaurant, gas station & apartment, retail, etc.

TABLE 10-5

ANTICIPATED AVERAGE DAILY DEMAND FLOWS
Mohonk Road Industrial Plant

PARAMETER	Marbletown	Rosendale	Potential Water Service Area
Population	293	71	364
Residential Average Demand (gpd) *	21,975	5,325	27,300
No. of Bedrooms	296	71	367
Residential Average Demand (gpd) **	44,400	10,650	55,050
No. of Commercial Establishments	30	1	31
Commercial Average Demand (gpd)	N/A	N/A	8,000
<u>By Population:</u>			
Average Daily Demand (gpd)	29,975	13,325	35,300
Maximum Daily Demand (gpm) (Two times the Average Demand)	41.6	18.5	49.0
<u>By No. of Bedrooms:</u>			
Average Daily Demand (gpd)	52,400	18,650	63,050
Maximum Daily Demand (gpm) (Two times the Average Demand)	72.8	25.9	87.6

27,300 + 8

55,050 + 80

* - Based on 75 gallons / day / person.
** - Based on 150 gallons / day / bedroom.
N/A - Not available; the commercial average demand was calculated for both towns together.

+Disk No.: \\Lms-srvr1\data\HazWaste\JOBS\600\650-254\mohonk1999/finalfs/PWSA information.xls Demand 1/26/99 5 12.37 PM+

Because of the limited historical water use data available, NYSDOH recommends that the maximum daily demand be calculated as twice the average daily demand (NYSDOH 1975). The maximum daily demand is calculated to account for the wide variation of the hourly water demand at times of peak use. This maximum demand is needed to size certain units and equipment in the storage and distribution systems, including piping. The maximum daily demand requirements for the potential PWSA are summarized in Table 10-5.

10.3.2 **Water Supply Components**

Although the actual size of all water supply components will be determined during the design stage of this project, the conceptual framework of such a system has been developed in this FS to compare alternatives. The cost and impact of constructing a water distribution system are determined by site conditions. Water supply pipes are normally installed beneath pavement (e.g., roadways) or buried in trenches below the frost line. Depending on the local conditions, substantial excavation and blasting may be required.

The anticipated size of the water supply components was determined based on average or maximum daily demand, depending on the component. According to the Ten State Standards, a water storage tank is used to store potable water to meet the community's water demand; the working capacity of a storage tank for a new water supply system should be one day's average daily demand because of the wide fluctuation in potable water demand (Great Lakes 1992).

NYSDOH's policy is installation of new water supply systems should include sufficient pipe size and storage capacity to provide fire protection. The community is currently serviced by the High Falls Fire Department, which uses Rondout Creek as its source for fire service water and uses pumper trucks and hoses as its equipment. Based on NYSDOH's policy, fire protection is included as part of the design of the water system.

Providing fire service increases the sizes of pipes and the size of the storage unit because fire demand affects the maximum daily demand of a system. The National Board of Fire Underwriters calculates required fire flow based on the formula:

$$G = 1020\,(P)^{1/2}\,(1 - 0.01\,(P)^{1/2})$$

where G is the required fire flow in gpm and P is the population in thousands (NFPA 1986). The population of the potential PWSA is approximately 364 people. Using the fire flow formula the required fire flow for the potential PWSA is 612 gpm. As fire water service is typically measured in 250-gpm increments, the design fire flow for the potential PWSA based on this calculation is 750 gpm. The Insurance Services Office (ISO) states that the High Falls area have a rating of at least 500 gpm. Sizing the system for 750 gpm more than meets the ISO requirements.

Table 10-6 summarizes the anticipated size of the different water supply components assuming the water system supplies water for fire service. Assuming the system is designed for a fire flow duration of 2 hrs (NFPA 1986), the storage required to maintain fire flow is 90,000 gal. UCHD states that fire service storage is not usually added to a daily demand and that the size of the storage tank is determined either by one day's maximum demand or fire demand, whichever is larger (UCHD 1998). The maximum daily demand has been calculated to be 126,100 gpd. Therefore, the total working capacity required for the potential PWSA will be based on the higher of the two numbers or, 126,100 gal.

Fire service also impacts the size of the distribution system piping. An 8-in. diameter transmission main would be necessary between the storage tank and the end user's property.

10.4 NUMERICAL GROUNDWATER FLOW MODEL

10.4.1 Methods

To assist in evaluating water supply and remediation alternatives, a finite-difference groundwater flow model of the MRIP site and surrounding area was utilized. The latest version of the U.S. Geological Survey (USGS) modular finite-difference groundwater flow model (MODFLOW) was used in performing the simulations. A Windows-based graphical pre- and postprocessor, Processing MODFLOW, was used in model preparation and interpretation. Additionally, a particle-tracking utility, PM-PATH, aided in performing capture zone and contaminant migration simulations.

TABLE 10-6

ANTICIPATED SIZE OF WATER SUPPLY COMPONENTS (WITH FIRE SERVICE)

Mohonk Road Industrial Plant Site

COMPONENTS	AVERAGE OR MAXIMUM DEMAND	DESIGN CAPACITY
Water Treatment Plant Components	2 Times Average	126,100 gal
Transmission Line	Maximum	88 gpm
Potable Water Storage Tank Working Capacity Actual Capacity	2 Times Average*	 126,100 gal 150,000 gal

* allows for 2-hr fire service demand.
gpd - gallons per day
gpm - gallons per minute

+Disk No. \\Lms-srvr1\data\HazWaste\JOBS\600\650-254\mohonk 1999/finals/WELLS XLS TAB 10-6 2/3/99 3 18 PM

APPENDIX A

Water Demand Calculations

DATE: 26 January 1999

FILE NO.: 650-256

TO: File

FROM: Laura Robinson

SUBJECT: Commercial Water Demand in High Falls (Mohonk)

When the commercial water supply demand was calculated for the business in the potential water supply area, there were different water use values for different types of businesses.

To identify the water demands, two sources were used: the Ulster Country Department of Health and the book Water Quality by George Tchobanoglous and Edward D. Schroeder (see attached).

An explanation follows:

Manufactoring properties (70.3-35 and 70.3-3-37) used Water Quality as a source and were considered as industries without cafeterias.

Offices (70.3-6-3 – First Aid and Rescue, 70.3-6-17, 70.46-1-14.200 – Collins Real Estate and Frank Wellington Dunn, 70.46-1-31, 70.46-2-9, 70.46-2-24.100 – Wethesby Realty, 70.9-2-24) used Water Quality as a source

Restaurants (70.46-1-15, 70.46-2-5) used Ulster County as a source.

A tavern (70.46-3-23) used Water Quality as a source.

A gas station (70.46-1-34) used Water Quality as a source.

Stores (70.46-2-1.2 – pottery and gift stores, 70.46-2-3, 70.46-2-24.100 – pottery and gift stores, 70.46-2-27, 70.46-2-28, 70.46-3-1) used Water Quality as a source.

Coffee shops (70.46-2-2) used Water Quality as a source.

A flower shop (70.46-2-2) used Water Quality as a source and was treated as two twice the water demand for the number of employees (i.e., 2 X 11 = 22).

A bed and breakfast (70.46-2-24.100) used the Health Department as a source.

Churches (70.46-2-25, 70.46-3-2, 70.9-1-6 [R]) used Water Quality as a source.

A visitor center (70.46-3-22) used Water Quality as a source.

WATER QUALITY MANAGEM

$$\frac{\partial C_A}{\partial t}\Delta V = QC_A\big|_x - QC_A\big|_{x+\Delta x} + r_A \Delta V$$

WATER QUALITY

CHARACTERISTICS ▪ MODELING ▪ MODIFICATION

George Tchobanoglous

Edward D. Schroeder

Mike Komeroske, P.E.
Draft Feasibility Report Study
Mohonk Road Industrial Plant Site
December 31, 1998
Page 2

I believe we did it this way.

of the facility:

Restaurant	35	gallons per day per seat
Factory	25	gallons per day per shift
Churches	3	gallons per day per seat
Hotel	120	gallons per day per room
Offices	0.1	gallons per day per square foot or 15 gallons per day per employee
Shopping		Same as Offices
Service station	400	gallons per toilet per day

This method of determining estimated flows will assure that the water system will be able to handle demands at all times.

2. In Section 10.3.3, LMS states correctly that nothing in 10NYCRR, Part 5-1 or in "Ten States Standards" requires that a public water supply provide for fire flows. LMS goes on to say that fire flows are not required "especially if a fire water system is already in place. The community is currently serviced by the High Falls Fire Department, which uses the Rondout Creek as its source of fire water." I believe that LMS did not interpret this section correctly. Using their interpretation, if there were fire hydrants in the system, there would not be any need for the fire department. Obviously the fire company is still needed to pump out of hydrants and to equate one, 1000-gallon tank truck with a system of hydrants is ridiculous.

Have addressed per my 1/5/99 letter - MJK

Enclosed, please find a letter from Warren P. Longacker, P.E., Section Chief of the Design Section of the Bureau of Public Water Supply Protection stating that it is the policy of the New York State Health Department that mains and storage facilities for new public water supply systems be sized for fire flow demands. If the distribution grid is not sized for fire demands at this time, it is unlikely that it will ever be done, at least until design life of the pipe has expired which is approximately 100 years.

The greatest cost in installing water lines is the excavation and restoration costs. These do not change regardless of the size of the pipe that is installed in the excavation. I have asked an engineer that frequently works on such projects what the additional cost would be to go from a 4-inch pipe to an 8-inch pipe. His best guess is that it would add about $3.00 per foot of pipe. For the total project, including the cost of hydrants, the additional cost would be less than 1% more than putting the small pipe in the ground.

AL

TABLE 1.3

Typical Distribution of Domestic Household Water Use in the United States

USE	FLOW, L/capita · d	PERCENT OF TOTAL
Toilet	88	40.0
Hand and body washing	75	34.1
Kitchen	16	7.3
Drinking*	10	4.5
Clothes washing	16	7.3
House cleaning	3	1.4
Garden watering†	10	4.5
Car washing	2	0.9
Total	220	100

*Includes running tap to obtain cold water, spillage, etc.

†Areas not requiring extensive irrigation.

$\frac{L/\text{unit}\cdot\text{day}}{3.8} = \text{gpd}$

TABLE 1.4

Typical Water-Use Values for Commercial Facilities

FACILITY	UNIT	FLOW, L/unit · d Range	Typical
Airport	Passenger	8–15	10
Automobile service station	Vehicle served	30–60	40
	Employee	35–60	50 13
Bar and cocktail lounge	Customer	5–20	8
Boarding house	Resident	80–200	150
Hotel	Guest	150–220	190 −50
	Employee	30–50	40
Industrial building (excluding industry and cafeteria)	Employee	30–65	55 −14.5
Laundry (self-service)	Machine	1500–2500	2000
	Wash	180–200	190
Motel	Person	90–150	120
Motel with kitchen	Person	190–220	120
Office	Employee	30–65	55 −14.5
Public lavatory	User	10–25	15 −4
Restaurant (including toilet)			
Conventional	Meal	30–40	35
Short-order	Meal	10–30	15
Tavern	Seat	60–100	80 −21
Rooming house	Resident	80–200	150
Department store	Toilet room	1600–2400	2000 −533
	Employee	30–50	40 −11
Shopping center	Parking space	2–8	4 −1
	Employee	30–50	40
Theater			
Indoor	Seat	8–15	10
Drive-in	Car	10–20	15

Source: Adapted in part from Refs. [1.9] and [1.12].

TABLE 1.6
Typical Water-Use Values for Recreational Areas

SOURCE	UNIT	FLOW, L/unit · d	
		Range	Typical
Apartment, resort	Person	200–280	220
Bowling alley	Alley	600–1000	800
Cabin, resort	Person	130–190	160
Cafeteria	Customer	4–10	6
Camp			
Pioneer type	Person	60–120	80
Children's (toilet and bath)	Person	140–200	160
Day (with meals)	Person	40–80	60
Day (without meals)	Person	30–70	50
Trailer	Trailer	400–600	500
Campground (developed)	Person	80–150	120
Cocktail lounge	Seat	50–100	75
Coffee shop	Customer	15–30	20 -5
	Employee	30–50	40 -11
Country club	Member present	250–500	400
	Employee	40–60	50 -13.2
Dining hall	Meal served	15–40	30
Dormitory, bunkhouse	Person	75–175	150 -40
Fairground	Visitor	2–6	4
Hotel, resort	Person	150–240	200
Laundromat	Machine	1500–2500	2000
Park, picnic (with toilets)	Person	20–40	30
Store, resort	Customer	5–20	10 -3
	Employee	30–50	40 -11
Swimming pool	Customer	20–50	40
	Employee	30–50	40
Theater			
Indoor	Seat	8–15	10 -3
Drive-in	Car	10–20	15
Visitor center	Visitor	15–30	20 -5.5

Source: Adapted in part from Refs. [1.9] and [1.12].

Commercial and Industrial (Nondomestic) Water Use

The amount of water provided by public water supply agencies to commercial and industrial users is usually limited, although in some communities, industries such as canneries utilize public supplies. The largest industrial water use is for cooling, which accounts for approximately 50 percent of all nonagricultural water use in the United States. In 1975, the steam electric-power industry (Fig. 1.2) used over 1.22×10^{11} m^3/yr, compared to 2.2×10^{11} m^3/yr for agricultural irrigation and 0.3×10^{11} m^3/yr for domestic use [13].

AREA SERVED IN MARBLETOWN:

Tax Map Number	Name	location / address	property type	# of residents	# of bedrooms	Notes
70.46-1-13	D&H Canal	Route 213 E	vacant	0	0	
70.46-1-14.100	Novi, John	Route 213 E	vacant	0	0	
70.46-1-14.200	Frank Wellington Dunn	Route 213 E	commercial			(business)
70.46-1-14.200	May Collins Real Estate	Route 213 E	commercial			(business)
70.46-1-14.200	Murphy, Richard	Route 213 E	residential	2.56	3	
70.46-1-15	Murphy, Richard	Route 213 E	commercial			(restaurant)
70.46-1-16	Serravalli, Dorothy	14 Bruceville Road	vacant	0	0	
70.46-1-17	Flanagan, John	19 Bruceville Road	residential	2.56	4	
70.46-1-18			vacant			NOT LISTED IN TAX RECORDS!
70.46-1-19	Esmark, Bruce	Bruceville Road	residential	2.56	3	
70.46-1-20	Zwick, Eli	Bruceville Road	residential	2.56	4	
70.46-1-21	Seymour, John	Gravel Road	vacant	0	0	
70.46-1-22	Eaton, James	17 Old Route 213	residential	2.56	3	
70.46-1-23	Scanlan, David	22 Bruceville Road	residential	2.56	3	
70.46-1-24	Friedman, Alfred	18 Bruceville Road	residential	2.56	3	
70.46-1-25	Abrahamsen, Eric	Old Route 213	residential	2.56	3	
70.46-1-26	Rodriguez, Jose	Old Route 213	residential	2.56	3	
70.46-1-27	Serravalli, Dorothy	14 Bruceville Road	residential	1	2	
70.46-1-28	Farkas, Susan	Bruceville Road	residential	2.56	2	
70.46-1-29	Dalton, Wm.	Route 213 E	vacant	0	0	
70.46-1-30	Oppenheim, Jeffrey	Route 213 E	residential	2.56	7	
70.46-1-31	D & D LLC	Route 213 E	commercial			(retail)
70.46-1-34	Brennan, Donald	Old Route 213	residential	2.56	1	(apartment)
70.46-1-34	Brennan, Donald	Old Route 213	commercial			(gas station)
			sum	**36.84**	**44**	
70.46-2-1.100	Smith, Vaughn	Main Street	residential	2.56	4	
70.46-2-1.200	Westcote Bell Pottery	Main Street	commercial			(store)
70.46-2-1.200	Mules Laigo Gifts	Main Street	commercial			(store)
70.46-2-1.200	Glassman, Sheldon	Main Street	residential	2	3	
70.46-2-2	Town Pantry, Inc.	Main Street	residential	2	1	(apartment)
70.46-2-2	Town Pantry, Inc.	Main Street	commercial			(store)
70.46-2-3	Masters, Allan	Main Street	residential	2	1	(apartment)
70.46-2-3	Masters, Allan	Main Street	commercial			(post office)
70.46-2-4	Dales, Donald	Main Street	residential	3	1	(apartment)
70.46-2-4	Dales, Donald	Main Street	commercial			(retail)
70.46-2-5	Novi, John	Route 213 E	residential	1	1	(apartment)
70.46-2-5	Novi, John	Route 213 E	commercial			(restaurant)
70.46-2-6	D&H Canal	Route 213 E	vacant	0	0	
70.46-2-7	High Falls Fire	Route 213 E	vacant	0	0	
70.46-2-8	D&H Canal	Route 213 E	vacant	0	0	
70.46-2-9	D&H Canal	Route 213 E	vacant	0	0	(DEC says vacant, but may be fire house)
70.46-2-10	Reed, Gretchen	Fire House Road	residential	2	2	
70.46-2-11	Crepet, Louis	40 Canal Road	residential	4	4	
70.46-2-12	D&H Canal	30 Canal Road	vacant	0	0	
70.46-2-13	Hines, Eugene	Canal Road	residential	2	4	

C-36

AREA SERVED IN MARBLETOWN:

Tax Map Number	Name	location / address	property type	# of residents	# of bedrooms	Notes
70.46-2-14	Hines, Eugene	Canal Road	vacant	0	0	
70.46-2-15	Kaiser, Harvey	50 Mohonk Road	residential	3	3	
70.46-2-16	Brown, Rollin	Mohonk Road	residential	3	5	
70.46-2-17	Bush, Ruth	Steep Hill Road	residential	1	3	
70.46-2-18	Bush, Ruth	Steep Hill Road	residential	2.56	2	
70.46-2-19	McGrath, Richard	Mohonk Road	residential	4	4	
70.46-2-20	O'Connell, Warren	32 Mohonk Road	residential	2	4	
70.46-2-21	Vegas, Sonia	Mohonk Road	residential	5	3	
70.46-2-22	Hamm, Wendy	24 Mohonk Road	residential	4	3	
70.46-2-23	Hamm, Wendy	24 Mohonk Road	residential	2	2	
70.46-2-24.100	Krieg, Julia	Firehouse Road	residential	7	1	
70.46-2-24.100	Krieg's Bed and Breakfast	Firehouse Road	commercial			(bed and breakfast)
70.46-2-24.100	Lanzrein Pottery	Firehouse Road	commercial			(store)
70.46-2-24.100	Wethesby Realty	Firehouse Road	commercial			(business)
70.46-2-24.100	Linger Gifts	Firehouse Road	commercial			(store)
70.46-2-25	Reformed Church	Firehouse Road	commercial			(church)
70.46-2-26	Patterson, Suzanne	Firehouse Road	commercial	3		(store)
70.46-2-27	Barking Dog Antiques	Route 213 E	residential	2.56	1	(residence)
70.46-2-27	Barking Dog Antiques	Route 213 E	commercial			(store)
70.46-2-28	Clove Valley Trading Co.	Mohonk Road	commercial			(DEC says that this is a restaurant)
70.46-2-29.100	High Falls Fire	Second Street	commercial			(firehouse)
			sum	**59.68**	**52**	
70.46-3-1	Rand, Nathan	Route 213 E	residential	2.56	1	(apartment)
70.46-3-1	Rand, Nathan	Route 213 E	commercial			(store)
70.46-3-2	Reformed Church	Mohonk Road	residential	2.56	3	(residence)
70.46-3-2	Reformed Church	Mohonk Road	commercial			(church)
70.46-3-3	Weber, Kenneth	11 Mohonk Road	residential	4	4	
70.46-3-4	Pasturak, Ed	Mohonk Road	residential	1	4	
70.46-3-5	Rask, David	Mohonk Road	residential	2	2	
70.46-3-6	Rask, David	Mohonk Road	residential	2.56	3	
70.46-3-7	Tintori, Marco	Mohonk Road	residential	2	2	
70.46-3-8	Wasserman, Claire	39 Mohonk Road	residential	4	3	
70.46-3-9	Alter, Bruce	Steep Hill Road	residential	2	1	
70.46-3-10	Dane, Enid	Mohonk Road	residential	3	2	
70.46-3-11	Schneller, Robert	Mohonk Road	residential	2.56	2	
70.46-3-12	Eichhorn, Erich	Mohonk Road	residential	2	1	
70.46-3-13	Merrihew, Ella	Mohonk Road	residential	2.56	4	
70.46-3-14	Harrington, James	School Hill	residential	2.56	2	
70.46-3-15	Levine, Amy	22 Fourth Street	residential	4	3	
70.46-3-16	Fahey, Patrick	20 Fourth Street	residential	4	3	
70.46-3-17	Finn, Louise	18 Fourth Street	residential	2.56	2	
70.46-3-18	Alter, Bruce	Fourth Street	residential	1	2	
70.46-3-19	Cothern, Kevin	112 Steep Hill Road	residential	2	2	
70.46-3-20	Alter, Beth	Fourth Street	residential	1	3	
70.46-3-21	Herman, Joyce	Fourth Street	residential	2.56	3	

AREA SERVED IN MARBLETOWN:

Tax Map Number	Name	location / address	property type	# of residents	# of bedrooms	Notes
70.46-3-22	D&H Canal	Mohonk Road	residential	2	1	(apartment)
70.46-3-22	D&H Canal	Mohonk Road	commercial	2	1	(museum)
70.46-3-23	Parkin, Dorothy	Route 213 E	residential	1	1	(apartment)
70.46-3-23	Parkin, Dorothy	Route 213 E	commercial			(tavern)
70.46-3-25	Parkin, Dororthy	Route 213 E	vacant	0	0	
70.46-3-26	Stokes, George	21 Quicks Road	residential	2.56	3	
70.46-3-27	D&H Canal	Steep Hill	vacant	0	0	
70.46-3-28	Proman, Jane	Fourth Street	residential	2.56	1	
70.46-3-29	Hendrix, Wayne	Fourth Street	residential	2.56	2	
70.46-3-30	Hunt, Douglas	Fourth Street	residential	9	4	
70.46-3-31.100	Hunt, Douglas	Fourth Street	residential	4	4	
70.46-3-31.200	Hunt, Douglas	School Hill	residential	2.56	2	
70.46-3-32	High Falls Fire	School Hill	vacant	0	0	
70.46-3-33	Reformed Church	School Hill	residential	2.56	3	
70.46-3-34	Sutton, Marguerite	School Hill	residential	2.56	3	
			sum	**83.28**	**76**	
70.9-2-23	Dalton, Wm.	Route 213 E	residential	2.56	3	
70.9-2-24	NYNEX	Route 213 E	commercial			(phone facility)
70.9-2-25	Rand, Nathan	Route 213 E	residential	2.56	2	
70.9-2-26	Carroll, Patricia	Route 213 E	residential	2.56	6	
70.9-2-27	Celuch, Timothy	Route 213 E	commercial			(DEC says this is a restaurant)
70.9-2-28	Grossman, Frances	Main Street	residential	2.56	4	
70.9-2-29	Russak Philip		residential	2.56	5	
70.9-2-30	Tenhagen, Edna		vacant	0	0	
70.9-2-31	Jackson, Mary	51 Depew Road	vacant	0	0	
70.9-2-32	Ellyn, Maura	52 Canal Road	residential	1	1	
70.9-2-33.100	Town of Marbletown		vacant	0	0	
70.9-2-33.200	Ricci, Lawrence	30 Depew Road	residential	2.56	1	(mobile)
70.9-2-34	Johnsen, Walter	50 Depew Road	residential	2.56	4	
70.9-2-35.100	Ricci, Lawrence	10 Depew Road	residential	2.56	2	
70.9-2-35.200	Ricci, Lawrence	30 Depew Road	residential	2.56	3	
70.9-2-36	Parkins, Dorothy		residential	2.56	2	
70.9-2-37	Williams, Linda		residential	2.56	2	
70.9-2-38	Williams, Linda		residential	2.56	3	
70.9-2-39	Gibbs, Colvin		residential	2.56	4	
70.9-2-41	Jackson, Mary	51 Depew Road	residential	5	5	
70.9-2-42	Tenhagen, Edna		residential	2.56	2	
			sum	**41.84**	**49**	

sum =	**293**	**298**	
assuming 75 gallons / day / person:	21960		gpd
assuming 150 gallons / day / bedroom:		44400	gpd

RECORD OF DECISION

Mohonk Road Industrial Plant Superfund Site

Hamlet of High Falls,
Towns of Marbletown and Rosendale
Ulster County, New York

United States Environmental Protection Agency
Region II
New York, New York
March 2000

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Mohonk Road Industrial Plant Site

Superfund Identification Number: NYD986950012

Hamlet of High Falls, Towns of Marbletown and Rosendale

Ulster County, New York

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the Mohonk Road Industrial Plant Superfund Site, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document explains the factual and legal basis for selecting the remedy for the Site. The information supporting this remedial action decision is contained in the administrative record. The index for the administrative record is attached to this document (APPENDIX III).

The New York State Department of Environmental Conservation (NYSDEC) concurs with the selected remedy. A letter of concurrence from the NYSDEC is attached to this document (APPENDIX IV).

ASSESSMENT OF THE SITE

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

DESCRIPTION OF THE SELECTED REMEDY

The remedial action described in this document addresses contaminated soil and groundwater at the Mohonk Road Industrial Plant Site. The Site includes the Mohonk Road Industrial Plant property as well as those areas impacted by the groundwater plume emanating from the property. This remedial action supplements a non-time critical removal action (NTCRA) undertaken by EPA to address the most contaminated portion of the groundwater plume, and interim remedial measures taken by NYSDEC to provide granular activated carbon (GAC) filters for residential and commercial wells

- Off-site disposal of the contaminated soil at appropriately permitted facilities.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy meets the requirements for remedial actions set forth in CERCLA §121. It is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective.

The selected remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and the groundwater remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., it reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, but will take more than five years to attain remedial action objectives and cleanup levels in the groundwater, a policy review may be conducted no less often than each five years after completion of the construction of the remedial action components for the Site to ensure that the remedy is, or will be, protective of human health and the environment.

DATA CERTIFICATION CHECKLIST

The Decision Summary of this ROD contains the remedy selection information noted below. More details may be found in the administrative record file for this Site.

- Chemicals of concern and their respective concentrations (see pages 10 through 16, and TABLES 1 through 8 on pages II-1 through II-47);
- Baseline risk represented by the chemicals of concern (see pages 18 through 24, and TABLES 8 through 13 on pages II-44 through II-64);
- Cleanup levels established for chemicals of concern and the basis for these levels (see pages 25 and 26, and TABLE 14 on page II-65);

WATER QUALITY

CHARACTERISTICS ▪ MODELING ▪ MODIFICATION

George Tchobanoglous Edward D. Schroeder

When the growing season is dry (as in California) crops and lawns must be watered intensively. During the hot summer months, water use in arid areas may exceed 2.3 m^3/capita · d, compared to a normal demand of 0.4 m^3/capita · d, because of the need to water lawns and shrubs. Larger pipes, pumps, wells, treatment facilities, and reservoirs are required in arid areas, thus greatly increasing the cost of supplying water. The need for water and the long dry periods between rainfall events provided the impetus for the development of the large water resource management projects in the western United States.

1.3 SOURCES OF WATER

Most of the water used or affected by humans can be classified as fresh water because the concentration of dissolved constituents is low. The definition of fresh water is not precise, but a value of 1500 g/m^3 total dissolved solids (TDS) is an approximate upper limit. Brackish waters may have TDS values of up to 5000 g/m^3, waters containing higher TDS concentration being termed "saline." Seawater is usually in the 30,000- to 34,000-g/m^3-TDS range. Fresh waters are derived from surface sources and groundwater aquifers. Surface waters include lakes, rivers, and those waters stored as ice or snow. Surface waters tend to be turbid, a property caused by the presence of clays and other light-scattering colloidal particles, and treatment for turbidity removal is usually necessary prior to uses other than in irrigation. Groundwaters usually have higher TDS concentrations than surface waters because of mineral pickup from soil and rocks, and many groundwaters are noted for high concentrations of particular ions or elements such as calcium, magnesium, boron, and fluoride. Because of their high quality with respect to potability and their minimum treatment requirements, groundwaters are often preferred sources of water for individual homes and small communities. Large communities often find surface-water sources in remote mountain areas attractive because of their more desirable chemical characteristics and reliability. Cities such as New York, Denver, Los Angeles, and San Francisco transport water over long distances rather than rely on less desirable and often inadequate local surface and groundwater supplies.

1.4 MUNICIPAL WATER USE

Municipal water use is generally divided into four categories: (1) domestic, (2) commercial and industrial (nondomestic), (3) public service, and (4) unaccounted system losses and leakage. Typical per-capita values for

and lawns must
water use in arid
mal demand of
d shrubs. Larger
are required in
water. The need
nts provided the
ce management

assified as fresh
nts is low. The
500 g/m³ total
Brackish waters
ing higher TDS
n the 30,000- to
surface sources
ivers, and those
rbid, a property
terin colloidal
nec ary prior
ave higher TDS
ickup from soil
oncentrations of
m, boron, and
bility and their
often preferred
nunities. Large
mountain areas
racteristics and
geles, and San
an rely on less
ater supplies.

ies: (1) domes-
lic service, and
pita values for

these uses are reported in Table 1.2. Each of these uses is considered separately in the following discussion. In addition, the factors affecting water use and the variations that can be expected in water use are also considered. Estimation of municipal water use is illustrated in Example 1.2, presented at the end of this section.

Domestic Water Use

Domestic water use encompasses the water supplied to housing areas, commercial districts, institutional facilities, and recreational facilities. The uses to which this water is put include drinking, washing, bathing, culinary, waste removal, and yard watering.

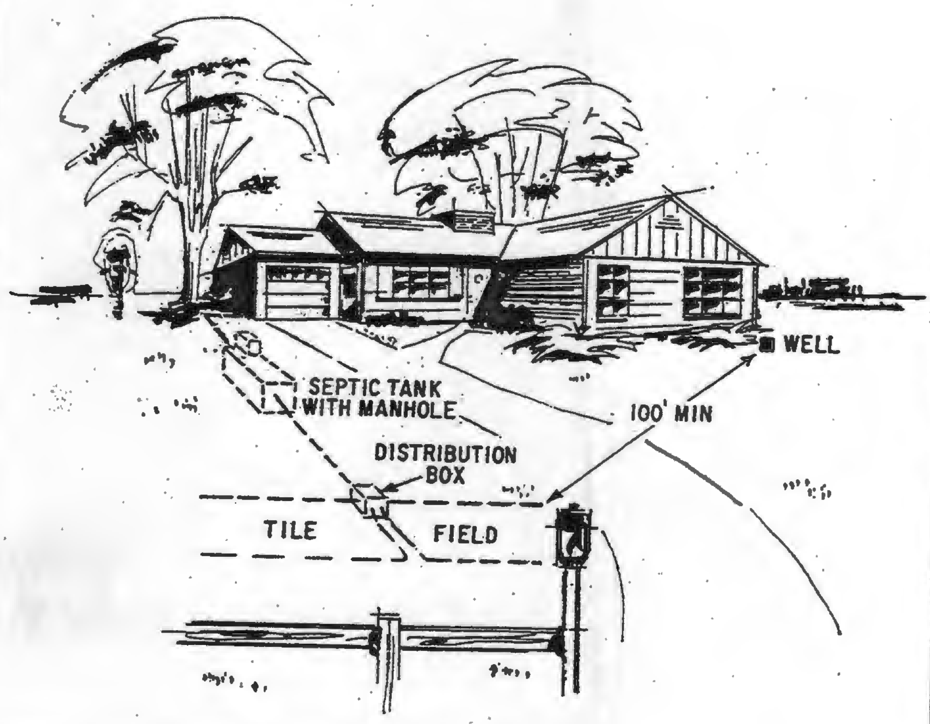
Housing Areas

The per-capita water supplied to individual residences and apartments varies from 150 to 480 L/capita · d, averaging about 220 L/capita · d. This quantity includes the water used for the purposes cited above. Referring to Table 1.2, domestic water usage is about 36.7 percent of the total usage in a community. Factors that influence the quantity of water used are discussed at the end of this section. The distribution of water use in an individual residence is reported in Table 1.3.

In general, new developments have more water-using appliances than older ones. Garbage disposals, dishwashers, number of bathrooms, and landscaping can be expected to increase with time in any given community. Many communities are, however, wisely insisting on water conservation measures in new construction; such measures include the use of showers rather than bathtubs, of low-flow shower heads, and of low-water-use toilets (2 to 6 liters per flush versus 16 to 20). In some communities, kitchen garbage-disposal units are banned, and in regions with restricted seasonal precipitation, landscaping with drought-tolerant plants is encouraged.

TABLE 1.2
Typical Municipal Water Use in the United States

USE	FLOW, L/capita · d Range	Average	Percent based on average flow
Domestic	150–480	220	36.7
Commercial and industrial (nondomestic)	40–400	260	43.3
Public service	20–80	30	5.0
Unaccounted system losses and leakage	40–160	90	15.0
	250–1120	600	100



rural
'ater supply

' YORK STATE DEPARTMENT OF HEALTH
HOLLIS S. INGRAHAM, M.D., COMMISSIONER

RURAL WATER SUPPLY

NEW YORK STATE DEPARTMENT OF HEALTH

Nelson A. Rockefeller
Governor

Hollis S. Ingraham, M.D.
Commissioner of Health

Reprinted 1972

TABLE 2

Guides for Water Use

Type of Establishment	Gallons per day*
Residential:	
Dwellings and apartments (per bedroom)	150
Temporary quarters:	
Boarding houses	65
Additional (or non-resident boarders)	10
Camp sites (per site)	100
Cottages, seasonal	50
Day camps	15–20
Hotels	65–75
Mobile home parks (per unit)	125–150
Motels	50–75
Restaurants (toilets and kitchens)	7–10
Without public toilet facilities	~~2½~~–3 2
With bar or cocktail lounge, additional	2
Summer camps	40–50
Public establishments:	
Boarding schools	75–100
Day schools	15–20
Hospitals (per bed)	250–500
Institutions other than hospitals (per bed)	75–125
Places of public assembly	3–10
Turnpike rest areas	5
Turnpike service areas (10 per cent of cars passing)	15–20
Amusement and commercial:	
Airports (per passenger)	3–5
Country clubs	25
Day workers (per shift)	15–35
Drive-in theaters (per car space)	5
Gas station (per vehicle serviced)	10
Milk plant, pasteurization (per 100 lbs of milk)	11–25
Movie theaters (per seat)	3
Picnic parks with flush toilets	5–10
Self-service laundries (per machine)	400
Shopping center (per 1000 sq ft floor area)	250
Stores (per toilet room)	400
Swimming pools and beaches with bathhouses	10
Farming:	
Livestock (per animal)	
Cattle	12
Dairy	35
Goat	2
Hog	4
Horse	12
Mule	12
Sheep	2
Steer	12
Poultry (per 100):	
Chickens	5–10
Turkeys	10–18

* Per person unless otherwise stated.

Metcalf & Eddy

THIRD EDITION

Wastewater Engineering

TREATMENT
DISPOSAL
REUSE

2. *Industrial wastewater.* Wastewater in which industrial wastes predominate.
3. *Infiltration/inflow (I/I).* Water that enters the sewer system through indirect and direct means. Infiltration is extraneous water that enters the sewer system through leaking joints, cracks and breaks, or porous walls. Inflow is stormwater that enters the sewer system from storm drain connections (catch basins), roof leaders, foundation and basement drains, or through manhole covers.
4. *Storm water.* Runoff resulting from rainfall and snowmelt.

Three types of sewer systems are used for the removal of wastewater and stormwater: sanitary sewer systems, storm sewer systems, and combined sewer systems. Where separate sewers are used for the collection of wastewater (sanitary sewers) and stormwater (storm sewers), wastewater flows in sanitary sewers consist of three major components: (1) domestic wastewater, (2) industrial wastewater, and (3) infiltration/inflow. Where only one sewer system (combined sewer) is used, wastewater flows consist of these three components plus stormwater. In both cases, the percentage of the wastewater components varies with local conditions and the time of the year.

For areas now served with sewers, wastewater flowrates are commonly determined from existing records or by direct field measurements. For new developments, wastewater flowrates are derived from an analysis of population data and corresponding projected unit rates of water consumption or from estimates of per capita wastewater flowrates from similar communities. These subjects are considered further in this chapter.

2-2 ESTIMATING WASTEWATER FLOWRATES FROM WATER SUPPLY DATA

If field measurements of wastewater flowrates are not possible and actual wastewater flowrate data are not available, water supply records can often be used as an aid to estimate wastewater flowrates. The types of water-use data available and how the data can be analyzed and applied for estimating wastewater flowrates are discussed in this section. Where water records are not available, useful data for various types of establishments and water-using devices are provided for making estimates of wastewater flowrates.

Municipal Water Use

→ Municipal water use is generally divided into four categories: (1) domestic (water used for sanitary and general purposes), (2) industrial (nondomestic purposes), (3) public service (water used for fire fighting, system maintenance, and municipal landscape irrigation), and (4) unaccounted for system losses and leakage. Typical per capita values for these uses are reported in Table 2-1. The importance of categorizing water use for the purposes of estimating wastewater flows is discussed in this section.

TABLE 2-1
Typical municipal water use in the United States[a]

	Flow, gal/capita · d		
Use	Range	Average	Percent based on average flow
Domestic	40–130	60	36.4
Industrial (nondomestic)	10–100	70	42.4
Public service	5–20	10	6.0
Unaccounted system losses and leakage	10–40	25	15.2
	65–290	165	100.0

[a] Ref. 8.
Note: gal × 3.7854 = L

Domestic Water Use. Domestic water use encompasses the water supplied to residential areas, commercial districts, institutional facilities, and recreational facilities, as measured by individual water meters. The uses to which this water is put include drinking, washing, bathing, culinary, waste removal, and yard watering. Using the average flow values reported in Table 2-1, over one-third of the water used in a municipal water supply system is for domestic purposes.

Residential areas. Water used by residential households consists of water for interior use such as showers and toilets and water for exterior use such as lawn watering and car washing. Typical data for interior water use are presented in Table 2-2. Water use for exterior applications varies widely depending upon the geographic location, climate, and time of year and mainly consists of landscape irrigation.

TABLE 2-2
Typical distribution of residential interior water use[a,b]

Use	% of total
Baths	8.9
Dishwashers	3.1
Faucets	11.7
Showers	21.2
Toilets	28.4
Toilet leakage	5.5
Washing machines	21.2
	100.0

[a] Adapted from Ref. 9.
[b] Without water-conserving fixtures.

is shown, a typical per capita value for residences in unsewered areas is about 55 gal/capita · d (210 L/capita · d) based on an average occupancy of about 2.4 to 2.8 residents per home.

An alternative method that can be used to estimate the flow from individual residences is based on allocating the total water use between household and personal uses. Assuming that the household use consists of 10 gal for dishwashing, 25 gal for laundry and 5 gal for miscellaneous use and that personal use consists of 3 gal for drinking and cooking, 2 gal for oral hygiene, 18 gal for bathing, and 17 gal for toilet flushing, the flow from a residence would be:

$$\text{Flow, gal/residence} \cdot \text{d} = 40\ \text{gal/residence} \cdot \text{d} + 40\ \text{gal/resident} \cdot \text{d} \times (\text{Number of residents/home}) \qquad (14\text{-}1)$$

Applying Eq. 14-1 to a residence with 2.6 residents results in an average flow per resident of 55 gal. This value correlates well with the values given in Table 14-1. Equation 14-1 can be revised to account for other household uses and the use of low-flush toilets and fixtures. For example, if 1.5 gal/flush toilets are used, the corresponding average flow for a residence with 2.6 occupants, based on five flushes per resident per day, would be 46 gal/capita · d.

Flowrate Variations. The flowrate variations that can be expected from an individual residence are quite variable, ranging from no flow in the early morning hours to peak hourly flowrates as high as 8 to 1 compared to the average daily flowrate. While the flowrate variation from an individual home is quite variable and unpredictable, the flowrate variation for 50 or more homes is quite similar to that given in Fig. 5-2 in Chap. 5. Typical peaking factors for individual residences, small commercial establishments, and small communities are reported in Table 14-2. The peaking factors for individual residences and small commercial establishments are, as shown, considerably greater than those for small communities. Peaking factors are of importance in the design of wastewater management facilities, especially for sizing grease traps for small commercial establishments and secondary settling tanks in package or built-in-place treatment plants.

TABLE 14-2
Peaking factors for wastewater flows from individual residences, small commercial establishments, and small communities[a]

Peaking factor	Individual residence		Small commercial establishment		Small community	
	Range	Typical	Range	Typical	Range	Typical
Peak hour	4–8	6	6–10	8	3–6	4.7
Peak day	2–6	4	4–8	6	2–5	3.6
Peak week	1.25–4	2.0	2–6	3	1.5–3	1.75
Peak month	1.2–3	1.75	1.5–4	2	1.2–2	1.5

[a] The reported peaking factors are exclusive of extreme flow events (i.e., values greater than the 99 percentile value).

Mohonk Water Treatment Plant

Calculating Peak Daily and Maximum Hourly Demand

MRG 9/27/01
Revised 11/08/01, 12/14/01

Purpose

To calculate the peak daily and peak hourly demand for the High Falls Water District given the average daily demand of 85,000 gpd or 59 gpm.

Method

Flow-rate variations can be quite great in small community water works such as the High Falls Water District (Metcalf and Eddy, 1991). The Feasibility Study (1999) states that because of limited historical water use data, the NYSDOH recommends that the maximum daily demand be calculated as twice the average daily demand (NYSDOH 1975). In the text, *Water Quality*, peak water use flows specifically for small communities are as stated in the following table. Peak hour factor is generally taken as 1.5 times the peak daily factor.

Peaking Factor	Range	Typical	Design Factor
Peak Hour	2.25-3.2	2.7	3.0
Peak Day	1.6-2.2	1.8	2.0

For the purpose of this design we will take the NYSDOH recommendation and more conservative daily peaking factor of 2.0 and a peak hour factor of 3.0 (1.5 times the peak daily factor).

Calculation

Peak Hourly Demand = Peak Hour Factor*Avg. Daily Demand = 85,000gpd*3.0 = **255,000 gpd (177 gpm)**
Peak Daily Demand = Peak Day Factor*Avg. Daily Demand = 85,000 gpd*2.0 = **170,000 gpd (118 gpm)**

References

Haestad et al., *Water Distribution Modeling*, 2001

Lawler, Matusky, and Skelly Engineers LLP, *Feasibility Study Report* Mohonk Road Industrial Superfund Site, March 1999

NYSDOH New York State Department of Health, *Designing Community Water Systems*, 1975

Tchobanoglous, George and Franklin Burton, *Wastewater Engineering Treatment, Disposal, and Reuse*, Metcalf and Eddy, Inc., 1991

Tchobanoglous, George and Shroeder *Water Quality* 1987

WATER QUALITY MANAGEMENT

WATER QUALITY

CHARACTERISTICS ■ MODELING ■ MODIFICATION

George Tchobanoglous Edward D. Schroeder

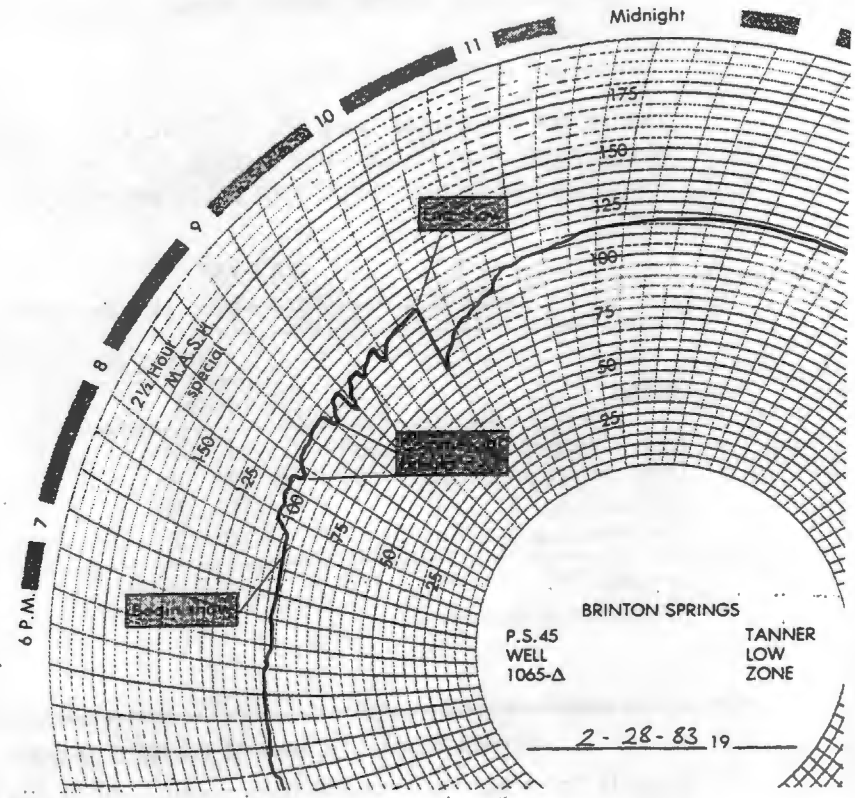


FIGURE 1.7

Effect of TV commercial breaks on pressure in water distribution systems. As demand and flow increase, distribution line pressure decreases.

Source: Courtesy of W. E. Evenson, Superintendent, Salt Lake City Department of Water Utilities.

water supply system is shown in Fig. 1.7, a copy of the pressure record for the Salt Lake City service area during the February 28, 1983, M*A*S*H special.

Design Factors

Important facts to note when examining Figs. 1.5 and 1.6 are the peak-to-minimum ratios and the duration of the peak flow. Facilities must be constructed to supply peak demand, and therefore capital costs are affected by relatively short time periods. Typical design values for the fluctuations that can be expected in water supply systems are presented in Table 1.9. Equation (1.3) has been proposed to estimate peak consumption as a function of the annual average [1.2]:

$$p = 180t^{-0.10} \tag{1.3}$$

where

p = percentage of the annual average demand corresponding to time, t

t = time, d ($2/24 \leq t \leq 360$)

The values determined using Eq. (1.3) are most applicable to small communities, since the variation is damped as communities increase in size, and where industries utilize the public water supply.

TABLE 1.9

Typical Fluctuations in Water Use in Municipal Systems

FLOW	PERCENT OF AVERAGE FOR YEAR		
	Range	Typical	Eq. (1.3)*
Daily average in maximum month	110–140	120	128
Daily average in maximum week	120–170	140	148
Maximum day	160–220	180	180
Maximum hour	225–320	270†	

*$p = 180t^{-0.10}$ [1.2].

†1.5 × maximum-day value.

EXAMPLE 1.2

ESTIMATION OF MUNICIPAL WATER DEMANDS

Estimate the water requirements for a community of 200,000 persons. Use Eq. (1.1) to estimate the required fire flows.

SOLUTION:

1. Determine the average daily demand using the data given in Table 1.2.

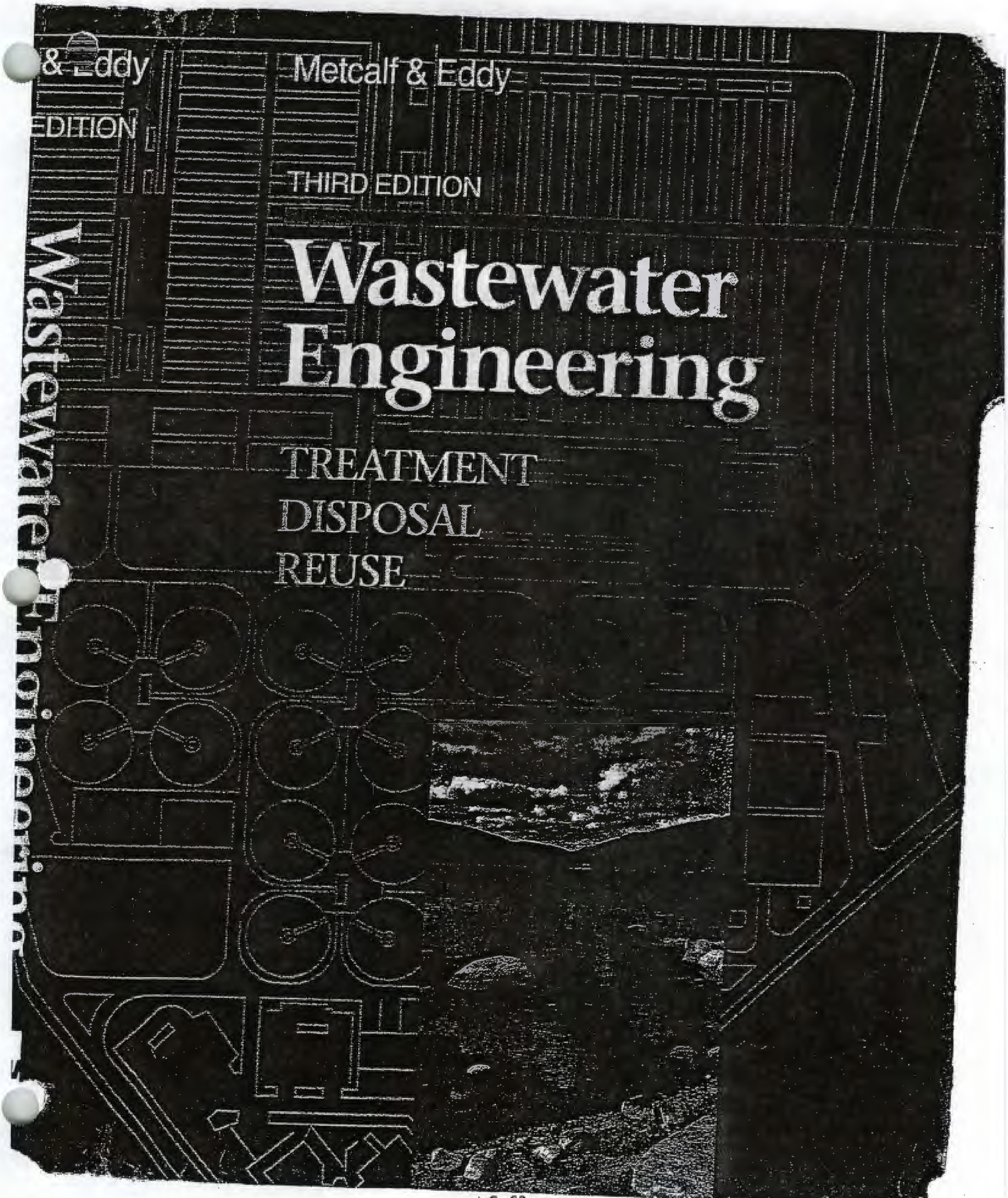
$$Q_{avg} = 0.6\ \text{m}^3/\text{person} \cdot \text{d}\ (200{,}000\ \text{persons})$$
$$= 1.2 \times 10^5\ \text{m}^3/\text{d}$$

2. Determine the maximum daily demand using the data given in Table 1.9.

$$Q_{\text{peak day}} = 1.2 \times 10^5\ \text{m}^3/\text{d} \times 1.8$$
$$= 2.16 \times 10^5\ \text{m}^3/\text{d}$$

3. Determine the maximum hourly demand using the data given in Table 1.9.

$$Q_{\text{peak hour}} = 1.2 \times 10^5\ \text{m}^3/\text{d} \times 2.7$$
$$= 3.24 \times 10^5\ \text{m}^3/\text{d}$$


& Eddy
EDITION
Wastewater Engineering
Metcalf & Eddy
THIRD EDITION
Wastewater Engineering
TREATMENT
DISPOSAL
REUSE

is shown, a typical per capita value for residences in unsewered areas is about 55 gal/capita · d (210 L/capita · d) based on an average occupancy of about 2.4 to 2.8 residents per home.

An alternative method that can be used to estimate the flow from individual residences is based on allocating the total water use between household and personal uses. Assuming that the household use consists of 10 gal for dishwashing, 25 gal for laundry and 5 gal for miscellaneous use and that personal use consists of 3 gal for drinking and cooking, 2 gal for oral hygiene, 18 gal for bathing, and 17 gal for toilet flushing, the flow from a residence would be:

$$\text{Flow, gal/residence}\cdot\text{d} = 40\ \text{gal/residence}\cdot\text{d} + 40\ \text{gal/resident}\cdot\text{d} \times (\text{Number of residents/home}) \quad (14\text{-}1)$$

Applying Eq. 14-1 to a residence with 2.6 residents results in an average flow per resident of 55 gal. This value correlates well with the values given in Table 14-1. Equation 14-1 can be revised to account for other household uses and the use of low-flush toilets and fixtures. For example, if 1.5 gal/flush toilets are used, the corresponding average flow for a residence with 2.6 occupants, based on five flushes per resident per day, would be 46 gal/capita · d.

Flowrate Variations. The flowrate variations that can be expected from an individual residence are quite variable, ranging from no flow in the early morning hours to peak hourly flowrates as high as 8 to 1 compared to the average daily flowrate. While the flowrate variation from an individual home is quite variable and unpredictable, the flowrate variation for 50 or more homes is quite similar to that given in Fig. 5-2 in Chap. 5. Typical peaking factors for individual residences, small commercial establishments, and small communities are reported in Table 14-2. The peaking factors for individual residences and small commercial establishments are, as shown, considerably greater than those for small communities. Peaking factors are of importance in the design of wastewater management facilities, especially for sizing grease traps for small commercial establishments and secondary settling tanks in package or built-in-place treatment plants.

TABLE 14-2
Peaking factors for wastewater flows from individual residences, small commercial establishments, and small communities[a]

Peaking factor	Individual residence		Small commercial establishment		Small community	
	Range	Typical	Range	Typical	Range	Typical
Peak hour	4–8	6	6–10	8	3–6	4.7
Peak day	2–6	4	4–8	6	2–5	3.6
Peak week	1.25–4	2.0	2–6	3	1.5–3	1.75
Peak month	1.2–3	1.75	1.5–4	2	1.2–2	1.5

[a] The reported peaking factors are exclusive of extreme flow events (i.e., values greater than the 99 percentile value).

WATER DISTRIBUTION MODELING

FIRST EDITION

HAESTAD • WALSKI • CHASE • SAVIC

individual nodes do not necessarily follow the same demand pattern as the system as a whole.

Peaking factors from average day to maximum day tend to range from 1.2 to 3.0, and factors from average day to peak hour are typically between 3.0 and 6.0. Of course, these values are system-specific, so they must be determined based on the demand characteristics of the system at hand.

Fire flows represent a special type of peaking condition, and they are described on page 147. Fire flows are usually added to maximum day flow when evaluating the capacity of the system for fire fighting.

Demands in Systems with High Unaccounted-for Water. Using global demand multipliers for projections in systems with high unaccounted-for water is based on the assumption that the relative size of unaccounted-for water will remain constant in the future. Unaccounted-for water can also be treated as one of the parts of a composite demand, as discussed on page 131. If unaccounted-for water is reduced, then the utility will see higher peaking factors because unaccounted-for water tends to flatten out the diurnal demand curve. Walski (1999) describes a method for correcting demand multipliers for systems where leakage is expected to change over time.

$$\frac{M}{A} = \frac{\left(\frac{M}{A}\right)_c Q_c + L}{Q_c + L} \tag{4.9}$$

where M/A = corrected multiplier
$(M/A)_c$ = multiplier for consumptive users only
Q_c = water use through customer meters in future (cfs, m^3/s)
L = leakage in future (cfs, m^3/s)

■ **Example - Peaking Factors** For example, if the multiplier for metered customers (M/A_c) is 2.1, and the metered demand (Q_c) is projected to be 2.4 MGD in a future condition, then the overall multiplier can be determined based on estimated future leakage as shown below.

Leakage (MGD)	M/A
0.0	2.1
0.5	1.9
1.0	1.8

Because leakage contributes the same to average and peak demands, the peak demand multipliers increase as leakage decreases. The numerical value of $(M/A)_c$ can be calculated using current year data and Equation 4.10.

Mohonk Water Treatment Plant
Calculating Fire Flow
MRG 9/28/01
Revised 10/31/01
Revised 11/15/01, 11/19/01

11/20/01
JJF 11/20/01

Purpose
To calculate the fire demand for the High Falls Water District.
Based on NYSDOH policy, fire protection is included as part of the water system design.

Method
The National Board of Fire Underwriters calculates required fire flow based on the formula:

$$G = 1020\,(P)^{1/2}\,(1 - 0.01\,(P)^{1/2})$$

Where G is the required fire flow in gpm and P is the population in thousands (NFPA 1986). This is fire flow formula used in the FS. The FS, using a population of 364 people calculated a fire flow of 750 gpm.

E&E calculated the fire flow using a present population of the High Falls Water District is 403. The future population is estimated to be 523.

$$G = 1020\,(0.403)^{1/2}\,(1 - 0.01\,(0.403)^{1/2}) = 643 \text{ gpm (present)}$$
$$G = 1020\,(0.523)^{1/2}\,(1 - 0.01\,(0.523)^{1/2}) = 732 \text{ gpm (future)}$$

Fire flows are rounded up to the nearest 250 gpm, making a fire flow of 750 gpm.

However, according to the National Fire Protection Association (NFPA), this method is not considered reliable for determining fire flow in decentralized cities, such as the Hamlet of High Falls (NFPA 1986).

The NFPA's preferred method of determining fire flow requirements is found in the Insurance Services Office (ISO) "Guide for Determination of Needed Fire Flow". This document provides guidance for estimating fire flow requirements for specific structures for insurance rating purposes. The method takes into account types of construction, the area of buildings, as well as building density. The basic formula is:

$$NFF = (C)(O)(1+(X+P))$$

Where,
NFF = the needed fire flow in gpm
C = a factor related to the type of construction
O = a factor related to the type of occupancy
X = a factor related to the exposure of the building
P = a factor related to the communications between buildings

The maximum needed fire flow in the HFWD was determined to be 1500 gpm (see calculations attached). This is the fire flow needed at a few residences and businesses in the district prone to more severe fires, requiring a maximum amount of fire flow.

ISO calculates general fire flow requirements for towns using the following ISO table. This is for towns comprised of dwellings of one and two family homes not more than 2 stories high, such as in the Hamlet of High Falls.

Distance Between Buildings	Needed Fire Flow
More than 100'	500 gpm
31-100'	750 gpm
11-30'	**1,000 gpm**
10' or less	1,500 gpm

The required general fire flow in the HFWD would be 1000 gpm, as houses are within 11 to 30' in the Hamlet of High Falls.

During a meeting held with he High Falls Volunteer Fire department on 10/15, the fire department has requested a fire flow of 1000 gpm (Contact report HF VFD 10/22/01). The fire district has three trucks each with a 1,250 gpm capacity.

Therefore the designed fire flow for the HFWD will be 1000 gpm based on the general ISO calculation and upon High Falls Volunteer Fire Department's request.

Assuming that the fire flow duration required is 2 hours (NFPA 1986) the storage required to maintain the flow is 120,000 gallons.

References

NFPA, National Fire Protection Association, *Fire Protection Handbook*, 16th edition, March 1986

Contact Report 10/22/01, High Falls Volunteer Fire Department, Ms. Lisa Scherrieble, Commissioner 845-687-9235, Site meeting 10/15/01

ISO, *Guide for Determination of Needed Fire Flow*, 10/2001

ISO Determination of Needed Fire Flow

NFF = (C)(O)(1+(X+P))

NFF = the needed fire flow in gpm
C = a factor related to the type of construction
O = a factor related to the type of occupancy
X = a factor related to the exposure of the building
P = a factor related to the communications between buildings

Step 1: Determine the predominant construction type and the associated factor (F)

F = coefficient related to the class of construction
= 1.5 for Class 1 wood frame construction
= 1.0 for Class 2 jointed masonry construction
= 0.8 for Class 3 or 4 noncombustible construction
= 0.6 for Class 5 or 6 fire resistive construction

Step 2: Determine the effective area (A)

Step 3: Determine C, $C=18F(A)^{0.5}$, round C to the nearest 250 gpm

Step 4: Determine the predominant occupancy type (O)

O = type of occupancy factor
= 0.75 for C-1 noncombustible
= 0.85 for C-2 limited-combustible
= 1.00 for C-3 combustible
= 1.15 for C-4 free-burning
= 1.25 for C-5 rapid-burning

Step 5: Determine if there is an exposure charge by identifying the construction type and the length-height value of the exposure building as well as the distance (in feet) to the exposure building. Also make note of any openings and protection of those opening in the wall facing the subject building (the building the needed fire flow is being calculated on). The factor related to the exposure building is X.

Step 6: Determine if there is communication charge by identifying the combustibility of the passageway, whether the passageway is open or closed, the length, and a description of any protection provided in the passageway openings. The factor related to the communications between buildings is P.

Step 7: Substitute the values for the factors in the formula NFF = (C)(O)(1+(X+P))

Scenarios for the Towns of Marbletown and Rosendale in the High Falls Water District

	Factor	Type	Value	
Rosendale				
2-Story	F	wood	1.5	
Colonial (1998)	A	4172 ft^2	4172	
"worst case"	C		1750	
	O	residential	0.85	
	X	no exposure	0	
	P	no communications	0	
	NFF (gpm)		**1487.5**	**1500**

	Factor	Type	Value	
Marbletown				
2-story	F	wood	1.5	
Colonial (1930)	A	2910 ft^2	2910	
In town	C		1500	
"fifth highest"	O	residential	0.85	
"basic fire flow"	X	unprotected, 31-60' away	0.1	
	P	no communications	0	
	NFF (gpm)		**1402.5**	**1500**

Other Considerations

For 1 and 2-family dwellings not exceeding 2 stories in height, ISO uses the following fire flows

Distance Between Buildings	Needed Fire Flow
More than 100'	500 gpm
31-100'	750 gpm
11-30'	*1,000 gpm*
10' or less	1,500 gpm

10/22/01

CONTACT REPORT
(X) Site Visit
MRIP

CLIENT: United States Army Corps of Engineers Kansas City District

CONTACT: High Falls Vol Fire Dept, Ms. Lisa Scherrieble, Commissioner, 845-687-9235

TELEPHONE: (845- 331-5533).

DATE: October 15, 2001

TO: Bob Pender

FROM: Don Miller

cc: Mohonk Team

SUMMARY: On 10/15/01, 7:00 PM, a meeting was held at the HF V FD in High Falls, NY. Present were: Ms. Lisa Scherrieble, Commissioner, 845-687-9235 and fax 845-687 - 7786; Otto Scherrieble 2nd Assist Chief, 845-687-9235; John Marks, Commissioner, 845 – 687 – 7786; Arthur Rapp, Jr, Lt.,

DETAILS: The following questions were asked to the H F V FD:

1. The required nozzle thread type and nozzle diameters,
2. Typical hydrant spacing along roads,
3. The need for additional hydrants to compensate for residences with long setbacks,
4. Type of hydrant preferred,
5. The length of "bridges" through roadside ditches to the hydrants ("bridges" will consist of pipe laid within the roadside ditches with backfill placed to grade or similar),
6. Maximum expected fire flow,
7. Other design considerations that the Fire Department may require.

Answers were as follows:

1. A 4 ½ " steamer connection and 2 – 2 ½" hose connections are required. American Standard Thread, type NH should be specified for the connections.
2. Spacing along the roads should be at 400 ft intervals and at intersections. However, a tighter spacing may be required within the Hamlet.

Fire Protection Handbook

Sixteenth Edition

NFPA®

National Fire Protection Association

to operate with pressures that high. Pressure reducing valves can be used in some sections of a system where variations in topography result in excessive pressures. Individual water services to buildings may require pressure reducing valves to keep the pressure on domestic piping at safe levels.

Systems for Higher Elevations

When water must be supplied to high elevations, a separate water distribution system is usually provided for the elevated section so that normal pressures are maintained. In such cases, the elevated area should be provided with its own water storage facility, and pumps may be provided to boost the water from other parts of the system. Likewise, the upper stories of a high building should be provided with water supply systems in the building itself. These systems have the same requirements as areas on a hill. High rise structures are normally divided into a number of pressure zones. Zones of more than twelve stories tend to get outside the normal pressure ranges. In any case, each pressure zone must have storage of water in amounts needed for the sprinkler service or hose streams to be provided, and a system of pumps so that each zone is supplied from the zone below. Care should be taken to ensure that pumps will be able to operate even during power failures.

(For information and guidance concerning water supplies for high rise structures, see NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*; and NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.)

CALCULATING FIRE FLOWS

For many years the NBFU formula (see Table 17-3A) was commonly used as a guide to determine the fire flow required in the downtown business districts of municipalities. The formula

$$G = 1020\sqrt{P}\,(1 - 0.01\sqrt{P})$$

gave the fire flow, G, in gallons per minute as a function of the population, P, in thousands.

In making fire protection surveys, the fire flow requirements in the sections of the municipalities outside the downtown business district were estimated by the engineers of the NBFU and insurance bureaus.

As cities became more decentralized, the formula based on population became less reliable as a guide for the fire flow needed downtown. In addition, it became apparent that a guide to engineering judgment was needed for the other sections of the cities. In 1948, a paper by A. C. Hutson, assistant chief engineer of the NBFU, provided some specific suggestions for estimating fire flow requirements in these sections based on type of construction and area of building (Hutson 1948).

The Fire Suppression Rating Schedule

The latest developments in estimating fire flow requirements are found in the Insurance Services Office's "Fire Suppression Rating Schedule" (ISO 1980). It provides guidance for estimating fire flow requirements for specific structures for insurance rating purposes. The basic formula in the schedule is:

$$NFF_i = (C_i)(O_i)(X+P)_i$$

Where NFF_i is Needed Fire flow in gallons per minute (L/min); C_i is a construction factor which depends upon the type of construction of the structure under consideration; O_i is an occupancy factor which depends upon the determination of the type of occupancy in terms of rates of combustibility; and $(X+P)_i$ is an exposure factor which depends upon the extent of exposure from and to adjacent structures.

The needed flow should not exceed 12,000 gpm (45 425 L/min) nor be less than 500 gpm (1893 L/min). The practical reason for these figures is that manual fire fighting methods using hose streams and heavy stream appliances are not likely to need a larger supply considering the general arrangement of buildings and the availability of hydrants. However, the possibility of a second simultaneous fire in the largest cities is considered.

For groupings of one family and small two family dwellings not more than two stories high, the short method of determining required fire flow given in Table 17-3B may be used. The required fire flow should be available with consumption at the maximum daily rate. The number of hours during which the required fire flow should be available varies from 2 to 10 hours as indicated in Table 17-3C.

TABLE 17-3B. Fire Flows for Groups of Dwellings

Exposure Distances		Suggested Required Fire Flow	
Ft	m	gpm	L/min
Over 100	30	500	1893
31 to 100	9.5–30	750–1,000	2839–3785
11 to 30	3.4–9.1	1,000	3785
10 or less	3 or less	1,500	5678

There are fires where quantities of water in excess of the required fire flow are used. Water supplies of 50,000 gpm (190 000 L/min) or greater have been used in fire suppression, but to design systems capable of delivering flows of that magnitude in the average community for a possible unusual situation is too expensive.

ADEQUACY AND RELIABILITY OF SUPPLY

The adequacy of any given water supply system can be determined by engineering estimates. The source, including storage facilities in the distribution system, must be sufficient to furnish all the water that combined fire and domestic needs may call for at any one time. Arrangement of the supply works and details of the pumping facilities may limit the adequacy of the supply or affect its reliability.

In a pumping system, a common arrangement is to have one set of pumps that takes suction from wells or from a river, lake, or other body of water. If the water does not have to be filtered, the pumps may discharge directly into the distribution system. Where filtration or other treatment is necessary, pumps take suction from the primary or raw water source and discharge to sedimentation

TABLE 17-3C. Duration of Required Fire Flow

Required Fire Flow					Required Fire Flow				
gpm	L/min	Million gallons per day	Million liters per day	Duration hours	gpm	L/min	Million gallons per day	Million liters per day	Duration hours
…00 ←	3785	1.44	5.45	2	4,500	17 034	6.48	24.53	4
…250	4732	1.80	6.81	2	5,000	18 927	7.20	27.25	5
…500	5678	2.16	8.18	2	5,500	20 820	7.92	29.99	5
…750	6624	2.52	9.54	2	6,000	22 712	8.64	32.71	6
…000	7571	2.88	10.90	2	7,000	26 498	10.08	38.16	7
…250	8517	3.24	12.26	2	8,000	30 283	11.52	43.61	8
…500	9463	3.60	13.63	2	9,000	34 069	12.96	49.06	9
…000	11 356	4.32	16.35	3	10,000	37 854	14.40	54.51	10
…500	13 249	5.04	19.08	3	11,000	41 639	15.84	59.96	10
…000	15 142	5.76	21.80	4	12,000	45 425	17.28	65.41	10

…ns or other facilities and then to filter beds. After …essing, the water flows to clear water reservoirs from …re a second set of pumps takes suction and discharges …water directly into the supply system. Unfortunately, …ure of any part of the equipment may affect the entire …em. This is usually taken care of by duplication of …its and by arrangement of the plant to facilitate repairs. When assessing the reliability of the supply works, …tures which should be evaluated are: minimum yield; …quency and duration of droughts; condition of intakes; …sibility of earthquakes, floods, and forest fires; ice …ditions, silting up or shifting of river channels; and …ence of guards or watchmen where needed to protect …facility, from physical injury. Reservoirs out of service …cleaning, and the interdependence of parts of water-…ks also affect reliability. The condition, arrangement, …dependability of individual units of plant equipment, …ch as pumps, engines, generators, electric motors, fuel …ply, electric transmission facilities and similar items, …so factors. Pumping stations of combustible construc-…are subject to destruction by fire unless protected by …atic sprinkler systems.

…uplication of pumping units and storage facilities, …rrangement of mains and distributors so that water …is supplied to them from more than one direction, are …res that can assure continuous operation. The im-…nce of duplicate facilities is shown by the frequency …raise.

FUTURE REQUIREMENTS FOR DETERMINING FIRE FLOW

…he amount of water needed to control and extinguish …in a given property cannot be established currently in …terms. Better fire experience data bases should …possible to tailor fire flows more specifically to …ions that might be expected at the time of a fire. …analysis may indicate a need to increase fire flow …what is presently required, or it may result in a …system design based upon a balance between the …olved and the economics of maintaining the water …

…e American Water Works Association (AWWA) at a …g in St. Louis in 1981 formed a working committee …rotection under the supervision of the AWWA's Distribution Division. The committee is in the process of developing a "Manual of Standard Practice for Considerations which Affect Fire Protection and Suppression." The document will be one of a comprehensive nature which will include all elements of water supply systems in terms of adequacy and reliability in addition to providing a procedure for determing required fire flows.

The Role of Codes and Ordinances

Fire prevention codes can effectively limit hazards and ignition sources within buildings which in turn not only limits the number of fires, but the size of fires throu… the control of combustibles in a fire area. A good buildi… code further reduces the chance for a serious fire by requiring construction materials and building assemblies which will contain a developing fire to a given area. Codes alone can reduce considerably the amount of water needed for fire fighting. Zoning ordinances that establish distances between properties can be effective in controlling exposure situations.

The Role of Fire Detection and Extinguishing Systems

The increased use of automatic extinguishing systems, whether they use water or some other agent, will affect the quantities of water required. However, until more widespread use is made of early warning systems and automatic extinguishing systems, it will not be possible to equate the effect of these systems to required fire flow. Water supply requirements are just one factor in a system that determines what the potential for a fire is, how extensive the fire will be, and the measures needed to suppress it. Research will someday measure all these factors and permit establishing fire flows on the basis of thoroughly researched and documented principles.

Bibliography

References Cited

ASCE. 1951. "Fundamental Considerations in Rates and Rate Structures for Water and Sewage Works: A Joint Report o… Committees of the American Society of Civil Engineers and the Section of Municipal Law of the American Bar Association and of Representatives of the American Water Works

GUIDE FOR DETERMINATION

OF NEEDED FIRE FLOW

545 Washington Boulevard
Jersey City, New Jersey 07310-1686
(800) 888-4ISO (4476)
www.iso.com

EDITION 10-2001

INDEX

PREFACE

ISO is the premier source of information, products, and services related to property and liability risk. For a broad spectrum of types of insurance, ISO provides statistical, actuarial, underwriting, and claims information and analyses; consulting and technical services; policy language; information about specific locations; fraud-identification tools; and data processing. In the United States and around the world, ISO serves insurers, reinsurers, agents, brokers, self-insureds, risk managers, insurance regulators, fire departments, and other government agencies.

One of ISO's important services is to evaluate the fire suppression delivery systems of jurisdictions around the country. The result of those reviews is a classification number that ISO distributes to insurers. Insurance companies use the Public Protection Classification (PPC™) information to help establish fair premiums for fire insurance – generally offering lower premiums in communities with better fire protection.

ISO uses the Fire Suppression Rating Schedule (FSRS) to define the criteria used in the evaluation of a community's fire defenses. Within the FSRS, a section titled "Needed Fire Flow" outlines the methodology for determining the amount of water necessary for providing fire protection at selected locations throughout the community. ISO uses the needed fire flows to:

1. Determine the community's "basic fire flow." The basic fire flow is the fifth highest needed fire flow in the community. ISO uses the basic fire flow to determine the number of apparatus, the size of apparatus fire pumps, and special fire-fighting equipment needed in the community.
2. Determine the adequacy of the water supply and delivery system. ISO calculates the needed fire flow for selected properties and then determines the water flow capabilities at these sites. ISO then calculates a ratio considering the need (needed fire flow) and the availability (water flow capability). ISO uses that ratio in calculating the credit points identified in the FSRS.

ISO developed the needed fire flow through a review of actual large-loss fires. ISO recorded the average fire flow and other important factors, including construction type, occupancy type, area of the building, and exposures. Those factors are the foundation of the needed fire flow formula.

The following pages include a number of excerpts from another ISO document, the Specific Commercial Property Evaluation Schedule (SCOPES). ISO uses the SCOPES manual to weigh features of individual properties for the purpose of defining the building's vulnerability to future fire loss. Insurers also use the information in their underwriting and ratemaking decisions.

CHAPTER 1

Needed Fire Flow Formula

To estimate the amount of water required to fight a fire in an individual, nonsprinklered building, ISO uses the formula:

$$NFF_i = (C_i)(O_i)(1+(X+P)_i)$$

where

NFF_i	=	the needed fire flow in gallons per minute (gpm)
C_i	=	a factor related to the type of construction
O_I	=	a factor related to the type of occupancy
X	=	a factor related to the exposure buildings
P	=	a factor related to the communication between buildings

To calculate the needed fire flow of a building, you will need to determine the predominant type (class) of construction, size (effective area) of the building, predominant type (class) of occupancy, exposure to the property, and the factor for communication to another building.

Here is the step-by-step process:

Step 1. Determine the predominant construction type and the associated factor (F).
Step 2. Determine the effective area (A).
Step 3. Substituting the values for "F" and "A" into the formula $C_i=18F(A)^{0.5}$ and calculate the construction factor (C_i).
Step 4. Round the construction factor (C_i) to the nearest 250 gpm.
Step 5. Determine the predominant occupancy type and the associated factor (O_i).
Step 6. Determine if there is an exposure charge by identifying the construction type and length-height value of the exposure building as well as the distance (in feet) to the exposure building. Also make note of any openings and protection of those openings in the wall facing the subject building (the building the needed fire flow is being calculated on). The factor related to the exposure building is (X).
Step 7. Determine if there is a communication charge by identifying the combustibility of the passageway, whether the passageway is open or closed, the length, and a description of any protection provided in the passageway openings. The factor related to the communications between buildings is (P).
Step 8. Substitute the values for the factors in the formula $NFF_i = (C_i)(O_i)(1+(X+P)_i)$ to determine the needed fire flow.

Note: ISO does not determine a needed fire flow for buildings rated and coded by ISO as protected by an automatic sprinkler system meeting applicable National Fire Protection Association standards. See Chapter 6, "Determining Recognition of Automatic Sprinkler Systems," for more information.

CHAPTER 2

Type of Construction (C_i) and Effective Area (A_i)

To determine the portion of the needed fire flow attributed to the construction and area of the selected building, ISO uses the formula:

$$C_i = 18F (A_i)^{0.5}$$

where

F = coefficient related to the class of construction
- F = 1.5 for Construction Class 1 (wood frame construction)
- = 1.0 for Construction Class 2 (joisted-masonry construction)
- = 0.8 for Construction Class 3 (noncombustible construction and Construction Class 4 (masonry noncombustible construction)
- = 0.6 for Construction Class 5 (modified fire-resistive construction) and Construction Class 6 (fire-resistive construction)

A_i = effective area

Appendix A provides C_i for a range of construction classes (F) and effective areas (A_i).

1. Construction Materials and Assemblies

ISO uses the following definitions to determine the construction class for a building:

a. Combustible: Wood or other materials that will ignite and burn when subjected to fire, including materials with a listed flame-spread rating greater than 25. Also included are assemblies or combinations of combustible materials with other materials, such as the following:

(1) Metal walls or floors sheathed on either interior or exterior surfaces (with or without air space) with wood or other combustible materials (flame-spread rating over 25).

(2) Metal floors or roofs with combustible insulation or other combustible ceiling material attached to the underside of the floor or interior surface of the roof deck, or within 18" of the horizontal supports.

(3) Combustible wall materials with an exterior surface of brick, stone, or other masonry materials (commonly known as "masonry veneer").

(4) Noncombustible wall or roof construction on a skeleton wood frame (commonly known as "wood-iron clad").

(5) Combustible wall or roof construction on a noncombustible or slow-burning frame.

(6) Composite assemblies of noncombustible materials with combustible materials, such as a combustible core between two noncombustible panels, or a noncombustible panel with a combustible insulation material (flame-spread rating over 25).

(7) Composite assemblies of noncombustible or slow-burning materials combined with foamed plastic materials (with any flame-spread rating), unless the foamed plastic materials qualify as slow-burning. (Refer to Item f, below.)

(8) Combustible assemblies which are listed as having not less than a one-hour rating.

b. **Fire-resistive:** Noncombustible materials or assemblies which have a fire-resistance rating of not less than one hour.

c. **Masonry:** Adobe, brick, cement, concrete, gypsum blocks, hollow concrete blocks, stone, tile, and similar materials with a minimum thickness of 4".

d. **Noncombustible:** Materials, no part of which will ignite and burn when subjected to fire, such as aluminum, asbestos board, glass, gypsum board, plaster, slate, steel, and similar materials. Also included are:

(1) Fire-resistive and protected-metal assemblies with a fire-resistance rating of less than one hour

(2) Materials or composite materials with a listed surface-flame-spread rating of 0 and of such composition that surfaces that would be exposed by cutting through the material in any way would not have a listed flame-spread rating greater than 0

(3) Masonry walls less than 4" thick, which are not a part of combustible walls (masonry veneer)

Note: Combustible nailing (furring) strips fastened directly to noncombustible supports shall not affect the classification of noncombustible walls, floors, or roofs.

e. **Protected metal:** Metal which is protected by materials so that the resulting assembly has a fire-resistance rating of not less than one hour.

f. **Slow-burning:** Materials with a listed flame-spread rating greater than 0 but not greater than 25; except, foamed plastic materials shall be rated as slow-burning if such materials or coverings meet one of the conditions in (1) or (2) below.

An acceptable thermal barrier includes those which have been tested as part of a field-fabricated or factory-manufactured composite assembly which has passed one of the acceptable wall or ceiling panel tests, when applied over foamed plastic material of a thickness and listed flame-spread rating not greater than that used in the composite assembly tested. Where any material is of a type which falls or drips to the floor of the furnace during the flame-spread test, the flame-spread rating of the material, when not protected by a thermal barrier, shall be based on the flame-spread rating of the material on the floor of the furnace, where this flame-spread is higher than the flame-spread of the material on the furnace ceiling. In all other cases, the normal flame-spread rating of the material on the furnace ceiling shall be used.

(1) An acceptable thermal barrier consisting of 1/2" or greater noncombustible material, such as plaster, cement, or gypsum board, when used over foamed plastic material having a listed flame-spread rating not greater than 25

(2) An acceptable thermal barrier which is listed with not less than a 15-minute finish rating when used over foamed plastic material having a listed flame-spread rating not greater than 25

Note 1: Combustible nailing (furring) strips fastened directly to slow-burning supports shall not affect the classification of slow-burning walls, floors, or roofs.

Note 2: Lumber and lumber products shall be eligible for consideration as slow-burning only when all the ceilings and the walls are treated with a listed flame-retardant impregnation which meets all of the following requirements:

(1) Impregnation-treated materials shall be properly identified as having a flame-spread rating of 25 or less.

(2) Such identification shall indicate that there is no evidence of significant progressive combustion when subjected to at least 30 minutes test duration.

(3) Such identification shall indicate that the material has a permanent treatment not subject to deterioration from the effects of weathering, exposure to moisture or humidity, etc. (This requirement only applies where the treated material is exposed to the weather or moisture.) However, combustible nailing (furring) strips, doors, trim, and the top surfaces of combustible floors shall not be required to be treated.

g. **Unprotected metal:** Metal with no fire-resistive protection, or with a fire-resistance rating of less than one hour.

2. Classification of Basic Construction Types

ISO classifies construction types into six different categories:

Construction Class 6 (fire-resistive construction)
Construction Class 5 (modified fire-resistive construction)
Construction Class 4 (masonry noncombustible construction)
Construction Class 3 (noncombustible construction)
Construction Class 2 (joisted-masonry construction)
Construction Class 1 (wood frame construction)

Note: In applying the rules below, ISO disregards below-grade basement walls and the construction of the lowest floor (usually concrete).

a. **Fire-resistive (Construction Class 6):** Buildings constructed of any combination of the following materials:

Exterior walls or exterior structural frame:

- Solid masonry, including reinforced concrete, not less than 4 inches in thickness
- Hollow masonry not less than 12 inches in thickness
- Hollow masonry less than 12 inches, but not less than 8 inches in thickness, with a listed fire-resistance rating of not less than two hours

- Assemblies with a fire-resistance rating of not less than two hours

  Note: Panel or curtain sections of masonry may be of any thickness.

Floors and roof:

- Monolithic floors and roof of reinforced concrete with slabs not less than 4 inches in thickness

- Construction known as "joist systems" (or pan-type construction) with slabs supported by concrete joists spaced not more than 36 inches on centers with a slab thickness not less than 2 _ inches

- Floor and roof assemblies with a fire-resistance rating of not less than two hours

Structural metal supports:

- Horizontal and vertical load-bearing protected metal supports (including prestressed concrete units) with a fire-resistance rating of not less than two hours

  Note: Wherever in the SCOPES reference is made to "prestressed," this term shall also include "posttensioned."

b. **Modified fire-resistive (Construction Class 5):** Buildings with exterior walls, floors, and roof constructed of masonry materials described in a., above, deficient in thickness, but not less than 4 inches; or fire-resistive materials described in a., above, with a fire-resistance rating of less than two hours, but not less than one hour.

c. **Masonry noncombustible (Construction Class 4):** Buildings with exterior walls of fire-resistive construction (not less than one hour), or of masonry, not less than 4 inches in thickness and with noncombustible or slow-burning floors and roof (including noncombustible or slow-burning roof decks on noncombustible or slow-burning supports, regardless of the type of insulation on the roof surface).

d. **Noncombustible (Construction Class 3):** Buildings with exterior walls, floors, and roof of noncombustible or slow-burning materials supported by noncombustible or slow-burning supports (including noncombustible or slow-burning roof decks on noncombustible or slow-burning supports, regardless of the type of insulation on the roof surface).

e. **Joisted-masonry (Construction Class 2):** Buildings with exterior walls of fire-resistive construction (not less than one hour), or of masonry, and with combustible floors and roof.

f. **Frame (Construction Class 1):** Buildings with exterior walls, floors, and roof of combustible construction, or buildings with exterior walls of noncombustible or slow-burning construction, with combustible floors and roof.

Notes applicable to construction-type definitions above:

Note 1: Masonry or fire-resistive walls with panels composed of glass, noncombustible, slow-burning, combustible, or open sections shall retain their classification as masonry or fire-resistive, provided that such panels are in or supported by a structural frame of masonry or protected metal (two hours fire resistance if in walls classed as Construction Class 6, one hour in classes 2, 4, or 5). Similarly, masonry or fire-resistive floors with wood or other combustible surfacing in buildings otherwise subject to Construction Classes 5 or 6 shall retain their classification as Classes 5 or 6.

Note 2: Noncombustible or slow-burning roof deck with an exterior surface of combustible materials, such as combustible insulation, felt, asphalt, or tar, shall retain its classification as noncombustible or slow-burning.

3. **Classification of Mixed Construction**

In buildings constructed as defined in two or more classes above, ISO determines the appropriate construction class as follows:

Note: In applying these rules, ISO disregards basement walls and the lowest floor level.

a. **Fire-resistive:** Any building with 66 2/3 % or over of the total wall area and 66 2/3 % or over of the total floor and roof area constructed as defined in Construction Class 6.

b. **Modified fire-resistive:** Any building with 66 2/3 % or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in Construction Class 5; or

Any building with 66 2/3% or over of the total wall area, and 66 2/3% or over of the total floor and roof area constructed as defined in Construction Classes 5 and 6, but with neither type in itself equaling 66 2/3% or over of the total area.

c. **Masonry noncombustible:** Any building with 66 2/3% or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in Construction Class 4; or

Any building not qualifying under a. or b., above, with 66 2/3% or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in two or more of Construction Classes 4, 5, and 6, but with no single type in itself equaling 66 2/3% or over of the total area.

d. **Noncombustible:** Any building with 66 2/3% or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in Construction Class 3; or

Any building not qualifying under a. through c., above, with 66 2/3% or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in two or more of Construction Classes 3, 4, 5, and 6, but with no single type in itself equaling 66 2/3% or over of the total area.

e. **Joisted-masonry:** Any building not qualifying under a. through d., above, with 66 2/3% or over of the total wall area constructed as described in Construction Class 2; or

Any building not qualifying under a. through d., above, with 66 2/3% or over of the total wall area and 66 2/3% or over of the total floor and roof area constructed as defined in two or more of

Construction Classes 2, 3, 4, 5, and 6, but with no single type in itself equaling 66 2/3% or over of the total area.

f. **Frame:** Any building not qualifying under a. through e., above, or any building with over 33 1/3 % of the total wall area of combustible construction, regardless of the type of construction of the balance of the building.

4. **Determining Effective Area (A_i)**

In the portion of the needed fire flow formula attributed to the construction and area of the subject building,

$$C_i = 18F (A_i)^{0.5}$$

the factor "A" is the "effective area" of the subject building.

a. **Exempt areas:**
Disregard the following in the determination of the effective area:

- In nonsprinklered buildings, or buildings which do not qualify for sprinkler credit (see Chapter 6. "Determining Recognition of Automatic Sprinkler Systems"), disregard floor areas (including basement and subbasement) where the entire floor is protected by an acceptable system of automatic sprinklers or other acceptable automatic fire protection systems, provided that there are no Combustibility Class C-5 occupancies on the floor (see "Occupancy Factor," 1e., "Rapid-burning or flash-burning").

- Basement and subbasement areas which are vacant, or are used for building maintenance, or which are occupied by occupancies having C-1 or C-2 contents combustibility (see "Occupancy Factor") regardless of the combustibility class applicable to the building. A basement is a story of a building which is 50% or more below grade, unless such story is accessible at grade level on one or more sides. A story which is less than 50% below grade shall also be considered a basement if such story is wholly enclosed by blank masonry foundation walls.

- In breweries, malt mills, and other similar occupancies, disregard perforated (slatted) operating decks which contain no storage.

- Roof structures, sheds, or similar attachments.

- Courts without roofs.

- Areas of mezzanines less than 25% of the square foot area of the floor immediately below.

b. **Modification for division walls:**
An acceptable division wall shall be constructed entirely of noncombustible materials with a fire-resistance rating of not less than one hour, or of masonry materials, and shall:

(1) Extend from one exterior wall to another (or form an enclosed area within the building).

(2) Extend from one masonry or fire-resistive floor to another masonry or fire-resistive floor, or from a masonry or fire-resistive floor to a roof of any construction.

(3) Have all openings through the wall protected by an automatic or self-closing labeled Class B (not less than one-hour) fire door.

Where division walls meet the above requirements, the maximum area on any floor used to determine the effective area shall be the largest undivided area plus 50% of the second largest undivided area on that floor.

c. Effective-area calculation:

After modification for division walls as provided above, the effective area shall be the total square foot area of the largest floor in the building, plus the following percentage of the total area of the other floors:

(1) Buildings classified as Construction Classes 1 - 4: 50% of all other floors.

(2) Buildings classified as Construction Classes 5 or 6:

(a) If all vertical openings in the building are protected (see 4d., "Protection requirements." below), 25% of the area of not exceeding the two other largest floors.

(b) If one or more vertical openings in the building are unprotected (see 4d., "Protection requirements." below), 50% of the area of not exceeding 8 other floors with unprotected openings.

Note: The effective area determined under item 4c.(2)(b), above, shall not be less than the effective area that would be determined under item 4c.(2)(a), above, if all openings were protected.

d. Protection requirements:

The protection requirements for vertical openings are only applicable in buildings of Construction Class 5 or 6. The type of protection for vertical openings shall be based on the construction of the enclosure walls and the type of door or other device used for the protection of openings in the enclosure.

The following materials are acceptable for one-hour construction in enclosure walls: 4-inch brick, 4-inch reinforced concrete, 6-inch hollow block, 6-inch tile, or masonry or noncombustible materials listed with a fire-resistance rating of not less than one hour.

Protected openings:

Enclosures shall have walls of masonry or fire-resistive construction with a fire-resistance rating of not less than one hour.

Doors shall be automatic or self-closing and be labeled for Class B opening protection (not less than one-hour rating).

Elevator doors shall be of metal or metal-covered construction, so arranged that the doors must normally be closed for operation of the elevator.

Unprotected openings:

Unprotected floor openings. Also includes doors or enclosures not meeting the minimum requirements for protected openings, above.

5. Maximum and Minimum Value of C_i:

The value of C_i shall not exceed

8,000 gpm for Construction Class 1 and 2
6,000 gpm for Construction Class 3, 4, 5, and 6
6,000 gpm for a 1-story building of any class of construction

The value of C_i shall not be less than 500 gpm.

ISO rounds the calculated value of C_i to the nearest 250 gpm.

CHAPTER 3

Occupancy Factor (O_i)

The factors below reflect the influence of the occupancy in the subject building on the needed fire flow:

Occupancy Combustibility Class	Occupancy Factor (O_i)
C-1 (Noncombustible)	0.75
C-2 (Limited-combustible)	0.85
C-3 (Combustible)	1.00
C-4 (Free-burning)	1.15
C-5 (Rapid-burning)	1.25

1. **Determining Occupancy Type**

Occupancy combustibility classifications reflect the effect of the combustibility of contents on the building structure. ISO uses the following definitions to determine the combustibility classification of an occupancy:

a. **Noncombustible (C-1)** - Merchandise or materials, including furniture, stock, or equipment, which in permissible quantities do not in themselves constitute an active fuel for the spread of fire.

No occupancy shall be eligible to this classification which contains a sufficient concentration of combustible material to cause structural damage OR which contains a sufficient continuity of combustible materials so that a fire could spread beyond the vicinity of origin.

The maximum amount of combustible materials in any 10,000-square-foot section of an occupancy otherwise containing noncombustible materials shall not exceed 1000 board feet of lumber, or over 2 barrels (110 gallons) of combustible liquids or greases or equivalent amounts of other combustible materials. Further, the maximum total area containing combustible material in an occupancy otherwise containing noncombustible materials shall not exceed 5% of the total square foot area of that occupancy.

Note: In determining the applicability of C-1, combustible interior walls or partitions (including combustible finish), mezzanines, racks, shelves, bins, and similar combustible construction shall be considered combustible material.

Examples of occupancies which may (subject to survey) be eligible for C-1 classification include those storing asbestos, clay, glass, marble, stone, or metal products and some metalworking occupancies.

b. **Limited-combustible (C-2)** - Merchandise or materials, including furniture, stock, or equipment, of low combustibility, with limited concentrations of combustible materials.

Examples of occupancies classified as C-2 include banks, barber shops, beauty shops, clubs, habitational occupancies, hospitals, and offices.

Occupancies classified as C-2 in the occupancy classification list may be eligible for C-1 classification provided that such occupancy meets all of the requirements for C-1 classification.

Note: For manufacturing occupancies where over 20% of the total square foot area of the occupancy contains storage of combustible material or materials crated or wrapped in combustible containers, the combustibility class applicable to the occupancy shall not be less than C-3.

c. **Combustible (C-3)** - Merchandise or materials, including furniture, stock, or equipment, of moderate combustibility.

Examples of occupancies classified as C-3 include food markets, most wholesale and retail occupancies, etc.

Occupancies classified as C-3 in the occupancy classification list may be eligible for C-2 classification, provided that the total square foot area containing combustible material does not exceed 10% of the total square foot area of the occupancy.

Note: For the purpose of the above rule, combustible interior walls or partitions (including combustible finish), racks, shelves, bins, and similar combustible construction shall be considered combustible material.

d. **Free-burning (C-4)** - Merchandise or materials, including furniture, stock, or equipment, which burn freely, constituting an active fuel.

Examples of occupancies classified as C-4 include cotton bales, furniture stock, and wood products.

e. **Rapid-burning or flash-burning (C-5)** - Merchandise or materials, including furniture, stock, or equipment, which either

(1) burn with a great intensity

(2) spontaneously ignite and are difficult to extinguish

(3) give off flammable or explosive vapors at ordinary temperatures

(4) as a result of an industrial processing, produce large quantities of dust or other finely divided debris subject to flash fire or explosion

Examples of occupancies classified as C-5 include ammunition, excelsior, explosives, mattress manufacturing, matches, and upholsterers.

2. Determining Occupancy Combustibility Classification in Multiple Occupancy Buildings

In sole-occupancy buildings or in multiple-occupancy buildings with occupancies subject to a single-occupancy classification, the occupancy classification applicable to the occupant(s) shall also apply to the building.

In multiple-occupancy buildings with occupancies having different occupancy classifications, the occupancy classification applicable to the building shall be determined according to the total floor area (including basements and subbasements) occupied by each occupancy, as follows:

Note: Basement and subbasement areas which are either vacant or used for building services or building maintenance shall be considered C-2 combustibility. Where such areas are used for other purposes, the combustibility class for those areas shall be determined according to the combustibility class of their occupancies.

- C-1 combustibility shall apply ONLY where 95% or more of the total floor area of the building is occupied by C-1 occupants, and there are no C-5 occupancies.

- C-2 combustibility shall apply to buildings which
  - a. do not qualify as C-1 above, but where 90% or more of the total floor area of the building is occupied by C-1 and C-2 occupancies; OR
  - b. are classified as CSP Construction Class 5 or 6, AND where 80% or more of the total floor area of the building is occupied by C-1 and C-2 occupancies, AND NOT MORE THAN 5% of the total floor area is occupied by C-5 occupancies.

- C-4 combustibility shall apply to any building containing C-4 occupants, where the combined total area occupied by C-4 and C-5 (if any) occupants is 25% OR MORE OF THE TOTAL FLOOR AREA of the building, provided the C-5 occupancies occupy, in total, less than 15% of the total floor area.

- C-5 combustibility shall apply to any building where 15% OR MORE OF THE TOTAL FLOOR AREA is occupied by C-5 occupancies.

- C-3 combustibility shall apply to any building not provided for above.

Occupancy Type Examples

Noncombustible (C-1) - Merchandise or materials, including furniture, stock, or equipment, which in permissible quantities do not in themselves constitute an active fuel for the spread of fire.

C-1 occupancy type examples:

- Asbestos storage
- Clay storage
- Marble storage
- Metal products storage
- Stone storage

Limited-combustible (C-2) - Merchandise or materials, including furniture, stock, or equipment, of low combustibility, with limited concentrations of combustible materials.

C-2 occupancy type examples:

- Airport, bus, railroad terminal
- Apartment
- Artist's studio
- Auto repair shop
- Auto showroom
- Aviary
- Barber shop
- Church
- Cold storage warehouse
- Day care center
- Educational institution
- Gasoline service station
- Greenhouse
- Health club
- Jail
- Library
- Medical laboratory
- Motel
- Museum
- Nursing home
- Office
- Pet grooming shop
- Photographer's studio
- Radio station
- Recreation center
- Rooming house
- Undertaking establishment

Combustible (C-3) - Merchandise or materials, including furniture, stock, or equipment, of moderate combustibility.

C-3 occupancy type examples:

- Auto parts store
- Auto repair training school
- Bakery
- Boat sales (where storage_15%)
- Book store
- Bowling establishment
- Casino
- Commercial laundry
- Contractor equipment storage
- Department store (where storage_15%)
- Dry cleaner (no flammable fluids)
- Gift shop (where storage_15%)
- Hardware store (where storage_15%)
- Leather processing
- Municipal storage building
- Nursery sales outlet store
- Pavilion or dance hall
- Pet shop
- Photographic supplies
- Printer
- Restaurant
- Sandwich shop
- Shoe repair
- Sporting goods (where storage _15%)
- Supermarket
- Theater
- Vacant building
- Wearing apparel factory (except furs)

Free-burning (C-4) - Merchandise or materials, including furniture, stock, or equipment, which burn freely, constituting an active fuel.

C-4 occupancy type examples:

- Aircraft hangers
- Boat sales (where storage > 15%)
- Cabinet making
- Combustible metals (e.g., Magnesium)
- Department store (where storage > 15%)
- Dry cleaner (using flammable fluids)
- Feed store (with > 1/3 ton of hay)
- Fur apparel manufacturing
- Furniture manufacturing
- Gift shop (where storage > 15%)
- Hardware store (where storage > 15%)
- Kennels
- Lumber
- Packaging and crating
- Paper products manufacturing
- Petroleum bulk-distribution center
- Sporting goods (where storage > 15%)
- Stables
- Tire manufacturing
- Tire recapping or retreading
- Wax products (candles, etc.)
- Woodworking shop

Rapid-burning or flash-burning (C-5) - Merchandise or materials, including furniture, stock, or equipment, which either

(1) burn with a great intensity

(2) spontaneously ignite and are difficult to extinguish

(3) give off flammable or explosive vapors at ordinary temperatures

(4) as a result of an industrial processing, produce large quantities of dust or other finely divided debris subject to flash fire or explosion

C-5 occupancy type examples:

- Ammunition
- Feed mill (with > 7 tons of hay & straw)
- Fireworks
- Flammable compressed gases
- Flammable liquids
- Flour mill
- Highly flammable solids
- Matches
- Mattress factory
- Nitrocellulose-based plastics
- Painting with flammables or combustibles
- Rag storage
- Upholstering shop
- Waste paper storage

CHAPTER 4

Exposure and Communication Factor ($X_i + P_i$)

The factors developed in this item reflect the influence of adjoining and connected buildings on the needed fire flow. An exposure building has a wall 100 feet or less from a wall of the subject building. A communicating building has a passageway to the subject building. ISO develops a value for the exposure to another building for the side with the highest charge. Likewise, ISO develops a value for a communication to another building for the side with the highest charge. The formula is:

$$(X + P)_i = 1.0 + (X_i + P_i), \text{ with a maximum value of } 1.60$$

1. **Exposures (Table 330.A)**
   The factor for X_i depends upon the construction and length-height value (length of wall in feet, times height in stories) of the exposure building and the distance between facing walls of the subject building and the exposure building. Table 330.A of the FSRS gives the factors. When there is no exposure on a side, $X_i = 0$.

   a. Construction of facing wall of exposure – ISO considers the wall construction of the exposure. The exposure factor used considers only the side of the subject building with the highest factor.
   b. Length-height value of the facing wall of the exposure – ISO determines the length-height value of the facing wall of the exposure by multiplying the length of the facing wall of the exposure in feet by the height of the exposure in stories. ISO considers buildings five stories or more in height as five stories. Each 15 feet or fraction thereof equals one story.
   c. Exposure distance – The distance in feet from the subject building to the exposure building, measured to the nearest foot, between the nearest points of the buildings. Where either the subject building or the exposure is at a diagonal to the other building, ISO increases the exposure distance by 10 feet.
   d. Construction of facing wall of subject building – The wall construction of the subject building.

2. **Exposure exceptions**
   The following conditions rule out exposure charges from adjacent buildings:
   - Buildings rated sprinklered (See Chapter 6, "Determining Recognition of Automatic Sprinkler Systems.")
   - Buildings rated as habitational, including their appurtenant outbuildings
   - Buildings of Construction Class 5 or 6
   - Buildings of Construction Class 3 or 4 with C-1 or C-2 contents combustibility class applicable to the building

TABLE 330.A FACTOR FOR EXPOSURE (X_i)

Construction of Facing Wall of Subject Building	Distance in Feet to the Exposure Building	Length-Height of Facing Wall of Exposure Building	Construction of Facing Wall of Exposure Building Classes: 1,3	2, 4, 5, & 6: Unprotected Openings	2, 4, 5, & 6: Semiprotected Openings (wired glass or outside open sprinklers)	2, 4, 5, & 6: Blank Wall
Frame, Metal or Masonry with Openings	0 - 10	1-100	0.22	0.21	0.16	0
		101-200	0.23	0.22	0.17	0
		201-300	0.24	0.23	0.18	0
		301-400	0.25	0.24	0.19	0
		Over 400	0.25	0.25	0.20	0
	11 - 30	1-100	0.17	0.15	0.11	0
		101-200	0.18	0.16	0.12	0
		201-300	0.19	0.18	0.14	0
		301-400	0.20	0.19	0.15	0
		Over 400	0.20	0.19	0.15	0
	31 - 60	1-100	0.12	0.10	0.07	0
		101-200	0.13	0.11	0.08	0
		201-300	0.14	0.13	0.10	0
		301-400	0.15	0.14	0.11	0
		Over 400	0.15	0.15	0.12	0
	61 - 100	1-100	0.08	0.06	0.04	0
		101-200	0.08	0.07	0.05	0
		201-300	0.09	0.08	0.06	0
		301-400	0.10	0.09	0.07	0
		Over 400	0.10	0.10	0.08	0
Blank Masonry Wall	Facing wall of the exposure building is higher than the subject building. Use the above table EXCEPT use only the length-height of the facing wall of the exposure building ABOVE the height of the facing wall of the subject building. Buildings five stories or over in height, consider as five stories.					
	When the height of the facing wall of the exposure building is the same or lower than the height of the facing wall of the subject building, $X_i = 0$.					

3. **Communications (Table 330.B)**

The factor for P_i depends upon the protection for communicating party-wall openings and the length and construction of communications between fire divisions. Table 330.B of the FSRS gives the factors. When more than one communication type exists in any one side wall, apply only the largest factor P_i for that side. When there is no communication on a side, $P_i = 0$.

a. Communications with combustible construction - An open passageway must be open on top or at least one side.
b. Fire-resistive, noncombustible, or slow-burning communications – ISO considers the type of construction found within the passageway.
c. Description of protection of passageway openings – The protection for the openings to the passageway by Class A or B, single or double fire door.

4. **Communications Exceptions**

The following conditions rule out charges for communication with other separately rated buildings:

- Buildings rated sprinklered (See Chapter 6. "Determining Recognition of Automatic Sprinkler Systems.")
- Buildings rated as habitational, including their appurtenant outbuildings
- Buildings of Construction Class 5 or 6
- Buildings of Construction Class 3 or 4 with C-1 or C-2 contents combustibility class applicable to the building

TABLE 330.B FACTOR FOR COMMUNICATIONS (P_i)

Description of Protection of Passageway Openings	Fire-resistive, Noncombustible, or Slow-Burning Communications				Communications with Combustible Construction					
					Open			Enclosed		
	Any Length	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +
Unprotected	0	.40	0.30	0.20	0.30	0.20	0.10	.50	.40	0.30
Single Class A Fire Door at One End of Passageway	0	0.20	0.10	0	0.20	0.15	0	0.30	0.20	0.10
Single Class B Fire Door at One End of Passageway	0	0.30	0.20	0.10	0.25	0.20	0.10	0.35	0.25	0.15
Single Class A Fire Door at Each End or Double Class A Fire Doors at One End of Passageway	0	0	0	0	0	0	0	0	0	0
Single Class B Fire Door at Each End or Double Class B Fire Doors at One End of Passageway	0	0.10	0.05	0	0	0	0	0.15	0.10	0

\+ For over 50 feet, $P_i = 0$.

Note: When a party wall has communicating openings protected by a single automatic or self-closing Class B fire door, it qualifies as a division wall for reduction of area. Where communications are protected by a recognized water curtain, the value of P_i is 0.

CHAPTER 5

Separate Classifications of Buildings

ISO classifies the following as separate buildings:

a. Buildings separated by two independent walls, with no common or continuous combustible roof, that meet all of the requirements under either (1), (2), or (3) below.

(1) Where there is no communication between the two buildings

(2) Where the independent walls have communicating passageways constructed and protected as follows:

(a) A passageway open on the top or at least one side

(b) An enclosed passageway of glass, noncombustible, slow-burning, or fire-resistive construction more than 10 feet in length (or, if combustible, more than 20 feet in length)

(c) An enclosed passageway of glass, noncombustible, slow-burning or fire-resistive construction 10 feet or less in length (or, if combustible, 20 feet or less in length), provided that any such passageway is protected on at least one end by an automatic or self-closing labeled Class A fire door installed in a masonry wall section in accordance with standards

Where one or both of the communicating buildings qualify for sprinkler credit under ISO's Specific Commercial Property Evaluation Schedule (see Chapter 6, "Determining Recognition for Automatic Sprinkler Systems"), the above rules (including the Class A door requirement) apply. However, where acceptable sprinklers are installed over the communication in a masonry wall in the sprinklered building, such sprinklers are acceptable in lieu of the Class A door.

NOTE: A passageway is a structure providing communication between two otherwise separate buildings. Passageways must not contain contents. Enclosed passageways must not be more than 15 feet in width (least dimension). Passageways open on the top or at least one side shall not be more than 25 feet in width (least dimension). Any communicating structure that contains contents, or is more than 15 feet in width if enclosed, or is more than 25 feet in width if open, is a structure subject to all of the requirements regarding separate classification under this item.

(3) Where the independent walls have no communications, or where the two buildings have passageways constructed and protected as provided above, ISO classifies each building separately, with appropriate charges for exposure and communication (if any) under Chapter 4, "Exposure and Communication Factor."

b. Buildings separated by one continuous masonry party wall conforming to all of the following requirements:

(1) The party wall is constructed of brick or reinforced concrete not less than 6 inches in thickness; OR reinforced concrete building units (or filled blocks) with a fire-resistance rating of not less than two hours and not less than 6 inches in thickness; OR other masonry materials not less than 8 inches in thickness.

(2) The party wall rises to the underside of AND is in direct contact with a fire-resistive, masonry, or noncombustible roof; OR pierces a slow-burning or combustible roof. In addition, no combustible material extends across any parapet that pierces a slow-burning or combustible roof.

(3) The party wall extends to the interior surface of AND is in direct contact with a fire-resistive, masonry, or noncombustible wall OR pierces a slow-burning or combustible wall. In addition, combustible cornices, canopies, or other combustible material do not extend across the party wall.

(4) All load-bearing structural metal members in the party wall are protected metal (not less than one hour).

(5) At least a single automatic or self-closing labeled Class A fire door protects all access communications through the party wall. Where one or both of the communicating buildings qualify for sprinkler credit under ISO's Specific Commercial Property Evaluation Schedule (see Chapter 6, "Determining Recognition for Automatic Sprinkler Systems"), acceptable sprinklers installed over the communications are acceptable in lieu of the Class A door.

A single, labeled 1_ hour damper protects all communications caused by air conditioning and/or heating ducts piercing a party wall.

Note 1: Where unprotected metal, noncombustible, or combustible wall, floor, or roof supports are continuous through a masonry wall, such a wall is not be acceptable for separate classification.

Note 2: ISO ignores the usual openings provided for common utilities when their size is limited to that necessary to provide for normal clearances and vibration; such openings are the rule rather than the exception, and their effect is included in the overall analysis. ISO also ignores openings protected by one-hour listed firestop systems. ISO may also ignore abnormally large openings when mortar or other masonry material fills the excessive clearances.

ISO classifies all buildings not eligible for separate classification under a. or b. as a single building.

CHAPTER 6

Determining Recognition of Automatic Sprinkler Systems

ISO uses the Specific Commercial Property Evaluation Schedule (SCOPES) to evaluate sprinkler protection of a property. The criteria within the SCOPES manual permit determination of the percentage of credit for the sprinkler protection. For ISO to rate and code the property as a sprinklered property, it must score at least 10 points (out of the initial 100 points available) in ISO's sprinkler grading.

A grading of 100 points represents the value of a two-source (water supply) wet-pipe installation, standard in all respects, where no unusual conditions of construction or occupancy exist. In addition, the system must be installed and maintained as outlined in the National Fire Protection Association (NFPA) Standard 13, NFPA Standard 25, and other NFPA standards as appropriate.

ISO classifies a property as a sprinklered property if it meets the following minimum conditions:

- The sprinklered building has assured maintenance. Shut down, idle, or vacant structures have acceptable watchman or waterflow and control-valve supervision (remote or central station) or a caretaker. A caretaker is a responsible person who visits the premises not less than weekly.
- The usable unsprinklered area does not exceed:
  - a) 25% of the total area in buildings with an Occupancy Combustibility Class of C-1
  - b) 20% of the total area in buildings with an Occupancy Combustibility Class of C-2 or C-3
  - c) 10,000 square feet or 15% of the total area in buildings with an Occupancy Combustibility Class of C-4
  - d) 5,000 square feet or 10% of the total square foot area in buildings with an Occupancy Combustibility Class of C-5

  See Chapter 3, "Occupancy Factor" for definitions of the occupancy combustibility classes.

  Note: the area limitations above do not include unused, unsprinklered areas such as underfloor areas, attic areas, etc. However, ISO classifies usable vacant areas as used areas. ISO considers areas with obstructed sprinklered protection as unsprinklered.
- Installation has evidence of flushing and hydrostatic tests of both the underground and overhead piping in accordance with NFPA Standard 13.
- A full-flow main drain test has been witnessed within the last 48 months.
- Dry-pipe installations have evidence of a satisfactory or partly satisfactory dry-pipe trip test conducted within the last 48 months.
- Fire-pump installations have evidence and results of a fire-pump test conducted within the last 48 months.

CHAPTER 7

Other Considerations for Determining Needed Fire Flow (NFF_i)

- When the subject building or exposure buildings have a wood-shingle roof covering and ISO determines that the roof can contribute to spreading fires, ISO adds 500 gpm to the needed fire flow.
- The maximum needed fire flow is 12,000 gpm. The minimum is 500 gpm.
- ISO rounds the final calculation of needed fire flow to the nearest 250 gpm if less than 2,500 gpm and to the nearest 500 gpm if greater than 2,500 gpm.
- For 1- and 2-family dwellings not exceeding 2 stories in height, ISO uses the following needed fire flows:

DISTANCE BETWEEN BUILDINGS	NEEDED FIRE FLOW
More than 100'	500 gpm
31-100'	750 gpm
11-30'	1,000 gpm
10' or less	1,500 gpm

- For other types of habitational buildings, the maximum needed fire flow is 3,500 gpm.

CHAPTER 8

Examples

Example 1.

1-story Wood frame Contractor equipment storage 2,250 sq. ft. No exposures or communications	30 ft.
75 ft.	

CONSTRUCTION TYPE

Construction Class 1 (wood frame construction)
Construction type coefficient (F) = 1.5
Effective area (A) = 2,250

$C_i = 18F\,(A)^{0.5}$
$C_i = 18(1.5)\,(2{,}250)^{0.5}$
$C_i = 27\,(47.43)$
$C_i = 1{,}280.72$
$\mathbf{C_i = 1{,}250}$ (rounded to the nearest 250 gpm)

OCCUPANCY TYPE

Contractor equipment storage
Occupancy combustibility class C-3 (Combustible)
Occupancy factor (O_i) = 1.00

EXPOSURES AND COMMUNICATIONS

None
Exposure and communication factor (X + P) = 0.00

CALCULATION

$NFF_i = (C_i)(O_i)(1+(X+P)_i)$
$NFF_i = (1{,}250)(1.00)(1+(0.00))$
$NFF_i = (1{,}250)(1.00)(1.00)$
$\mathbf{NFF_i = 1{,}250\ gpm}$

Example 2

2-story
Masonry walls, wood-joisted roof and floors
Concrete on Grade
Furniture manufacturing
Ground floor = 14,000 sq. ft. 80 ft.
No exposures or communications

175 ft.

CONSTRUCTION TYPE

Construction Class 2 (joisted-masonry construction)
Construction type coefficient (F) = 1.0
Effective area (A) = 21,000 (ground floor + _ of second floor area)

$C_i = 18F\,(A)^{0.5}$
$C_i = 18(1.0)\,(21{,}000)^{0.5}$
$C_i = 18\,(144.91)$
$C_i = 2{,}608.45$
$\mathbf{C_i = 2{,}500}$ (rounded to the nearest 250 gpm)

OCCUPANCY TYPE

Furniture manufacturing
Occupancy combustibility class C-4 (free-burning)
Occupancy factor (O_i) = 1.15

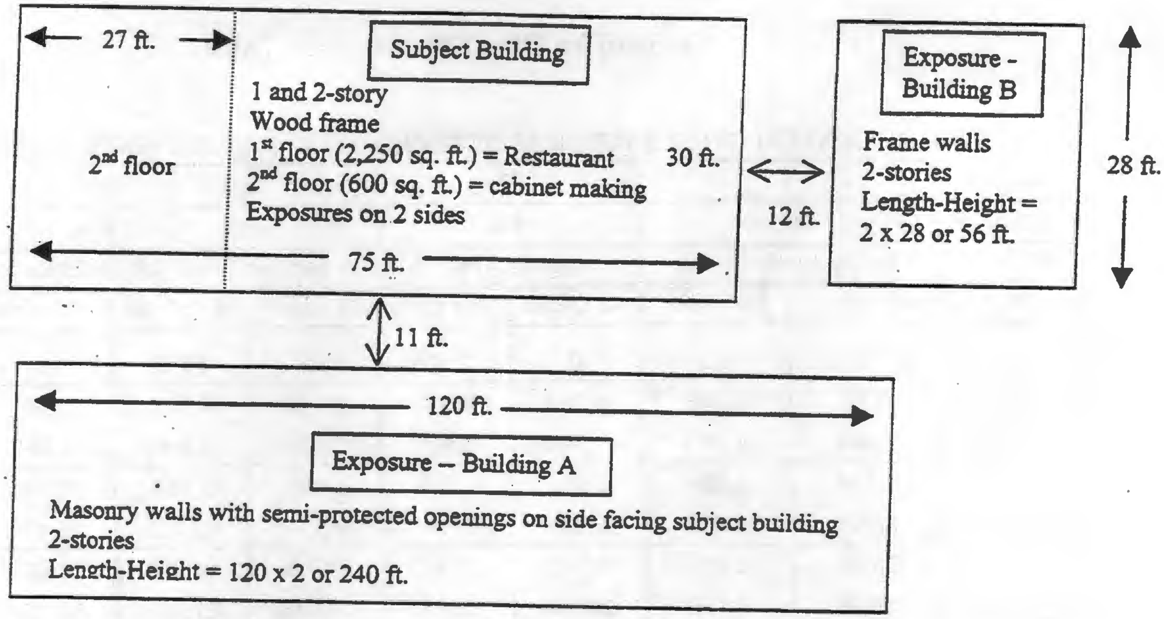
EXPOSURES AND COMMUNICATIONS

None
Exposure and communication factor (X + P) = 0.00

CALCULATION

$NFF_i = (C_i)(O_i)(1+(X+P)_i)$
$NFF_i = (2{,}500)(1.15)(1+(0.00))$
$NFF_i = (2{,}500)(1.15)(1.00)$
$NFF_i = 2{,}875$
$\mathbf{NFF_i = 3{,}000}$ **gpm** (because it is greater than 2,500 ISO rounds the NFF to the nearest 500 gpm)

Example 3



CONSTRUCTION TYPE

Construction Class 1 (wood-frame construction)
Construction type coefficient (F) = 1.5
Effective area (A) = 2,655 (ground floor + _ of second floor area)

$C_i = 18F\,(A)^{0.5}$
$C_i = 18(1.5)\,(2{,}655)^{0.5}$
$C_i = 27(51.53)$
$C_i = 1{,}391.31$
C_i = 1,500 (roumded to the nearest 250 gpm)

OCCUPANCY TYPE

Cabinet making (occupies over 25% of the total floor of the building)
Occupancy combustibility class C-4 (free-burning)
Occupancy factor (O_i) = 1.15

EXPOSURES AND COMMUNICATIONS

Exposure charge for Building A = 0.17
Exposure charge for Building B = 0.14
The building with the highest charge is Building A.
Exposure factor (X) = 0.17
Communication (P) charge = none
Exposure and communication factor (X + P) = 0.17

CALCULATION

$NFF_i = (C_i)(O_i)(1+(X+P)_i)$
$NFF_i = (1{,}500)(1.15)(1+(0.17))$
$NFF_i = (1{,}500)(1.15)(1.17)$
$NFF_i = 2{,}018$
NFF_i = 2,000 gpm

APPENDIX A

Needed Fire Flow/Effective Area Table

TYPE OF CONSTRUCTION FACTOR AS DETERMINED BY RANGE IN EFFECTIVE AREA

Class	1		2		3,4		5,6	
Factor (F)	1.5		1.0		0.8		0.6	
	Effective Area (A_i)		Effective Area (A_i)		Effective Area (A_i)		Effective Area (A_i)	
(C_i)	At Least	Not Over	At Least	Not Over	At Least	Not Over	At Least	Not Over
500	0	534	0	1,203	0	1,879	0	3,342
750	535	1,048	1,204	2,359	1,880	3,687	3,343	6,555
1,000	1,049	1,733	2,360	3,901	3,688	6,096	6,556	10,839
1,250	1,734	2,590	3,902	5,830	6,097	9,109	10,840	16,195
1,500	2,591	3,619	5,831	8,144	9,110	12,725	16,196	22,623
1,750	3,620	4,819	8,145	10,843	12,726	16,943	22,624	30,122
2,000	4,820	6,190	10,844	13,929	16,944	21,764	30,123	38,693
2,250	6,191	7,733	13,930	17,400	21,765	27,188	38,694	48,336
2,500	7,734	9,447	17,401	21,257	27,189	33,215	48,337	59,050
2,750	9,448	11,333	21,258	25,500	33,216	39,845	59,051	70,836
3,000	11,334	13,390	25,501	30,129	39,846	47,077	70,837	83,694
3,250	13,391	15,619	30,130	35,144	47,078	54,913	83,695	97,623
3,500	15,620	18,019	35,145	40,544	54,914	63,351	97,624	112,624
3,750	18,020	20,591	40,545	46,330	63,352	72,392	112,625	128,697
4,000	20,592	23,334	46,331	52,502	72,393	82,035	128,698	145,842
4,250	23,335	26,248	52,503	59,060	82,036	92,282	145,843	164,058
4,500	26,249	29,334	59,061	66,004	92,283	103,131	164,059	183,346
4,750	29,335	32,592	66,005	73,333	103,132	114,584	183,347	203,705
5,000	32,593	36,021	73,334	81,048	114,585	126,639	203,706	225,136
5,250	36,022	39,621	81,049	89,149	126,640	139,296	225,137	247,639
5,500	39,622	43,393	89,150	97,636	139,297	152,557	247,640	271,213
5,750	43,394	47,337	97,637	106,509	152,558	166,421	271,214	295,859
6,000	47,338	51,452	106,510	115,767	166,422		295,860	
6,250	51,453	55,738	115,768	125,411				
6,500	55,739	60,196	125,412	135,441				
6,750	60,197	64,825	135,442	145,857				
7,000	64,826	69,626	145,858	156,659				
7,250	69,627	74,598	156,660	167,846				
7,500	74,599	79,741	167,847	179,419				
7,750	79,742	85,057	179,420	191,379				

Memorandum

ecology and environment engineering, p.c.
International Specialists in the Environment
BUFFALO CORPORATE CENTER 368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

Date: May 25, 2004

~~**To:** Robert Pender, USACE~~

From: Don Miller, E&E

By: Jason DiIulio and Shawn Gardner

Checked: Maureen Gifford and John Fazzolari (3/19/04)

Subject: **Finished Water Storage Tank - Evaluation**

Purpose

The objective of the memorandum is to evaluate the height of the finished water storage tank for the High Falls Water District water distribution system. The height of the tank is directly dependent on drinking water treatment plant operations and design criteria. Design criteria are based on the design recommendations of the New York State Department of Health and Ulster County Department of Health.

Design Recommendations

Departments of Health

Ulster County and New York State Department of Health (UCDH and NYSDOH, respectively) both have recommendations regarding the sizing of the finished water storage tank. The recommended volume is equal to the maximum daily demand at the Water Treatment Plant (WTP), plus the required fire flow (Ecology & Environment, Contact Report NYSDOH, 11/01 and UCHD 10/01). The maximum daily demand is equal to 170,000 gallons or twice the average daily demand of 85,000 gallons in the High Falls Water District (Ecology & Environment, Design memorandum of Average Daily Flow, November 2001). The required fire flow for High Falls Water District is 120,000 gallons (Ecology & Environment, Design memorandum of Necessary Fire Flow, November 2001). Therefore a recommended volume of 290,000 gallons is recommended and the nearest standard size tank that satisfies the volume requirement is a 300,000 gallon tank.

NYCRR Title 10, Subpart 5.4-2 Certification Required, states that a designated certified operator must be *available* during plant operation. In NYCCR Title 10, Subpart 5.4-1 Definitions, states that *available* means a certified operator must be on site or able to be contacted within one hour to initiate the appropriate action. NYSDOH, Theresa Boepple, verified the operator must be on ~~site or able to be contacted within one hour to attend to the treatment plant.~~ (Ecology & Environment, Contact Report with NYSDOH and UCDH, 2/26/03-3/12/03)

New York City Department of Environmental Protection
The New York City Department of Environmental Protection (DEP) and Special Counsel to NYC Water Board requires the capacity to sustain connection shutdown provision for connection to the Catskill Aqueduct by the High Falls Water District of the Towns of Marbletown and Rosendale. Capacity shall satisfy a shutdown for a minimum of three consecutive periods, each period consisting of five consecutive days interrupted by a resumption of the connection's source (between shutdown periods) for two consecutive days. This language is subsequently contained in the High Falls Water District Draft Use Agreement.

Ten State Standards (Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers *Recommended Standards For Water Works*, 1997)
Fire Protection, if provided, shall be designed such that fire flows and facilities are in accordance with the requirements of the state Insurance Services Office, in accordance with Section 8.1.3 of Ten State Standards.

The distribution system of the water treatment plant shall be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system should be approximately 60 to 80 psi and not less than 35 psi, in accordance with Section 8.1.1.

The storage facilities should meet domestic demands and fire flow demands (if provided). Systems not providing fire protection shall have minimum capacity equal to the average daily consumption.

Design Criteria

Average Daily Flow Demand
Average expected daily flow demand for the High Falls Water District (HFWD) was calculated at 63,000 gpd. The average expected daily flow demand is calculated using existing population, but for conservative purposes the average daily demand of future population will be used to design the water treatment. Average daily flow demand for the High Falls Water District (HFWD) was calculated by multiplying the future population of the HFWD by the maximum allowable water usage of 160 gpcd, the average daily per capita demand of NYC in 1999. The result of this method was 83,680 gpd or 58 gpm. This method was also compared to a method adopted from *Water Quality* by Tchobanoglous, George and Edward Schroeder (1987), which produced an average daily demand of 83,680 gpd or 58 gpm. Therefore the final design average daily demand will be 85,000 gpd. (Ecology & Environment, Design memorandum of Average Daily Flow, November 2001)

Maximum Daily and Peak Hourly Demand
The maximum daily and peak hourly demand for the HFWD was calculated from factors in the text, *Water Quality* (1987). The factors were multiplied by the average daily demand of 85,000 gpd (59 gpm). The peak hourly demand was calculated to be 255,000 gpd (177gpm) and the maximum daily demand was calculated to be 170,000 gpd (118 gpm). (Ecology & Environment, Design memorandum of Maximum Daily and Peak Hourly Demand, November 2001).

Fire Flow Demand
The fire flow demand for the HFWD was based on NYSDOH policy that fire protection is included as part of the water system design. The method used was from the National Fire Protection Association preferred method, which is found in the Insurance Services Office "Guide for Determination of Needed Fire Flow". Based on the calculation a fire flow of 1000 gpm would

be required for general fire flow. Also, during a meeting held with the High Falls Volunteer Fire Department the fire department requested a fire flow of 1000 gpm. Therefore the designed fire flow for the HFWD will be 1000 gpm based on the general Insurance Services Office calculation and upon High Falls Volunteer Fire Department's request. It was assumed that the fire flow duration required is 2 hours (National Fire Protection Association, 1986) the storage required to maintain the flow is 120,000 gallons. (Ecology & Environment, Design memorandum of Necessary Fire Flow, November 2001)

Existing Water Treatment Plant Design

Raw Water Tank

The raw water tank was designed as a cylindrical tank of 45 feet in diameter and 40 feet high; it will have a total volume of 460,000 and a working volume of approximately 340,000 gallons. The tank base elevation is assumed to be approximately 320 feet. Therefore the raw water tank can accommodate up to 4 days of average daily demand of HFWD. The 4 days of storage in the raw water tank attribute to the 5 day storage requirement by DEP as discussed above in DEP Requirements, the remainder of required storage will be stored in the finished water tank. (Ecology & Environment, Design memorandum of Raw Water Tank Description, January 2003)

Clearwell

The clearwell was designed with dimensions approximately 38 feet long by 15 feet wide, and to have a total working storage capacity of approximately 25,000 gallons (29% of average daily demand). The minimum working depth is 5.8 feet, and a 3-foot deep sump that will house the finished water pumps. (Ecology & Environment, Design memorandum of Clearwell Description, January 2003)

Finished Water Tank

The tank was designed to hold a working volume of 290,000 gallons to accommodate 2 days of average daily demand or the maximum day demand (170,000 gallons) and the required fire flow (120,000 gallons). A 300,000-gallon tank was selected because it is a standard tank size. The two days of storage attribute to the 5 day storage requirement by the DEP as discussed above in DEP Requirements. The ground elevation at the proposed finished water tank site is 312 feet MSL. (Ecology & Environment, Design memorandum of Finished Water Tank Description, March 2003)

Engineering Assumptions for Finished Water Tank Evaluation

The following engineering assumptions were used to evaluate the selected operation and design scenarios affecting tank height.

1. The water treatment plant is designed to run automatically with an operator available during operation per NYCRR Title 10, Subpart 5.4. However, if the water district chooses or is required by UCDOH, the treatment system can run manually (i.e. only operate with an operator present).
2. Normal manned operation of the water treatment plant is assumed to be regular business hours Monday through Friday. If a fire occurs during the weekend and the plant is not running automatically, an operator will be available to operate the treatment system to replenish the consumed water for the fire flow.
3. The finished water tank has a 300,000 gallon capacity.
4. The tank is basically cylindrical and 40 ft in diameter.

5. Tank type (toro-sphere, ellipsoid, cylindrical, etc.) does not play a determining factor in the tank height based on tank manufacturer information on head ranges for the tanks. The head ranges for the tanks vary from approximately 30' to 32'. The head range of 32' is assumed for the 40 ft diameter to attain the 300,000-gallon capacity.
6. The physical top of the tank will be approximately 4 feet above the maximum water surface elevation.
7. The working pressure of the distribution system is assumed to be equal to the static pressure. This assumption is based on WaterCad results that show head losses through the distribution system to be negligible with a demand of 85,000 gpd.
8. The tank capacity is based on the assumption of future average daily consumption of 85,000 gpd. The expected average daily consumption is 63,000 gpd. Therefore, the tank should have enough capacity through the weekend even if the treatment system is not run based on the current design and expected water consumption.
9. The design tank (40 ft diameter cylinder) will store approximately 10,000 gallons of water for every one foot of height.

Design Criteria for Finished Water Tank Evaluation

1. The highest waterline-in-the-street elevation is 335 feet AMSL on Mountain View Rd.
2. The pressure at the "critical" house was measured at 53 psi (Amendment to High Falls WTP - Finished Water Tank Memo dated 3/18/03, dated 11/6/03).
3. The "critical" house elevation is defined by the existing well tank elevation (point of entry assumed to be 338 feet AMSL at 220 Mohonk Rd.).

Scenario Evaluation

Scenario 1

The distribution system shall meet or exceed the 35 psi working pressure and 20 psi residual pressure for all points in the distribution system. Working pressure occurs during normal water demands. The minimum residual pressure is required during maximum demand (fire flow). These are the Ten State Standard recommendations. The minimum 35 psi working pressure must be attained at the top of the fire flow storage (bottom of the drinking water storage) and the residual pressure must be attained at the bottom of the fire flow storage (bottom of tank) at a flowrate of 1,000 gpm.

Using a 40-foot diameter tank at 300,000 gallons results in a tank height of 32-feet (actual 31.9 feet). A tank height of 400 feet AMSL is the minimum elevation (bottom elevation) that will satisfy the fire flow requirements when the water level is near the bottom of the tank. However, to meet the minimum 35 psi throughout the tank's drinking water storage, the elevation at the top of the fire flow needs to be 419 feet AMSL. Therefore, a tank bottom elevation of 407 feet AMSL (419 feet AMSL – 120,000 gallon capacity for fire flow), a minimum water elevation of 419 AMSL and a maximum water elevation of 439 feet AMSL (419 Feet AMSL + 170,000 gallon capacity) and a resulting top of tank height of 443 feet AMSL (add 4 feet freeboard) will satisfy all requirements for this scenario.

The critical house and 13 other houses will not receive the water at the pressures currently existing in their homes.

Scenario 2
Assuming the same tank dimensions, the minimum water elevation in the tank will need to be 461 feet AMSL to satisfy 53 psi at the critical house. This height will also meet all required fire flows.

The "critical" house will receive the existing pressure of 53 psi ONLY at the top water elevation ~~(not including free-board) in the water tank (when it is full). When the drinking water storage is depleted, the water surface elevation will be at 441 feet AMSL and the pressure at the critical~~ house will be 44.6 psi. Five other houses will not receive the water at the pressures currently existing in their homes when drinking water is depleted in the tank.

Scenario 3
The "critical" house will receive the existing pressure of 53 psi at all elevations in the water tank (full to fire flow volume).

To meet a minimum pressure of 53 psi throughout the tank's volume range, the drinking water elevation would have to be established at 461 feet AMSL. The maximum drinking water surface elevation would be 481 feet AMSL with the top of tank (including free-board) around 485 feet AMSL. Assuming the same tank dimensions as discussed, this results in a pressure range of 61.6 to 53.6 psi at the top of the tank to the bottom, respectively. This height will also meet all required fire flows.

Scenario	Requirement	Tank Bottom Elevation (ft)	Top of Fire Flow Water Elevation (ft)	Top of Drinking Water Elevation (ft)	Tank Top Elevation (ft)/Height Above 312 AMSL (ft)	Number of Households Not Meeting Existing Pressures Bottom of Drinking Water Elevation
1	35 psi working pressure and 20 psi residual pressure	407	419	439	443/131	14
2	The "critical" house will receive the existing pressure of 53 psi ONLY at the top water elevation in the water tank (when it is full).	429	441	461	465/153	6
3	The "critical" house will receive the existing pressure of 53 psi at all elevations in the water tank (full to top of fire flow).	449	461	481	485/173	None

Conclusion
The Town of Marbletown Supervisor, Vincent Martello informed the EPA that the Town of Marbletown has chosen the 153 foot tank (scenario 2) in the multi column style (Email from V. Martello to S. Badalamenti 4/24/04).

Mohonk Road Industrial Plant
Pressures vs. Tank Height

SCENARIO 2					
Top of Tank Water Level at 461 ft and Bottom at 429 ft					
	Address	Elevation of Prop. P.O.E. (ft.)[10]	Existing Pressure (psi)	Static Pressure at Prop. POE, Top of Fire Flow in Tank 441 ft (psi)	Static Pressure at Prop. POE, Top Level in Tank 461ft (psi)
1	1042 Berme Road	215	50	98	107
2	1032 Berme Road	218	50	97	105
3	1097 Berme Road	187	54	110	119
4	1097 Berme Road Garage Apt.	191	54	108	117
5	19 Bruceville Road	132	50	134	142
6	19 Bruceville Road Garage	130	50	135	143
7	25 Bruceville Road	126	50	136	145
8	1026 Berme Road (house)	221	50	95	104
9	vacant lot (CNHTC-7)	210		100	109
10	vacant lot (CNHTC-7)	214		98	107
11	1033 Berme Road	217	50	97	106
12	1039 Berme Road	212	50	99	108
13	1047 Berme Road	196	50	106	115
14	1048 Berme Road	207	45	101	110
15	1044 Berme Road	210	50	100	109
16	1054 Berme Road	202	50	103	112
17	vacant lot (BEHTC-2)	195		107	115
18	vacant lot (BEHTC-2)	194		107	116
19	1066 Berme Road	196	58	106	115
20	vacant lot (BEHTC-2)	191		108	117
21	vacant lot (BEHTC-2)	192		108	116
22	1125 Berme Road	190	50	109	117
23	vacant lot (BEHTC-4)	185		111	120
24	1105 Berme Road	190	50	109	117
25	1154 Berme Road	204	50	103	111
26	vacant lot (BEHTC-6)	152		125	134
27	10 Bruceville Road	143	50	129	138
28	14 Bruceville Road	139	50	131	139
29	18 Bruceville Road	136	50	132	141
30	19 Bruceville Road	135	50	132	141
31	22 Bruceville Road	131	50	134	143
32	24 Bruceville Road	133	50	133	142
33	25 Bruceville Road	126	50	136	145
34	30 Bruceville Road	127	52	136	145
35	36 Bruceville Road	125	50	137	145
36	44 Bruceville Road	130	50	135	143
37	Transfer Station (CNHTC-8)	220	50	96	104
38	vacant lot (CNHTC-9)	218		97	105
39	vacant lot (CNHTC-9)	223		94	103
40	11 Canal Road	206	60	102	110
41	14/16 Canal Road	195	40	107	115
42	20 Canal Road	205	49	102	111
43	vacant lot (CNHTC-11)	218		97	105
44	30 Canal Road	220	50	96	104
45	12 Canal Road	183	50	112	120
46	52 Canal Road	224	48	94	103
47	43 Canal Road	249	46	83	92
48	vacant lot (CNHTC-10)	215		98	107
49	41 Canal Road	243	46	86	94
50	40 Canal Road	236	48	89	97
51	31 Canal Road	241	50	87	95
52	10 Depew Road	240	58	87	96
53	vacant lot (DYHTC-12)	241		87	95
54	Antique Shop (DYHTC-12)	241	50	87	95
55	(Ricki's Repair Shop)	241	58	87	95
56	18 Depew Road	241	50	87	95
57	30 Depew Road	238	58	88	97
58	vacant lot (DYHTC-12)	240		87	96
59	40 Depew Road	240	50	87	96
60	50 Depew Road	238	50	88	97
61	51 Depew Road	241	50	87	95
62	53 Depew Road	242	50	86	95
63	55 Depew Road	243	50	86	94
64	vacant lot (DYHTC-13)	215	–	98	107
65	12 JFK Lane	181	50	113	121
66	Our Lady Chapel (JFKHTC-14)	174	50	116	124
67	14/16 JFK Lane	178	50	114	123
68	20 Roman's Drive	180	60	113	122
69	9 Roman's Drive	180	50	113	122

Mohonk Road Industrial Plant
Pressures vs. Tank Height

SCENARIO 2

Top of Tank Water Level at 461 ft and Bottom at 429 ft

	Address	Elevation of Prop. P.O.E. (ft.) [10]	Existing Pressure (psi)	Static Pressure at Prop. POE, Top of Fire Flow in Tank 441 ft (psi)	Static Pressure at Prop. POE, Top Level in Tank 461ft (psi)
70	7 Roman's Drive	180	50	113	122
71	8/11 Roman's Drive	184	50	111	120
72	22 Roman's Drive	185	50	111	120
73	? Roman's Drive (JFKHTC-14)	185	50	111	120
74	25 JFK Lane	162	46	121	129
75	37 JFK Lane	177	50	114	123
76	47 JFK Lane	181	50	113	121
77	vacant lot (JFKHTC-14)	176		115	123
78	7 Mohonk Road	153	50	125	133
79	1209 Route 213 (Golden Whale)	153	50	125	133
80	11 Mohonk Road	156	50	123	132
81	17 Mohonk Road	161	50	121	130
82	23 Mohonk Road (D&H Canal Museum)	161	36	121	130
83	20 Mohonk Road	163	50	120	129
84	24 Mohonk Road	166	50	119	128
85	31A Mohonk Road	170	50	117	126
86	31B Mohonk Road	194	50	107	116
87	32 Mohonk Road	169	44	118	126
88	39 Mohonk Road	181	45	113	121
89	44 Mohonk Road	177	50	114	123
90	45 Mohonk Road	190	50	109	117
91	49 Mohonk Road	185	50	111	120
92	50 Mohonk Road	184	50	111	120
93	? Mohonk (MRHTC-15)	168	50	118	127
94	53 Mohonk Road	199	50	105	113
95	58 Mohonk Road	187	50	110	119
96	vacant lot (MRHTC-16)	211		100	108
97	vacant lot (MRHTC-16)	215		98	107
98	79 Mohonk Road	238	52	88	97
99	107 Steep Hill Road	176	42	115	123
100	vacant lot (MRHTC-17)	239		87	96
101	vacant lot (MRHTC-17)	222		95	103
102	vacant lot (MRHTC-17)	229		92	100
103	101 Mohonk Road	252	50	82	90
104	107 Mohonk Road	258	50	79	88
105	115 Mohonk Road	258	52	79	88
106	117 Mohonk Road	258	50	79	88
107	120 Mohonk Road	257	50	80	88
108	120 Mohonk Road Apt.	256	50	80	89
109	123 Mohonk Road	266	44	76	84
110	125 Mohonk Road	266	50	76	84
111	126 Mohonk Road front	264	50	77	85
112	126 Mohonk Road rear	255	50	81	89
113	130 Mohonk Road	273	50	73	81
114	136 Mohonk Road	274	48	72	81
115	150 Mohonk Road	286	50	67	76
116	137 Mohonk Road	269	50	74	83
117	171 Mohonk Road	311	34	56	65
118	vacant lot (MRHTC-19)	297		62	71
119	161 Mohonk Road	302	50	60	69
120	183 Mohonk Road	320	50	52	61
121	187 Mohonk Road	308	50	58	66
122	191 Mohonk Road	308	50	58	66
123	199 Mohonk Road	322	48	52	60
124	201 Mohonk Road	321	50	52	61
125	210 Mohonk Road (residence trailer)	328	50	49	58
126	210 Mohonk Road trailer	330	50	48	57
127	220 Mohonk Road (Mountain View)	338	53	45	53
128	vacant lot (MRHTC-19)	324		51	59
129	222 Mohonk Road	323	54	51	60
130	159 Mountain View (westerly)	271	50	74	82
131	159 Mountain View (easterly)	323	50	51	60
132	vacant lot (MVHTC-23)	327		49	58
133	Johnny On The Spot office (MVHTC-23)	328	50	49	58
134	? Mountain View	329	50	48	57
135	MRIP (w.l. proposed to enter SW corner of bldg)	331	44	48	56
136	7 Old Route 213	156	50	123	132
137	vacant lot (ORTHTC-25)	156		123	132
138	11 Old Route 213	156	50	123	132

Mohonk Road Industrial Plant
Pressures vs. Tank Height

	Address	Elevation of Prop. P.O.E. (ft.) (10)	Existing Pressure (psi)	Static Pressure at Prop. POE, Top of Fire Flow in Tank 441 ft (psi)	Static Pressure at Prop. POE, Top Level in Tank 461 ft (psi)
SCENARIO 2					
Top of Tank Water Level at 461 ft and Bottom at 429 ft					
139	15 Old Route 213	157	50	123	132
140	17 Old Route 213	157	62	123	132
141	vacant lot (ORTHTC-25)	165		120	128
142	34 Old Route 213	182	50	112	121
143	37 Old Route 213	177	54	114	123
144	38 Old Route 213	182	50	112	121
145	47 Old Route 213	181	40	113	121
146	54 Old Route 213	186	42	110	119
147	54 Old Route 213 studio	186	50	110	119
148	55 Old Route 213	185	60	111	120
149	60 Old Route 213	187	40	110	119
150	64 Old Route 213	193	56	107	116
151	72 Old Route 213	195	50	107	115
152	76 Old Route 213 (abandoned house?)	202	50	103	112
153	80 Old Route 213	203	45	103	112
154	vacant lot (ORTHTC-25)	206		102	110
155	107 Main St.(Post Office)	158	50	123	131
156	113 Main St. (Town Pantry)	159	50	122	131
157	1219 Main St. (Clove Café)	154	50	124	133
158	1061 State Route 213 (High Falls Motel)	205	50	102	111
159	1065 Route 213 (northerly structure)	195	50	107	115
160	1066 Route 213 (southerly structure)	200	50	104	113
161	1075 Route 213	190	50	109	117
162	1203 Main St. (Rock Cliff House)	153	64	125	133
163	1203 trailer	158	50	123	131
164	1204 Main St. (The Green Cottage)	153	50	125	133
165	1209 Main St.	153	50	125	133
166	7 Mohonk Road	153	50	125	133
167	1300 Main St. (Egg's Nest)	154	40	124	133
168	1300 Main St. (residence)	142	50	129	138
169	1304 Main St.	152	50	125	134
170	1306 Main St. (RTHTC-29)	155	50	124	132
171	1343 Main St.	198	50	105	114
172	1347 Main St. (Verizon)	200	50	104	113
173	1355 State Route 213	222	50	95	103
174	125 Main St.	176	50	115	123
175	133 Main St. (Westcote Bell Pottery Shop)	175	50	115	124
176	11 Gravel Road	162	50	121	129
177	15 Gravel Road	167	48	119	127
178	8/6 2nd St.	164	50	120	129
179	139 Old Route 213	191	50	108	117
180	16 School Hill Road	240	45	87	96
181	vacant lot (SCHTC-33)	240		87	96
182	17 School Hill Road	232	50	90	99
183	45 School Hill Road	217	66	97	106
184	53 School Hill Road	212	41	99	108
185	vacant lot (SCHTC-34)	209		100	109
186	vacant lot (SCHTC-34)	217		97	106
187	84 School Hill Road	246	44	84	93
188	96 School Hill Road	225	50	94	102
189	116 School Hill Road	200	50	104	113
190	1 - 4th St.	211	50	100	108
191	4 Steep Hill St.	212	48	99	108
192	5/7 4th Street	213	50	99	107
193	9 4th St.	218	60	97	105
194	11B-1 4th St.	218	56	97	105
195	11B-2 4th St.	222	56	95	103
196	14 4th St.	220	50	96	104
197	16 4th St.	222	50	95	103
198	18 4th St.	230	34	91	100
199	20 4th St.	230	50	91	100
200	22 4th St.	235	50	89	98
201	207 4th St.	225	50	94	102
202	1 Dutch Barn Drive	202	44	103	112
203	2 Dutch Barn Drive	202	44	103	112
204	112 Steep Hill Road	216	48	97	106
205	22 Bruceville Road	132	53	134	142
206	24 Bruceville Road	132	50	134	142
207	vacant lot (MRHTC-15)	178		114	123

Mohonk Road Industrial Plant
Pressures vs. Tank Height

SCENARIO 2

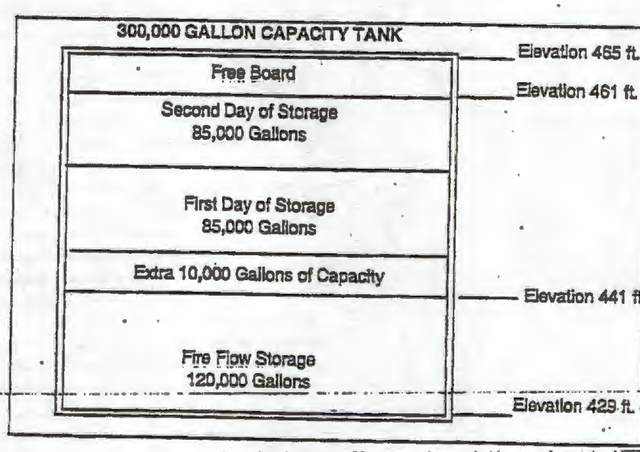
Top of Tank Water Level at 461 ft and Bottom at 429 ft

	Address	Elevation of Prop. P.O.E. (ft.)[10]	Existing Pressure (psi)	Static Pressure at Prop. POE, Top of Fire Flow in Tank 441 ft (psi)	Static Pressure at Prop. POE, Top Level in Tank 461ft (psi)
208	9 Steep Hill Road	175	34	115	124
209	10 Steep Hill Road	186	50	110	119
210	44 Steep Hill Road (MRHTC-15)	177	50	114	123
211	36 Steep Hill Road (MRHTC-15)	172	50	116	125
212	39 Steep Hill Road (MRHTC-15)	181	50	113	121
213	108 Steep Hill Road	206	50	102	110
214	1 Quick Road	193	50	107	116
215	vacant lot (RTHTC-30)	191		108	117
216	21 Quick Road	192	50	108	116
217	7 2nd St.	154	46	124	133
218	Firehouse (MRHTC-15)	162	50	121	129
219	4 Firehouse Road (High Falls Community Church)	155	50	124	132
220	7 Firehouse Road	155	50	124	132
221	8 Firehouse Road	163	50	120	129
222	9 Firehouse Road	154	50	124	133
223	159A Canal Road	323	48	51	60
224	159B Canal Road	270	53	74	83
225	Depuy Canal House (1315 Rte. 213)	156	50	123	132
226	Mobile Home (RTHTC-29)	155	50	124	132
227	1314 Rte. 213 (Locktender Cottage)	156	50	123	132
228	103 Main Street (New York Store)	156	50	123	132
229	103 Main Street (Woodworking Shop)	162	50	121	129
230	1315 Rte. 213 (office)	162	50	121	129
231	155 Old Route 213 (Northern Spy Restaurant)	205	36	102	111
232	vacant lot (RTHTC-28)	179		113	122
233	Marbletown First Aid Unit	240	50	87	96
234	Ulster County Ambulance Association	240	50	87	96
235	9/5 2nd St.	156	50	123	132
236	4 Orchard Street northerly structure	229	41	92	100
237	4 Orchard Street southerly structure	236	41	89	97
238	25 Orchard Street	243	50	86	94
239	45 Orchard Street	239	50	87	96
240	15 Strawberry Bank Road (Strawberry Hill Road?)	230	48	91	100
241	112 School Hill Road	213	45	99	107
242	#D Mohonk Road	260	50	78	87
243	70 School Hill Road	248	50	84	92
244	79 School Hill Road	227	50	93	101
245	1 Dutch Barn Drive (barn)	205	44	102	111
246	121 Main Street	178	48	114	123
247	# G Mohonk Road (b/w # 120 & # 150)	263	50	77	86
248	# M Mohonk Road (on NE side of intersection of Mohonk, Canal, School Hill)	208	50	101	110
249	# N Mohonk Road (greater than # 137)	303	50	60	68

High Water Elevation in Tank (ft)
461

Low Water Elevation in Tank (ft)
429

Top of Fire Flow in Tank (ft)
441



Miller, Don

Subject: FW: MRIP/HFWD Design

-----Original Message-----
From: Speckin, Paul D NWK [mailto:Paul.D.Speckin@nwk02.usace.army.mil]
Sent: Friday, May 21, 2004 1:02 AM
To: dmiller@ene.com
Subject: FW: MRIP/HFWD Design issues

Don,

Here is the e-mail regarding the Towns making a decision to go with the 153 ft tank height and multi-column tank style. You need to page down a bit to get to Martello's response to Sal on these issues.

Paul

-----Original Message-----
From: Badalamenti.Salvatore@epamail.epa.gov
[mailto:Badalamenti.Salvatore@epamail.epa.gov]
Sent: Monday, April 26, 2004 6:16 AM
To: Pender, Robert M; Speckin, Paul D
Cc: dmiller@ene.com
Subject: RE: MRIP/HFWD Design issues

----- Forwarded by Salvatore Badalamenti/R2/USEPA/US on 04/26/2004 07:10 AM -----

"Marbletown Supervisor: Vin Martello" <supervisor@marbletown.net>

04/24/2004 11:57 AM

To: Salvatore Badalamenti/R2/USEPA/US@EPA
cc: "Lewis C. Di Stasi" <dmmlaw@bestweb.net>, info@townofrosendale.com
Subject: RE: MRIP/HFWD Design issues

Sal:

On behalf of the Town of Marbletown, I would like to offer a response to the three issues indicated in your letter.

1. Tank Height: After discussions with our Attorney, Lew DiStasi and our Consulting Engineer, Dennis Larios, I would have to agree with your conclusion that the 153' height is the best and most balanced choice. Lew and Dennis differ on the ideal height. While Lew prefers the 173' option, Dennis believes that we could even lower than 153'.

2. Tank Style: Although several citizens had expressed concerns about the tank style at the last meeting, none have followed-up with specific input. I have since spoken to Gretchen Reed. She agrees as do I that, given the absence follow-up, the Multi-Column style that you recommended is probably the best way to go.

3. Sub Meters and Allocation of Water Costs: Per discussions with our Attorney, Lew DiStasi, we favor the addition of sub meters within the distribution system to enable the measurement of water use separately in the Town of Rosendale, so that the excess usage can be delivered accurately. With regard to the allocation of water use cost, it has been divided by assessed value, 85% to the Town of Marbletown and 15% to the Town of Rosendale. The two towns will resolve between them any changes to that allocation.

Unless the Town of Rosendale and/or other parties feels otherwise, I do not believe that a follow-up meeting is required at this time.

Sincerely,

Vincent C. Martello
Supervisor
Town of Marbletown

-----Original Message-----
From: Badalamenti.Salvatore@epamail.epa.gov
[mailto:Badalamenti.Salvatore@epamail.epa.gov]
Sent: Thursday, April 15, 2004 10:37 AM
To: supervisor@marbletown.net; info@townofrosendale.com
Cc: adum@co.ulster.ny.us; James Malcolm;
Robert.M.Pender@nwk02.usace.army.mil;
Paul.D.Speckin@nwk02.usace.army.mil; dmiller@ene.com
Subject: MRIP/HFWD Design issues

Dear Supervisors Martello and Gallagher;

The intent of this letter is to seek input and concurrence related to design issues from the High Falls Water District (HFWD). Since we are not aware that any of the administrative or technical functions of the HFWD have yet been established or delegated, we seek your input on these matters. These issues are a result of public meetings as well as recent discussions regarding the finalization of the HFWD/NYCDEP Use Agreement. We are at a juncture in the remedial design whereby these issues need to be resolved. In addition, we are anticipating additional involvement and coordination will be required from the HFWD. Current issues requiring a resolution are as follows:

1.Finished Water Tank Height - Attached is a technical memorandum discussing the issue. Basically, this is associated with providing an adequate water pressure to the majority of residents vs. potential visual impacts resulting from the tank's height. The EPA and Corps of Engineers recommendation remains as stated in the last public meeting. Namely, that a 153-foot high tank is a good balance of both concerns.

2.Finished Water Tank Style - A technical memorandum evaluating and recommending various tank styles was previously provided for community consideration. A tank style selection is required.

3.Addition of sub meters within the distribution system to enable measurement of water use separately in the Town of Rosendale, and then by subtraction, water use in the Town of Marbletown. This additional metering has been brought about as a result of a requirement of the New York City Department of Environmental Protection (NYCDEP) and its determination that the HFWD is in actuality two water districts being operated jointly as one. Both towns will need to resolve among each other allocation of water use costs attributable to flushing of dead end water mains.

Prior to finalizing the design documents for submittal and approval by all relevant parties we are seeking the input and formal concurrence of the HFWD on the above matters. This is in order to work cooperatively with the HFWD to address community concerns, minimize cost to the HFWD, and reduce redesign on our part which would lead to additional schedule delays.

Please advise as to whether or not a meeting to further discuss these matters is required prior to your response. Please contact me at (212)637 3314 should there be any questions concerning the above.

Sincerely
Sal Badalamenti
(See attached file: Water Tank Evaluation Final 14Apr04.pdf)
Remedial Project Manager
USEPA Region 2
Emergency and Remedial Response Division
(212) 637- 3314

D Water CAD Hydraulic Analysis

Memo

To: Project File

From: Shawn Gardner

Checked by:

Date: August 31, 2004

Re: **High Falls Water Distribution System WaterCad© Model Development and Results**

I. Purpose

Ten State Standards (Great Lakes 1997) requires a hydraulic analysis to evaluate flow demands and pressure requirements. To meet this requirement and assist with design of the water distribution system, a model of the proposed High Falls Water District's water distribution system was developed to simulate various operating scenarios in order to determine the effects of pipe sizing, initial chlorine dosage and resulting chlorine residuals, effects on pressure observations, and fire flows. The model was developed using WaterCad© software, version 6.5, by Haestad Methods, Inc.

II. Model Design and Data

The model of the water distribution system was based on the waterline layout as developed for the 95% designE & EE & E. This also includes the layout of the water treatment system and associated components such as the storage tanks, metering chamber, and raw water valve house.

Water demand information was obtained from the memo titled "Calculating Average Daily Flow Demand for the High Falls Water District" (E & E 2001b). Elevation data was established from the topographic information developed from the aerial survey information obtained previously at the beginning of this project (3Di 2001). Individual nodes, or water users, were assigned at each residence or business expected to receive water. In addition, one node was assigned to each vacant parcel to account for increased demand due to future development. Each node was assigned an elevation based on the contours developed from the aerial survey. The water pipes in the model are ductile iron as stated in the feasibility study (LMSE 1999) and in accordance with Ten States' Standards (Great Lakes 1997). The feasibility study recommended 8-inch inside-diameter (ID) pipes, and Ten States' Standards recommends a minimum 6-inch ID pipes. Both sizes were modeled to evaluate their impacts on pressures and velocities.

The treatment plant layout used in the model was based on the proposed layout presented on drawings G5-G((E & E 2004). Minimum normal working pressure requirements of 35 psi static pressure and 20 psi residual pressure during fire demand at each water user were obtained from Ten States' Standards (Great Lakes 1997). Surveys of individual residences, however, have revealed that existing pressures throughout the water district range from 34 to 64 psi. It is desirable to provide the same pressures that currently exist at each residence; a lower pressure may generate complaints, and a higher pressure may burst existing pipes within the residences. Therefore, the model accounted for existing pressures throughout the water district, and these values were used as the targets for the model.

The tank sizes used in the model were based on the memo titled "High Falls WTP - Tank Sizes and System Flows" (E & E 2002b). Calculated peak daily and maximum hourly demands were based on the memo titled "Mohonk WTP - Peak Daily and Peak Hourly Demand Calculations" (E & E 2001c). Calculated fire flows were based on the memo titled "Mohonk WTP - Fire Flow Demand Calculations" (E & E 2001d).

Chlorine decay (bulk and wall) rates are typically determined empirically from field tests and samples. However, for this model, assumed rates based on discussions with other professionals experienced with chlorine modeling were used. For bulk decay rates (chlorine content dissipating due to time and water temperature), typical values range from -0.1 to -1.0 mg/L per day; therefore, the bulk decay rate was assumed to be -0.5 mg/L per day. For wall decay, (chlorine content dissipating due to a reaction with the pipe walls), typical values range from -0.25 to -1.0 mg/L ft/day; therefore, the wall decay rate was assumed to be -0.6 mg/L/ft/day.

III. Methods

In order to evaluate the proposed drinking water supply and distribution system, a computer-generated model of the system was developed using WaterCad©, Version 6.5, by Haestad Methods. WaterCad© is a software program that facilitates the design and analysis of pressurized piping systems. WaterCad© software can be used to:

- Lay out complex networks of pipes, tanks, pumps, and ancillary equipment.
- Perform steady-state analyses of water distribution systems with pumps, tanks, and control valves.
- Perform extended-period simulations to analyze a piping system's response to various supply and demand schedules.
- Perform water-quality simulations to determine water source and age, or track the growth or decay of a chemical constituent throughout the network.
- Perform fire-flow analyses on the system to determine how the system will behave under extreme conditions.
- Develop scenarios to analyze combinations of "What if" conditions on the system.

Information regarding hydraulic parameters under normal operating conditions is easily obtained using WaterCad©, which uses basic engineering principles to determine pressure drops, hydraulic grade changes, chlorine concentrations, velocities, etc. The program is based on the user's choice of friction-loss methods, including Manning's Equation, Darcy-Weisbach, and Hazen-Williams. The Hazen-Williams method, the equation generally used in the United States for these types of calculations, was chosen for this model. When a model is run, the program calculates all of these design parameters, allowing the user to see how a system will theoretically operate under similar conditions in real life.

Model Development

The model for the High Falls Water District was developed based on drawings submitted by E & EE & E as modified throughout the design processE & E. The design process has taken into account all comments and design considerations provided throughout the project. The model was modified after each pipe section was plotted, and nodes were established at each expected water user, residence, and business, as well as at vacant parcels. Based on the memo submitted regarding the number of tax parcels, including homes, businesses, and vacant parcels (E & E 2001b), 216 nodes (water users) were plotted.

In addition to the 216 established nodes, the water source for the system, the raw water connection from the siphon house to the raw water storage tank, the clearwell, and the finished water storage tank were plotted. The proposed dimensions of the finished water storage tank, raw water storage tank, and treatment system building were calculated in the memos titled "Sizing Finished Water Storage Tank" (E & E 2001e), "Mohonk Road WTP – Raw Water Impoundment Size" (E & E 2003a), and "Mohonk Road WTP – Treatment System Building" (E & E 2003b). These dimensions were entered into the model to simulate the proposed conditions for each of the tanks and clearwell. The elevations entered into the program for each of the model components were obtained from the same maps used to determine the elevations (in feet above mean sea level [msl]) of the nodes (3Di 2001).

Based on measurements taken from drawings G5-G9pipe lengths between the siphon house, raw water tank, treatment plant, and finished tank were calculated and entered into the model. Pipe lengths throughout the distribution system were automatically calculated by WaterCad© as the nodes were plotted. To account for the depth of cover over the pipe (provided for frost protection), an elevation value (measured in feet above msl) of 4 feet less than the top of grade was entered for each node. Since the addition of 5 feet between the top of the tank and the bottom of the pipe can provide an additional 2 pounds of pressure, the depth of cover had to be accounted for to obtain a hydraulically more accurate model.

The sizes and configurations of the raw water tank, clearwell, and finished water storage tank were entered into the model. The required volume of the raw water tank is 340,000 gallons. This ground-level tank will be 46 feet in diameter tank. In order to provide operating pressure to the water treatment plant without the use of pumps, it is proposed to add 120,000 gallons, or 10 feet of head, resulting in an approximate tank height of 38 feet. This has been increased to 40 feet to meet manufacturers' availability. Therefore, the raw water tank will have a total operating volume of 48,200 ft^3 (360,500 gallons) with a 1-foot top-of-tank clearance (39 feet of actual water height). The raw water tank will be modeled at this volume and height

The clearwell requires an operating volume of 2,000 ft^3. The clearwell acts as the injection point for chlorine. A set-point chlorine level of 2.50 mg/L was established here (E & E 2002c), along with an initial chlorine level of 0.05 mg/L at each node. Because of this initial chlorine level, the model acts as if some residual chlorine was present in the system before the model started. The model was then run and the resulting chlorine residuals were determined at each node throughout the system. The

American Water Works Association (AWWA) requires that a chlorine residual (any concentration above 0.0 mg/L) be maintained throughout the system (AWWA and ASCE 1998). Therefore, for acceptance, each model analysis required chlorine residual to be present at each node.

The finished water storage tank has a design volume of 40,107 ft^3 (300,000 gallons). The tank will be a 43-foot diameter cylindrical elevated storage tank based on availability. The ground elevation at the tank is 312 ft above msl. The bottom of the tank is designed to be at 429 ft above msl with the top of fire flow at 441 ft. The resulting fire flow volume is 130,350 gallons. This volume will remain as storage while the operating level for drinking water will vary between 441 ft to 459 ft. The resulting drinking water volume will be 195,500 gallons, which provides over two days of supply. The top of the tank is 463 ft, which allows for 4 ft of headspace. The minimum proposed drinking water level will also provide the minimum residential pressures as well as meeting Ten-State Standard requirements throughout the system.

Raw water flow from the siphon house to the raw water tank will be provided by the current water pressure of 115 psi (equivalent to 266 feet of head) in the aqueduct system. The siphon house ground elevation is 215 feet. In order to simulate the hydraulic grade line (HGL) available at the siphon house of 266 feet, the siphon house elevation was set at 481 feet (266 feet of equivalent head and 215 feet actual elevation).

A metering chamber will be located after the siphon house and will contain a venturi meter and backflow prevention device. This will be added to the model as a backflow valve with appropriate headloss.

Prior to the raw water tank, a raw water valve house will contain a pressure-reducing valve (PRV) installed to reduce the pressure from the siphon house to meet the pressure required to adequately fill the raw water tank. The PRV is set at 16.88 psi, which limits the hydraulic grade to 359 feet (i.e., the maximum elevation of the raw water storage tank) when taking into account the elevation of the PRV. Two backflow prevention devices will also be located in this valve house set in parallel for each to act as a backup.

A flow control valve (FCV) was modeled between the raw water storage tank and the clearwell. The FCV was included to regulate the flow from the raw water storage tank to the clearwell and simulate the operating capacity of the treatment system (175 gpm). The output of the FCV was therefore set at 175 gpm. This was done to obtain information regarding the system's ability to fill the tanks within the required time period under a worst-case scenario of the tanks being empty.

A pump was modeled between the clearwell and finished water tank. The pump was set with an initial discharge rate of 175 gpm to simulate the operating capacity of the treatment system. Various pump rates were analyzed to determine the impacts on tank levels and chlorine (see Scenario 1 below).

Two fill line configurations were modeled for the finished water storage tank. In the first configuration, the tank is bypassed by a fill line that first satisfies the demand for water in the distribution system. After and/or while the demand is being met, any excess water is used to fill the tank. After the tank has been filled, demand is supplied from the tank, allowing the treatment system to be interrupted until demand exceeds the supply available from the finished storage tank.

In the second configuration, water is pumped through the finished storage tank and then to the distribution system. This alternative also satisfies the demand for water, as water is supplied from the tank to meet the demand. However, unlike the first analysis, water must first pass through the tank before supplying the demand. Excess water not needed to meet the demand is used to fill the tank until the tank is full. This option allows fresh, treated water, as well as the chlorine concentration, to be replenished in the tank until the tank is completely full. Operation of the treatment system is then interrupted while water is supplied from the full finished water storage tank.

Model Evaluation

The model can be run in either a steady-state or extended-period mode. The steady-state mode is a one-time run of the system and provides information regarding the operating behavior of the system under static conditions. Pressures, velocities, and hydraulic grades can be determined quickly by this method.

A fire-flow analysis can be performed in the steady-state mode. A minimum fire-flow requirement can be entered along with minimum system pressures to determine whether the system can provide the minimum fire flow at the minimum pressure at each node (i.e., water user). This allows the modeler to verify that enough water can be supplied to fight a fire without compromising the level of service to any other customers. As required by the Insurance Services Office (ISO) and discussed in the memo titled "Calculating Fire Flow" (E & E 2001f), a minimum fire flow of 1,000 gpm at a minimum residual pressure of 20 psi has been established for the proposed High Falls Water District distribution system.

The other modeling mode, extended-period simulation (EPS), allows the model to be run over a designated time period. This analysis provides information about the system at each time frame, allowing the user to observe tank levels, regulating valve operation, pressures, and flow rates in response to varying demand conditions.

In the EPS mode, a chlorine analysis can be performed along with age and trace options. Chlorine analysis calculates the chlorine decay rate based on time (bulk decay) and rate of decay associated with each section of pipe (wall decay) and can determine the residual chlorine at each node in the system at a given time. The age option provides the age of a hypothetical parcel of water (i.e., its duration within the system) at any point in time as it flows within the system based on the demand. As the parcel of water flows through the system, the time that it takes to get from Point A to Point B can be determined by the model. This feature helps determine the water's path and the resulting effect on chlorine concentration over time. The trace option provides a view of the water flow throughout the system and can identify areas where water is potentially stagnant or mixing at intersections, which can result in reduced aesthetic qualities (e.g., cloudiness or disagreeable taste and odor).

IV. Modeled Scenarios

Scenario 1: 6-Inch-Dameter Pipe Used Throughout the System

The first scenario evaluated the use of 6-inch inside-diameter (ID) ductile iron (DI) pipe within the entire system, including the raw water supply line. The objective of this analysis is to determine the ability of the system to fill the tanks in the required time, as imposed by NYCDEP. This requirement is a 5-day water supply established within 48 hours. To be conservative, it was assumed that all the tanks, and clear well, were completely empty. This would typically not be the case as the tanks would be full to the fire flow levels unless a fire occurred just before the tanks needed to be filled.

The operation of the treatment system would be represented by a pump set to run at 175 gpm. The treatment system itself would be represented by a flow control valve and would be set at 350 gpm to represent both treatment systems working. However, during normal operation, only one system would be running and would provide 175 gpm of treated water. When required, both systems would be able to run at a rate of 350 gpm.

Using the EPS mode along with the 6-inch diameter pipes between the siphon house and the raw water storage tank, the finished and raw water tanks fill within 28 hours under constant, normal demand. This meets the NYCDEP requirement to be able to store a 5-day water supply within 48 hours and provides a margin of approximately 40%.

A steady-state analysis was used to determine the pressure throughout the system when the pipes are 6-inch diameter and the water levels are at the bottom of the tanks. It is not anticipated that this situation would occurred since the drinking water levels would be maintained in each of the tanks as detailed above. But for a worst-case scenario, this analysis resulted in a low pressure of 40 psi near the corner of Mountain View Acres (a private road) and Mohonk Road and a high pressure of 132 psi at the end of Bruceville Road when the water elevation in the finished water storage tank is 441 feet. These pressures meet the minimum static pressure of 40 psi required by Ten States' Standards (Great Lakes 1997). When the finished water storage tank is full, the steady-state analysis indicated a low pressure of 53 psi near the corner of Mountain View Acres (a private road) and Mohonk Road and a high pressure of 146 psi at the end of Bruceville Road.

A fire-flow analysis indicated that 6-inch ID line in the distribution system would be unable to provide the required fire flow. The analysis indicated a low flow of 625 gpm, and many nodes were unable to obtain the required flow of 1,000 gpm. Most of the nodes capable of 1,000 gpm were located north of Route 213 at the lowest elevations relative to the treatment system.

Since 6-inch ID pipe within the distribution system would be unable provide the required fire flow, it was unnecessary to analyze the entire system using 6-inch ID pipe. However, the 6-inch ID raw water line was not eliminated at this time.

Scenario 2: 8-Inch Diameter Pipe Used Throughout the System

Using the EPS mode, this scenario evaluated the use of 8-inch ID DI pipe throughout the entire system under similar analysis as described for the 6-inch system. With a raw water supply line of this diameter, the finished and raw water tanks can be filled within 28 hours. This also meets the NYCDEP requirement to be able to store a 5-day supply within 2 days. Therefore, use of this pipe remains an option.

A steady-state analysis provided results similar to those under Scenario 1, with a low pressure of 41 psi near the corner of Mountain View Acres (a private road) and Mohonk Road, and a high pressure of 132 psi at the end of Bruceville Road when the water level in the finished water storage tank is at the bottom of the tank at elevation 429 feet. These pressures also meet the minimum static pressure requirement of 40 psi established by Ten States' Standards (Great Lakes 1997).

A fire-flow analysis also was run, and the 8-inch ID line in the distribution system was able to provide the required fire flow with the water level in the finish tank at the top of fire flow of 441 feet. The node with the lowest yield had a flow of 1,048 gpm, which surpasses the ISO requirement of at least 1,000 gpm.

Scenario 3: A 6-Inch ID Raw Water Supply Line and an 8-Inch ID Pipe in the Distribution System

The results of Scenario 1 (the use of 6-inch ID pipe throughout the system) indicated that the raw water supply line was able to fill the finished and raw water storage tanks within the time required by NYCDEP. Therefore, to minimize material costs, Scenario 3 evaluated the use of a 6-inch ID raw water supply line along with the use of 8-inch ID pipe in the distribution system. The results of this scenario indicated that the finished and raw water storage tanks filled within 28 hours, and the fire-flow analysis indicated that the minimum required flow of 1,000 gpm at each node can be achieved when the water level in the finish tank is at the top of fire flow of 441 feet.

Scenario 4: A 6-Inch ID Raw Water Supply Line and 6- and 8-Inch ID Pipes in a Modified Distribution System

To further reduce material costs, a scenario was developed to analyze the effects of different pipe sizes at various locations throughout the distribution system. The goal was to utilize 6-inch ID pipe in place of 8-inch ID pipe where possible and still provide the required fire flows. Based on the results of this scenario, locations were identified where 6-inch ID pipe could be used in place of 8-inch ID pipe.

Based on the results of this scenario, pipe size was increased from 6 inches to 8 inches south of the MRIP along Mountain View Acres (a private road), down Mohonk Road around Fire House Road to Route 213, and to the end of School Hill Road. This combination of pipe diameters also provides sufficient tank fill times (29 hours). A list of pipes and their sizes is included at the end of this memo.

With the initial chlorine settings as discussed above, after running this scenario in EPS mode over a time period of 30 days, chlorine residual was maintained at each user node throughout the system, thereby meeting the AWWA requirement for a chlorine residual (i.e., any concentration above 0.0 mg/L). Nodes at the dead ends (at the east end of Route 213 and south end of Canal Road), chlorine residual drops to zero after approximately 200 hours indicating that a flushing program will be required to maintain chlorine residual throughout the system at all times. Since this is the scenario that will be considered, the chlorine residual was determined only for this scenario.

This scenario was designed to provide information regarding the minimum number of pipe sections that needed to be increased to 8 inches. In addition to these sections, pipe segments to the end of Bruceville Road, School Hill Road, and the south end of Canal Road were increased to 8-inches to provide for future flows outside the proposed water district. This provision was requested by the

United States Army Corps of Engineers to facilitate potential expansion of the water district or provision of water services to surrounding communities.

The results of the above scenarios indicate that, under a normal, steady demand, a combination of 6- and 8-inch ID pipes will provide the required pressures, fire flows, and chlorine residuals at the lowest material cost. Therefore, further analysis regarding diurnal demand will be limited to this combination of pipe sizes.

Diurnal Demand Analysis

Using a combination of 6- and 8-inch ID pipes, normal, steady demands can be met while providing appropriate pressures and chlorine residuals. However, further analysis was required to determine whether pressures and residuals could still be supplied during diurnal demand periods. The diurnal demand pattern is the typical usage pattern during the day. Typically, a community's water usage varies throughout the day. Water usage is typically low at night during periods of low activity and increases during the early morning hours as activities involving water use increase. Usage typically decreases during the middle of the day and then increases during the evening, when people return home. There are even different demand considerations for residential and commercial usage. The average daily demand of 85,000 gpd remains constant; only the rate of distribution over the day varies.

Diurnal demand analysis is used to determine the effects of diurnal demand on water and chlorine levels in the finished water storage tank, chlorine residuals at the nodes, and pressures throughout the system as low flow occurs throughout the night and as flow then gradually peaks during the day. This pattern was simulated over a one-month period. The analysis was begun assuming a finished water storage tank level of 15 feet (approximately half full) and a chlorine residual of 0.05 mg/L at all nodes. The results of this scenario indicate that after the first 24-hour period, the lowest chlorine residual at any node in the system is 0.01 mg/L, and the lowest pressure at any node is 55 psi. These pressures and residuals do not occur at all nodes; these are the low values within the system and do not necessarily occur at more than one node.

At half full, after the first 15 hours, the finished water storage tank has reached full capacity and begins to drain, and the distribution system is supplied directly from the finished water storage tank. At this point, the chlorine levels decrease as decay occurs within the finished water storage tank. Water is supplied from the finished water storage tank until 79 hours, at which time the tank begins to fill again. At 79 hours, the lowest chlorine residual at any node in the system was 0.007 mg/L, and the lowest pressure at any node in the system was 48 psi, thereby meeting both the low pressure and chlorine residual requirements. After 79 hours, the finished water storage tank refills, resulting in higher pressure and refreshed chlorine levels.

V. Conclusion

As indicated above, a combination of 6- and 8-inch ID pipes will provide the required pressures, fire flows, and chlorine residuals at the lowest material cost. In addition, the results of the diurnal demand analysis for this scenario indicate that adequate chlorine residuals are maintained at all nodes except the dead ends, where the residuals approach 0.0 mg/L at 190 hours. These dead ends will be discussed in a separate memo.

VI. References

3Di, LLC, 2001, Aerial photographic data developed for the High Falls Water Treatment Plant project.

AWWA and ASCE, 1998, *Water Treatment Plant Design*, Third Edition.

Brinnier and Larios, P.C., 2000, *Plan, Map, and Report of the Proposed High Falls Water District*, January 2000.

Ecology and Environment Engineering, P.C.E & E, 2003a, Memo titled "Mohonk Road WTP – Raw Water Impoundment Size," dated January 10, 2003.

__________, 2003b, Memo titled "Mohonk Road WTP – Treatment System Building," dated January 10, 2003.

__________, 2002a, *Proposed Water Treatment Plant Existing Monitoring Wells and Proposed Soil Boring Locations*, Figure PT-4, dated August 16, 2002.

__________, 2002b, Memo titled "High Falls WTP - Tank Sizes and System Flows," dated July 8, 2002.

__________, 2002c, Memo titled "Calculations for Disinfection System Design," dated January 24, 2003.

__________, 2001a, *35% Design Review*, submitted to USACE for review on November 2001.

__________, 2001b, Memo titled "Calculating Average Flow Demand for the High Falls Water District," dated December 14, 2001.

__________, 2001c, Memo titled "Mohonk WTP - Peak Daily and Peak Hourly Demand Calculations," dated September 27, 2001.

__________, 2001d, Memo titled "Mohonk WTP - Fire Flow Demand Calculations," dated September 28, 2001.

__________, 2001e, Memo titled "Sizing Finished Water Storage Tank," dated December 20, 2001.

__________, 2001f, Memo titled "Calculating Fire Flow," dated November 19, 2001.

Lawler, Matusky, and Skelly Engineers LLP (LMSE), 1999, *Feasibility Study Report, Mohonk Road Industrial Superfund Site*, March 1999.

Great Lakes - Upper Mississippi River Board of Public Health and Environmental Managers (Great Lakes), 1997, *Recommended Standards For Water Works* (aka *Ten States' Standards*), published by Health Education Services, a Division of Health Research, Inc., Albany, New York

E High Falls Water Treatment Plant Pilot Study

New Paltz WTP as High Falls WTP Pilot Study

1. Approval to use New Paltz WTP as High Falls WTP Pilot - Letter from EEEPC to USACE
2. High Falls WTP Pilot Study
    a. Attachment A – Contact report with NYSDOH
    b. Attachment B – MCLs
    c. Attachment C – Annual Water Quality Reports for Village of New Paltz and New York City (2000)
    d. Attachment D – Excerpt from O&M Manual – New Paltz WTP

High Falls WTP Raw Water Testing

1. Technical memorandum – High Falls WTP Raw Water Testing
    a. Appendix A – USFilter Raw Water Analyses and Trident Treat-ability Report
        i. Appendix A – E & E Sampling plan (not included as part of EDR)
        ii. Appendix B – Raw Water Analyses
        iii. Appendix C – Jar Test Data Sheets and Graphs
2. Telephone Conference Call (EPA, USACE, UCHD, NYSDOH, E & E) – Lead-lined Riser Pipe
3. Contact Report – NYSDOH requirement for full-scale pilot for lead treatment at startup.

[illegible] Water Treatment Plant [illegible]

[illegible]

[illegible] Water Quality [illegible]

[illegible]

ecology and environment engineering, p.c.

BUFFALO CORPORATE CENTER
368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

November 27, 2001

Mr. Robert M. Pender
U.S. Army Corps of Engineers
Attn: CENWK-EC-ED
601 E. 12th Street
Kansas City, MO 64106-2896

Subject: Mohonk Road WTP
E&E Ref. 001002.UP02.04.01

Dear Mr. Pender:

When Ecology and Environment Engineering, P.C. (E&E) prepared the proposal for the preliminary design effort for the High Falls water treatment plant (WTP), it was anticipated that the main raw water source would require a treatability study to conform to New York State Department of Health (NYS DOH) guidelines. This requirement was included in our proposal as WE 04.01.

However, after the commencement of work regarding this subject, E&E realized that the NYS DOH has approved aqueduct water as the raw water source for a number of WTP's in the area. Further, the treatment processes utilized at these plants are similar to the treatment process proposed for the High Falls WTP. Therefore, as allowed by the NYS DOH and as per our agreement, E&E analyzed the performance of one WTP that utilizes the aqueduct water in lieu of a treatability study. The New Paltz WTP was chosen for analysis due to its proximity to the High Falls site and its relatively recent construction date.

Attached is our memo that contains the analysis of the aqueduct water for use as a raw water source. The information and conclusions contained within this memo are based on the operating data and history of the New Paltz WTP and should be sufficient to address the concerns of the NYS DOH for the Engineer's Design Report.

Call me if you have any questions.

Sincerely,

Donald J. Miller, PE
Project Manager

Attachment

cc: J. Fazzolari

recycled paper

Memo

To: Project File

From: John Fazzolari

Checked By: TML, DM

CC:

Date: 11/26/01

Re: Mohonk Road WTP – Pilot Study

I - Background
In the process of the preliminary design for the Mohonk Water Treatment Plant, a study must be performed to establish the adequacy of the proposed treatment process. The Recommended Standards for Water Works (Ten States Standards) requires that the proposed process and unit parameters be verified under the specific water under consideration, potentially requiring a Pilot Study. Ecology & Environment proposed that in lieu of performing a pilot study, the New Paltz Water Treatment Plant would be utilized as the pilot study for the Mohonk WTP. This method of pilot study was confirmed with the State and local Health Departments (see attached contact report in Attachment A).

In the scope of work dated August 28, 2000 and subsequent communication with the US Army Corps of Engineers, the process for performing this pilot study would be as follows:

1. Contact the State Health Officials to confirm all the treatment requirements which will be imposed by State and Federal Regulations.
2. Obtain and review all existing data regarding Contaminants of Concern (COC's) in the influent and effluent of the New Paltz Water Treatment Plant.
3. Obtain and review data for the influent and effluent from the groundwater treatment facility for COC's.
4. Collect a representative groundwater sample from the proposed up-gradient water source and analyze for all potential COC's.

Since that time, it has been agreed on that the primary source for the Water Treatment Plant will be the Catskill Aqueduct and the back-up source will be a raw water impoundment with the required supply obtained from the aqueduct. Therefore, the testing associated with the groundwater treatment facility and the up-gradient wells is not necessary. This pilot study report summarizes the results of tasks 1 and 2 from above.

II - Methodology

A - Pilot Study

The Village of New Paltz has a drinking water plant of similar design as the proposed Mohonk WTP. The New Paltz plant, designed and constructed in the late 1980's, has been operated by a contract operation company, Environmental Consultants of Poughkeepsie, NY. The primary water source for the New Paltz system is the Catskill Aqueduct, which is operated by the New York City Department of Environmental Protection. The proposed Mohonk WTP will also withdraw water from the Catskill aqueduct. Therefore, the New Paltz drinking water plant was used as a pilot study due to the fact that the plants are of similar design and will require the same amount of treatment to meet water quality standards.

B - Data Evaluation

The tasks involved in the data evaluation are to contact regulatory agencies to determine the treatment requirements that will be imposed on the Mohonk WTP, obtain and review the New Paltz raw water and point-of-entry data for all contaminants of concern, and evaluate how the New Paltz system treats the aqueduct water to meet current water quality standards.

1 - Contaminants of concern – Part 5 of Section 10 of The New York State Health Rules and Regulations provides guidance on the design of drinking water supplies. In this document, Tables 1 through 7 of section 5-1.52 list the maximum contaminant levels. This list of contaminants was confirmed with the Ulster County Health Department to verify that no other parameters or limits will be imposed on the Mohonk WTP.

The State Department of Health (DOH) was contacted to verify the County DOH contaminants of concern. While the State agreed that the current contaminants are listed in Part 5 of Title 10, some of the Maximum Contaminant Levels (MCLs) will be changing in the future. The limits for Arsenic, Total Tri-Halo Methanes (TTHMs), and Halo-Acetic Acids (HAAs) will change as follows:

Parameter	New Limit	As of:
Arsenic	10 ppb	Early 2002
Total Tri-Halo Methanes (TTHMs)	80 ppb	Jan 2004
Halo-Acetic Acids (HAAs)	60 ppb	Jan 2004

The tables of parameters and MCLs is listed in Attachment B.

2 - Review New Paltz Data – Information was obtained from the New Paltz treatment facility from their raw water and point-of-entry water monitoring for the past year. The data was included in the Annual Water Quality Reports for 2000 from New Paltz

WTP and New York City DEP (raw water source). These report was filed at the at the State Health Department in Albany and are attached to this memo in Attachment C.

As required by Part 5-1.72 of the State Sanitary Code, the report identifies all water quality parameters that were tested during the previous monitoring period and indicates which parameters were present in the finished water supply. The report also identifies which parameters were detected at levels above the maximum contaminant levels (MCLs) in the State sanitary code. For the 2000 New Paltz plant, there were no parameters detected above the MCLs.

Also obtained from the New Paltz WTP was an excerpt from the operation and maintenance manuals for the Trident water treatment system. This system was installed at the New Paltz WTP and is the primary equipment in the treatment at the plant. The excerpt obtained included a section describing the treatment system and the design loading rates of the New Paltz system. A copy of this excerpt is attached to this memo in Attachment D.

III - Analysis

A - Treatability

The following findings were made concerning the proposed Mohonk WTP.

1 - Existing Data

The data evaluated form the New Paltz system indicates that the system treats water that meets the standards set forth in the State Sanitary Code. The Annual Water Quality Report shows the following contaminants detected in the treated drinking water:

Total Coliform
Barium
Nitrate
Lead
Trihalo-methanes (THMs)

No other contaminants were detected. Of the detected parameters, none were detected at levels above State Maximum Contaminant Levels (MCLs) or Action Levels. The finished water samples were also compared to the future limits for Arsenic, TTHMs, and HAAs. None of these parameters were detected at levels above the MCL.

The only parameter that should be noted is Nitrate. The measured levels of Nitrate in the Catskill Aqueduct are lower than that coming from the New Paltz drinking water plant. The New Paltz facility recycles the filter backwash water through the plant after the sludge is settled out and the elevated Nitrate levels are the result of recycling process.

2 - Treatment System Components

The process used at the New Paltz plant treats the water by coagulation, up-flow adsorption filtration (clarification), mixed media filtration, and chlorination. The New Paltz system was a "package" system, supplied by USFilter/Microfloc systems. The proposed system at Mohonk will be designed to utilize the same treatment process Microfloc system as New Paltz.

The New Paltz water treatment system elements were designed based on loading rates of 10 gal/min (gpm) per sq. ft in the adsorption filter (clarifier) and 5 gpm per sq. ft in the mixed media filter. These values were verified by the vendor of the USFilter/Microfloc system and with Environmental Consultants that this is the rate at which the New Paltz facility operates. The proposed Mohonk WTP will be designed based on these parameters to ensure similar performance.

IV - Recommendations

The New Paltz drinking water plant has been in operation since the 1980's, treating an average daily flow of approximately 750,000 gallons per day of water. The Annual Water Quality Reports submitted by the Village show that the system has had no violations and complies with the State drinking water standard.

The design parameters that were used to construct the New Paltz facility can be duplicated in the Mohonk WTP, and the Microfloc system used in New Paltz is available from the vendor for use in the Mohonk WTP. Therefore, the following is recommended:

- Construct the Mohonk WTP using the same USFilter/Microfloc Trident treatment system at New Paltz, sized appropriately for the Mohonk demands.
- The parameters for design of the Mohonk WTP will be a loading of 10 gpm per sq. ft at the adsorption filter (clarifier) and 5 gpm per sq. ft to the mixed media filter.
- The proposed system should be designed to be expandable to allow the Water District to account for district expansion and future development.

ATTACHMENT A
CONTACT REPORT WITH STATE HEALTH
DEPARTMENT

☞ CONTACT REPORT ☜	
☎ Telephone <✓> ☺ Conference < > ✉ Other < >	
CONTACT:	Dave Phillips (NYS DOH)
TO:	D. Miller, T. Lewandowski, S. Gardner
FROM:	J. Fazzolari
DATE:	11/26/01
SUBJECT:	New Paltz WTP Design
CC:	

COMMENTS:

I Called Dave to ask him about the pilot study for the Mohonk WTP. In our previous discussion, I mentioned that the pilot study for our project would be the New Paltz Water Treatment Plant. However, we have no formal communication from the State Health Department that this would be sufficient.

Dave said that the details of design such as this would be best left to the local County Health Department (UCHD). I stated that we have previously spoken to Allan Dumas at the County Health Department and that he suggested we use New Paltz as our pilot since the systems will be treating the same raw water (Catskill Aqueduct) and comply with the same regulations (Part 5 of Title 10). Dave asked if the treatment technology at Mohonk would be the same as New Paltz. I told him that we have contacted the same manufacturer for design information and are planning to use the same system but with smaller units. Dave then asked if we can show that New Paltz is providing adequate treatment. I told him that we performed an analysis using New Paltz's Annual water Quality Reports showing they have no violations. This analysis will be included in the pilot study that will be attached to the Engineer's Design Report.

Dave said that, provided we have checked with the UCHD, using the New Paltz Water Treatment Plant as a pilot study would be acceptable.

ATTACHMENT B
TABLES 5-1.52 1 THROUGH 7
MAXIMUM CONTAMINANT LEVELS (MCL'S)

§ 5-1.52 Tables.

TABLE 1—INORGANIC CHEMICALS AND PHYSICAL CHARACTERISTICS MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminants	*(mg/[4])l*	*Determination of MCL violation*
Asbestos	7.0 million fiber/liter (MFL) (Longer than 10 microns)	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect one more sample from the same sampling point within 12 weeks or as soon as practical. An MCL violation occurs when the average[1] of the two results exceeds the MCL.
Antimony	0.006	
Arsenic	0.05	
Barium	2.00	
Beryllium	0.004	
Cadmium	0.005	
Chromium	0.10	
Cyanide (as free Cyanide)	0.2	
Mercury	0.002	
Selenium	0.05	
Silver	0.1	
Thallium	0.002	
Fluoride	2.2	
Chloride	250.0	
Iron	0.3[2]	
Manganese	0.3[2]	
Sodium	No designated limits[3]	
Sulfate	250.0	
Zinc	5.0	
Color	15 Units	
Odor	3 Units	

[1] Rounded to the same number of significant figures as the MCL for the contaminant in question.
[2] If iron and manganese are present, the total concentration of both should not exceed 0.5 mg/l. Higher levels may be allowed by the State when justified by the supplier of water.
[3] Water containing more than 20 mg/l of sodium should not be used for drinking by people on severely restricted sodium diets. Water containing more than 270 mg/l of sodium should not be used for drinking by people on moderately restricted sodium diets.
[4] mg/l = milligrams per liter.

TABLE 2—NITRATE, NITRITE, TOTAL NITRATE/NITRITE MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	*MCL (mg/l)*	*Determination of MCL violation*
Nitrate	10 (as Nitrogen)[1]	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect another sample from the same sampling point, within 24 hours of the receipt of results or as soon as practical.[2] An MCL violation occurs when the average of the two results exceeds the MCL.
Nitrite	1 (as Nitrogen)	
Total Nitrate and Nitrite	10 (as Nitrogen)	

[1] An MCL of 20 mg/l may be permitted at a noncommunity water system if the supplier of water demonstrates that:

(a) the water will not be available to children under six months of age;

(b) a notice that nitrate levels exceed 10 mg/l and the potential health effects of exposure will be continuously posted in conspicuous places in the area served by the system, within 14 days of the confirmation of an MCL violation;

(c) the State will be notified annually of nitrate levels that exceed 10 mg/l; and

(d) no adverse health effects shall result.

2 Systems unable to collect an additional sample within 24 hours must issue a public notice to consumers and must collect the additional sample within two weeks of receiving the initial sample results.

TABLE 3—ORGANIC CHEMICALS MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	*MCL (mg/l)*	*Type of water system*	*Determination of MCL violation*
General organic chemicals			
Principal organic contaminant (POC)	0.005	Community, NTNC and Noncommunity	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect one to three more samples from the same sampling point, as soon as practical, but within 30 days. An MCL violation occurs when at least one of the confirming samples is positive and the average of the initial sample and all confirming samples exceeds the MCL.
Unspecified organic contaminant (UOC)	0.05		
Total POCs and UOCs	0.1		
Trihalomethanes[2]			
Total trihalomethanes[1]	0.10	Community	The results of all analyses per quarter must be arithmetically averaged and must be reported to the State within 30 days of the public water system's receipt of the analyses. A violation occurs if the average of the four most recent sets of quarterly samples (12-month running average) exceeds the MCL.
		Noncommunity	Not applicable.
Group I Contaminants	*MCL (mg/l)*	*Type of water system*	*Determination of MCL violation*
Specific Organic Chemicals			
Alachlor	0.002	Community, NTNC and Noncommunity	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect one to three more samples from the same sampling point, as soon as practical, but within 30 days. An MCL violation occurs when at least one of the confirming samples is positive and the average of the initial sample and all confirming samples exceeds the MCL.
Aldicarb	0.003		
Aldicarb sulfone	0.002		
Aldicarb sulfoxide	0.004		
Atrazine	0.003		
Benzo(a)pyrene	0.0002		
Carbofuran	0.04		
Chlordane	0.002		
Di(2-ethylhexyl) phthalate	0.006		
Dibromochloropropane (DBCP)	0.0002		
2, 4-D	0.05		
Dinoseb	0.007		
Diquat	0.02		
Endrin	0.002		
Ethylene dibromaide (EDB)	0.00005		

Contaminant	MCL (mg/l)	Type of water system	Determination of MCL violation
Heptachlor	0.0004		
Heptachlor epoxide	0.0002		
Hexachlorobenzene	0.001		
Lindane	0.0002		
Methoxychlor	0.04		
Pentachlorophenol	0.001		
Polychlorinated biphenyls (PCBs)	0.0005		
Simazine	0.004		
Toxaphene	0.003		
2, 4, 5-TP (Silvex)	0.01		
2, 3, 7, 8 - TCDD(dioxin)	0.00000003		
Vinyl Chloride	0.002		

1 Effective one year after beginning sampling according to the minimum monitoring requirements.

2 The State may require a supplier of water to monitor for MTP at a frequency specified by the State.

TABLE 4—ENTRY POINT TURBIDITY MAXIMUM CONTAMINANT LEVEL DETERMINATION [1]

Contaminant	MCL	Determination of MCL violation
Entry point turbidity (surface water and ground water directly influenced by surface water)	1 NTU[2, 4] (Monthly average)	A violation occurs when the average of all daily entry point analyses for the month exceeds the MCL rounded off to the nearest whole number.
	5 NTU[3, 4]	A violation occurs when the average of two consecutive daily entry point analyses exceeds the MCL rounded off to the nearest whole number.

1 The requirements of this table apply to unfiltered systems that the State has determined, in writing pursuant to section 5-1.30 of this Subpart, must install filtration, until filtration is installed.

2 If the daily entry point analysis exceeds one NTU, a repeat sample must be taken as soon as practicable and preferably within one hour. If the repeat sample exceeds one NTU, the supplier of water must make State notification. The repeat sample must be used for the monthly average and the two-consecutive-day average.

3 If the two-consecutive-day average exceeds the MCL, the supplier of water shall analyze for microbiological contamination at a point downstream of the first consumer, but as close to the first consumer as is feasible. The additional microbiological sample should be taken within one hour or as soon as feasible after determining the two-consecutive-day average. The supplier of water shall report the result of this microbiological analysis to the State within 48 hours of obtaining the result. The result of this analysis shall not be used for monitoring purposes.

4 NTU = Nephelometric Turbidity Units.

TABLE 6—MICROBIOLOGICAL CONTAMINANTS MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	*MCL* [1,2]	*Determination of MCL violation*
Total coliform	Any positive sample[3]	A violation occurs at systems collecting 40 or more samples per month when more than 5.0 percent of the total coliform samples are positive.
		A violation occurs at systems collecting less than 40 samples per month when two or more samples are total coliform positive.
Escherichia coli (E. coli)	Any positive sample	A violation occurs when a total coliform positive sample is positive for Escherichia coli (E. coli) and a repeat total coliform sample is positive or when a total coliform positive sample is negative for Escherichia coli (E. coli) but a repeat total coliform sample is positive and the sample is also positive for Escherichia coli (E. coli).[4]

[1] Compliance with MCL for total coliform must be made by a public water system for each month the system is required to monitor for total coliform.

[2] All samples collected in accordance with table 11 footnotes 1, 2, 4 and 5 of this section and samples collected in accordance with section 5-1.51(f) of this Subpart shall be included in determining compliance with the MCL unless any of the samples have been invalidated by the State.

[3] If any total coliform sample is positive, a set of repeat samples must be collected in accordance with table 11 of this section.

[4] For notification purpose, an Escherichia coli (E. coli) MCL violation is a public health hazard.

TABLE 7—RADIOLOGICAL MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	*MCL*	*Type of water system*	*Determination of MCL violation*
Combined radium-226 and radium-228	5 picocuries per liter	Community	A violation occurs when the annual composite of four quarterly samples or the average of the analysis of four quarterly samples exceeds the MCL.
Gross alpha activity (including radium-226 but excluding radon and uranium)	15 picocuries per liter		
		Noncommunity	Not applicable

Contaminant	MCL (mg/l)	Type of water system	Determination of MCL violation
Heptachlor	0.0004		
Heptachlor epoxide	0.0002		
Hexachlorobenzene	0.001		
Lindane	0.0002		
Methoxychlor	0.04		
Pentachlorophenol	0.001		
Polychlorinated biphenyls (PCBs)	0.0005		
Simazine	0.004		
Toxaphene	0.003		
2, 4, 5-TP (Silvex)	0.01		
2, 3, 7, 8 - TCDD(dioxin)	0.00000003		
Vinyl Chloride	0.002		

1 Effective one year after beginning sampling according to the minimum monitoring requirements.

2 The State may require a supplier of water to monitor for MTP at a frequency specified by the State.

TABLE 4—ENTRY POINT TURBIDITY MAXIMUM CONTAMINANT LEVEL DETERMINATION [1]

Contaminant	MCL	Determination of MCL violation
Entry point turbidity (surface water and ground water directly influenced by surface water)	1 NTU[2, 4] (Monthly average)	A violation occurs when the average of all daily entry point analyses for the month exceeds the MCL rounded off to the nearest whole number.
	5 NTU[3, 4]	A violation occurs when the average of two consecutive daily entry point analyses exceeds the MCL rounded off to the nearest whole number.

1 The requirements of this table apply to unfiltered systems that the State has determined, in writing pursuant to section 5-1.30 of this Subpart, must install filtration, until filtration is installed.

2 If the daily entry point analysis exceeds one NTU, a repeat sample must be taken as soon as practicable and preferably within one hour. If the repeat sample exceeds one NTU, the supplier of water must make State notification. The repeat sample must be used for the monthly average and the two-consecutive-day average.

3 If the two-consecutive-day average exceeds the MCL, the supplier of water shall analyze for microbiological contamination at a point downstream of the first consumer, but as close to the first consumer as is feasible. The additional microbiological sample should be taken within one hour or as soon as feasible after determining the two-consecutive-day average. The supplier of water shall report the result of this microbiological analysis to the State within 48 hours of obtaining the result. The result of this analysis shall not be used for monitoring purposes.

4 NTU = Nephelometric Turbidity Units.

TABLE 4A—SURFACE WATER TURBIDITY PERFORMANCE STANDARDS MAXIMUM CONTAMINANT LEVEL DETERMINATION[1]

Contaminant	*Filtration Type*	*Performance standard*	*MCL*	*Determination of treatment technique/MCL violation*
Filtered water turbidity	Conventional filtration Slow sand filtration Diatomaceous earth filtration	0.5 NTU[2,3] 1.0 NTU[3] 1.0 NTU[3]	Not applicable	A treatment technique violation occurs if more than five percent of the composite filter effluent measurements taken each month exceed the performance standard values. The turbidity level of representative samples of the filtered water must at no time exceed 5.0 NTU.

1 The standards apply to systems with surface water sources or ground water sources directly influenced by surface water.

2 The performance standard applies to direct filtration and other alternative filtration technologies capable of complying with requirement of section 5-1.30(b) of this Subpart as demonstrated to the department by pilot studies.

3 NTU = Nephelometric Turbidity Unit.

TABLE 5—DISTRIBUTION SYSTEM TURBIDITY MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	*MCL*	*Determination of MCL violation*
Distribution point turbidity	5 NTU	A violation occurs when the monthly average of the results of all distribution samples collected in any calendar month exceeds the MCL rounded off to the nearest whole number.

ATTACHMENT C
ANNUAL WATER QUALITY REPORTS (2000) FOR VILLAGE OF NEW PALTZ AND NEW YORK CITY

Annual Drinking Water Quality Report for 2000
Village of New Paltz Water
25 Plattekill Avenue, New Paltz NY
Public Water Supply ID# 5503379

INTRODUCTION

To comply with State regulations, the Village of New Paltz Water, will be annually issuing a report describing the quality of your drinking water. The purpose of this report is to raise your understanding of drinking water and awareness of the need to protect our drinking water sources. Last year, your tap water met all State drinking water health standards. This report provides an overview of last year's water quality. Included are details about where your water comes from, what it contains, and how it compares to State standards.

If you have any questions about this report or concerning your drinking water, please contact The Village of New Paltz Water Treatment Facility at (845) 255-2637. We want you to be informed about your drinking water. If you want to learn more, please attend any of our regularly scheduled village board meetings. The meetings are held on the second and fourth Wednesday of each month, at 7:30 PM at the Village Hall.

WHERE DOES OUR WATER COME FROM?

In general, the sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include: microbial contaminants; inorganic contaminants; pesticides and herbicides; organic chemical contaminants; and radioactive contaminants. In order to ensure that tap water is safe to drink, the State and the EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the FDA's regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Our water system serves 5500 people through 900 service connections. Our surface water sources are the NYC Catskill Aqueduct and four New Paltz reservoirs, located near the New Paltz Water Filtration Facility on Mountain Rest Road. The Village has two storage tanks with a combined capacity of 2.4 million gallons. The water is filtered and chlorinated prior to distribution.

ARE THERE CONTAMINANTS IN OUR DRINKING WATER?

As the State regulations require, we routinely test your drinking water for numerous contaminants. These contaminants include: total coliform, turbidity, inorganic compounds, nitrate, nitrite, lead and copper, volatile organic compounds, total trihalomethanes, and synthetic organic compounds. The table presented below depicts which compounds were detected in your drinking water. The State allows us to test for some contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of our data, though representative, are more than one year old.

It should be noted that all drinking water, including bottled drinking water, may be reasonably expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791) or the Ulster County Health Department at (845) 340-3010.

Table of Detected Contaminants

Contaminant	Violation Yes/No	Date of Sample	Level Detected (Avg/Max) (Range)	Unit Measure -ment	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination

Contaminant	Violation Yes/No	Date of Sample	Level Detected (Maximum) (Range)	Unit Measure -ment	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination
Microbiological Contaminants							
Total Coliform	No	9/00	1 positive sample	n/a	0	MCL= 2 or more positive samples	Naturally present in the environment
Inorganic Contaminants							
Barium	No	9/00	.02	mg/l	n/a	2.0	Discharge of drilling wastes; discharge from metal refineries; erosion natural deposits
Nitrate	No	3/00	0.7	mg/l	10	10	Runoff from fertilizer use; leaching from septic tanks; Erosion of natural deposits
Lead	No	6/99	3 ND – 10	ug/l	0	AL- 15	Corrosion of household plumbing systems; Erosion of natural deposits
Inorganic Contaminants							
THM	No	3/00 6/00 9/00 12/00	6.8 49.8 20.4 37.6	mg/l	100	100	By-product of drinking water chlorination

Definitions:

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible.
Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.
Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.
Non-Detects (ND): Laboratory analysis indicates that the constituent is not present.
Milligrams per liter (mg/l): Corresponds to one part of liquid in one million parts of liquid (parts per million - ppm).
Micrograms per liter (ug/l): Corresponds to one part of liquid in one billion parts of liquid (parts per billion - ppb).

WHAT DOES THIS INFORMATION MEAN?

As you can see by the table, our system had no violations. We have learned through our testing that some contaminants have been detected; however, these contaminants were detected below the level allowed by the State.

IS OUR WATER SYSTEM MEETING OTHER RULES THAT GOVERN OPERATIONS?

During 2000, our system was in compliance with applicable State drinking water operating, monitoring and reporting requirements.

DO I NEED TO TAKE SPECIAL PRECAUTIONS?

Although our drinking water met or exceeded state and federal regulations, some people may be more vulnerable to disease causing microorganisms or pathogens in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice from their health care provider about their drinking water. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium, Giardia and other microbial pathogens are available from the Safe Drinking Water Hotline (800-426-4791).

Why Save Water and How to Avoid Wasting It?

Although our system has an adequate amount of water to meet present and future demands, there are a number o reasons why it is important to conserve water:

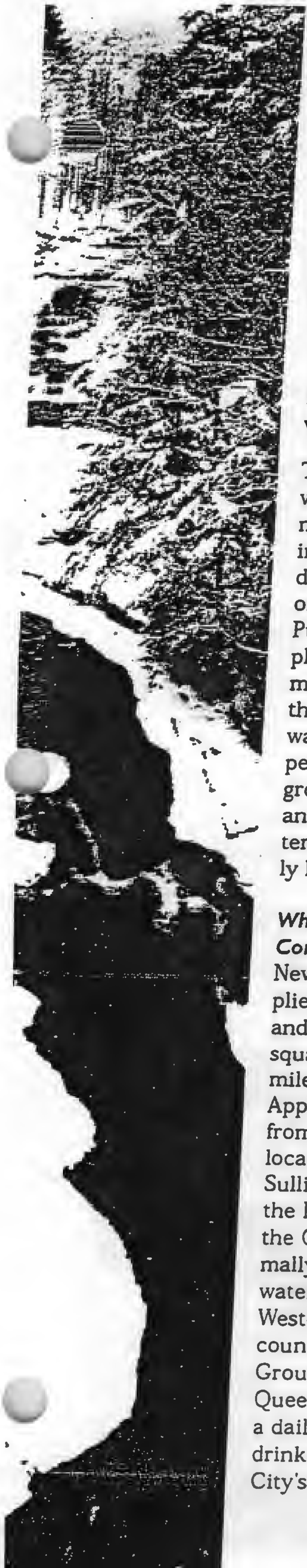
- Saving water saves energy and some of the costs associated with both of these necessities of life;
- Saving water reduces the cost of energy required to pump water and the need to construct costly new wells pumping systems and water towers; and
- Saving water lessens the strain on the water system during a dry spell or drought, helping to avoid severe wate use restrictions so that essential fire fighting needs are met.

You can play a role in conserving water by becoming conscious of the amount of water your household is using, and by looking for ways to use less whenever you can. It is not hard to conserve water. Conservation tips include:

- Automatic dishwashers use 15 gallons for every cycle, regardless of how many dishes are loaded. So get a run for your money and load it to capacity.
- Turn off the tap when brushing your teeth.
- Check every faucet in your home for leaks. Just a slow drip can waste 15 to 20 gallons a day. Fix it up and you can save almost 6,000 gallons per year.
- Check your toilets for leaks by putting a few drops of food coloring in the tank, watch for a few minutes to see if the color shows up in the bowl. It is not uncommon to lose up to 100 gallons a day from one of these otherwise invisible toilet leaks. Fix it and you save more than 30,000 gallons a year.

Closing

Thank you for allowing us to continue to provide your family with quality drinking water this year. In order to maintain a safe and dependable water supply we sometimes need to make improvements that will benefit all of our customers. The costs of these improvements may be reflected in the rate structure. Rate adjustments may be necessary in order to address these improvements. We ask that all our customers help us protect our water sources, which are the heart of our community. Please call our office if you have questions.



NEW YORK CITY 2000 DRINKING WATER SUPPLY AND QUALITY REPORT

The New York City Department of Environmental Protection is pleased to present its 2000 Annual Water Quality Report. This presentation is in accordance with Part 5-1.72 of the New York State Sanitary Code (10NYCRR), and the National Primary Drinking Water Regulations, 40 CFR Part 141 Subpart O, of the Environmental Protection Agency, which require all drinking water suppliers to provide the public with an annual statement describing the water supply and the quality of its water.

New York City's Water Supply

The New York City surface (reservoir) water supply system provides approximately 1.3 billion gallons of safe drinking water daily to over 8 million residents of New York City, approximately one million people living in Westchester, Putnam, Ulster, and Orange counties, plus the millions of tourists and commuters who visit the City throughout the year. In addition to our surface water supplies, approximately 350,000 people in southeastern Queens receive groundwater or a blend of groundwater and surface water. In all, the City system supplies high quality water to nearly half the population of New York State.

Where Does New York City's Water Come From?

New York City's surface water is supplied from a network of 19 reservoirs and three controlled lakes in a 1,969 square-mile watershed that extends 125 miles north of New York City. Approximately 90% of our water comes from the Catskill/Delaware System, located in Delaware, Greene, Schoharie, Sullivan, and Ulster counties, west of the Hudson River. The Croton System, the City's original upstate supply, normally provides about 10% of our daily water from 12 reservoir basins in Westchester, Putnam, and Dutchess counties. In 2000, New York City's Groundwater System in southeastern Queens operated 16 wells and supplied a daily average of 12 million gallons of drinking water, or less than 1% of the City's total use.

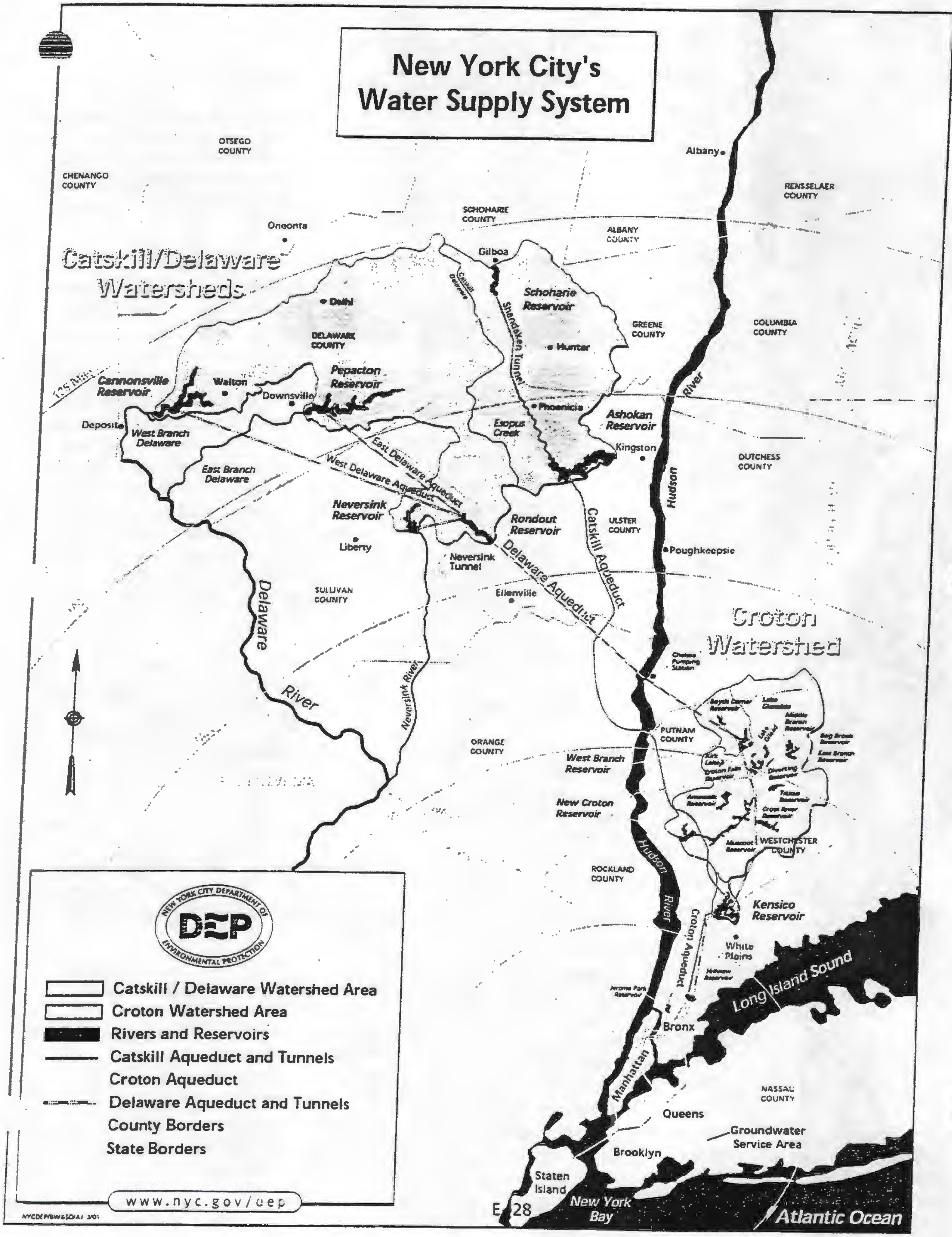
What's in Source Water?

Sources of drinking water worldwide (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include: microbial contaminants; inorganic contaminants; pesticides and herbicides; organic chemical contaminants; and radioactive contaminants.

Regulation of Drinking Water

In order to ensure that tap water is safe to drink, the New York State Department of Health and the United States Environmental Protection Agency (EPA) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the federal Food and Drug Administration's regulations establish limits for contaminants in bottled water.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800) 426-4791.


New York City's
Water Supply System
OTSEGO COUNTY
CHENANGO COUNTY
SCHOHARIE COUNTY
ALBANY COUNTY
RENSSELAER COUNTY
Albany
Oneonta
Gilboa
Catskill/Delaware Watersheds
Schoharie Reservoir
Delhi
DELAWARE COUNTY
Hunter
GREENE COUNTY
COLUMBIA COUNTY
Shandaken Tunnel
Cannonsville Reservoir
Walton
Pepacton Reservoir
Downsville
Deposit
West Branch Delaware
Phoenicia
Ashokan Reservoir
Esopus Creek
Kingston
East Branch Delaware
East Delaware Aqueduct
West Delaware Aqueduct
DUTCHESS COUNTY
Neversink Reservoir
Rondout Reservoir
Liberty
ULSTER COUNTY
Catskill Aqueduct
Poughkeepsie
Neversink Tunnel
Delaware Aqueduct
Ellenville
SULLIVAN COUNTY
Delaware River
Hudson River
Croton Watershed
Neversink River
PUTNAM COUNTY
ORANGE COUNTY
West Branch Reservoir
New Croton Reservoir
WESTCHESTER COUNTY
ROCKLAND COUNTY
Kensico Reservoir
Croton Aqueduct
White Plains
Long Island Sound
Bronx
Manhattan
NASSAU COUNTY
Queens
Groundwater Service Area
Brooklyn
Staten Island
New York Bay
Atlantic Ocean
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEP
Catskill / Delaware Watershed Area
Croton Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Croton Aqueduct
Delaware Aqueduct and Tunnels
County Borders
State Borders
www.nyc.gov/dep

s New York
City's water
hard?"

ardness is a mea-
of dissolved
and mag-
sium in the

lcium and mag-
sium in the
ter ("soft"
the easier
s to create lath-
and suds.
pending upon
ation, the hard-
s can be
in/gallon
for
skill/Delaware

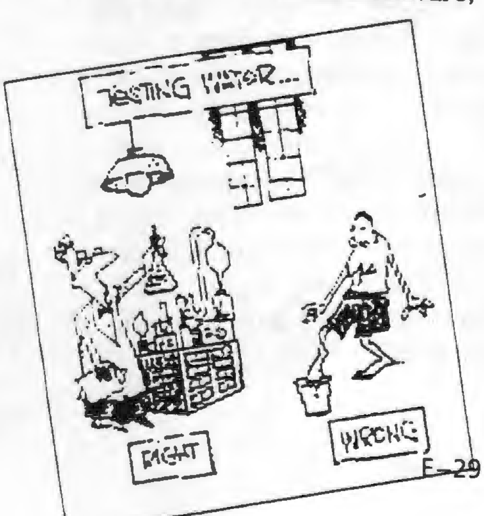
New York City's Water Quality

The New York City Department of Environmental Protection (DEP) operates the water supply system that delivers water to City residents. DEP's monitoring program — far more extensive than required by law — demonstrates that the quality of New York City's drinking water remains high and meets all health-related State and federal drinking water standards. Color, an aesthetic condition, may exceed the standard on a seasonal basis.

DEP monitors the water in the distribution system, the upstate reservoirs and feeder streams, and the wells that are the sources for our supply. Water quality is monitored continuously as the water enters the distribution system, and is regularly tested at sampling points throughout the entire City. DEP conducts analyses for a broad spectrum of microbiological, chemical, and physical measures of quality. In 2000, DEP collected more than 39,100 in-City samples and performed approximately 752,700 analyses.

Test Results

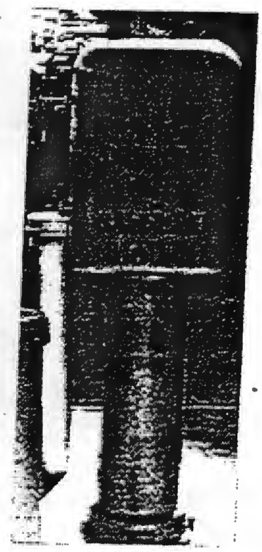
The results of the tests conducted in 2000 on distribution water samples under DEP's Distribution System Monitoring Program are summarized in the tables in this Statement. Data is presented separately for the Croton, Catskill/Delaware, and Groundwater Systems. Whether a particular user receives Croton, Catskill/Delaware, groundwater, or a mixture, depends on location, system operations, and consumer demand.



The State requires monitoring for some parameters at a frequency of less than once per year because the concentrations of these parameters do not change frequently. Accordingly, some of these data, though representative, are more than one year old. Unregulated parameter monitoring is conducted to help EPA determine where certain parameters occur and whether it needs to regulate those parameters.

Sampling Stations

DEP conducts most of its distribution water quality monitoring at approximately 1000 fixed sampling stations throughout the city. These stations, which you may have seen in your neighborhood, allow DEP to collect water samples throughout the distribution system in an efficient and sanitary manner.

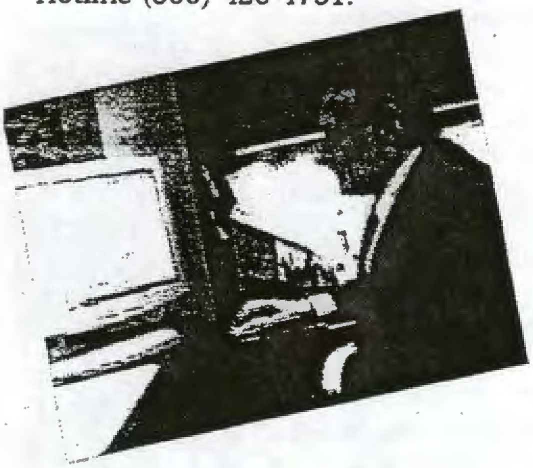


Lead in Drinking Water

New York City water is virtually lead-free when it is delivered from the City's upstate reservoir system, but water can absorb lead from solder, fixtures, and pipes found in the plumbing of some buildings or homes. Mandated at-the-tap lead monitoring is conducted at various households around the City. Based on the results of monitoring of 107 homes in 2000, New York City met the established standard or Lead Action Level (AL).

Infants and young children are typically more vulnerable to lead in drinking water than the general population. It is possible that lead levels at your home may be higher than at other homes in the community as a result of

materials used in your home's plumb-
ing. If you are concerned about elevated lead levels in your home's water you may flush your cold-water tap for 30 seconds to 2 minutes, until the water turns cold, before using water that has been standing in the pipes for more than six hours. Use only water from the cold water tap for cooking, drinking, and making baby formula. You also may wish to have your water tested. To request a free kit to test for lead in your drinking water, call DEP's 24-hour Help Center at (718) DEP-HELP. Additional information is available from the EPA's Safe Drinking Water Hotline (800) 426-4791.



Water Quality Tracking System
DEP operates a new state of the art computer program and water quality tracking system. This system, called the Distribution Water Quality Module (DWQM), allows Drinking Water Quality Control staff to quickly access a large number of water quality parameters, including chlorine residual, orthophosphate concentration, color, turbidity, bacteria, Heterotrophic Plate Count, and disinfection by-products, throughout the City as a whole or any section of the City. The system's ability to identify problem locations or areas with low chlorine or high color, and track water quality trends, makes it an effective water quality management tool and helps to provide the best possible water quality throughout the City.

Cryptosporidium and Giardia
While there is no evidence of illness related to the New York City water supply, federal and New York State law requires all water suppliers to notify their customers about the potential risks of Cryptosporidium and Giardia. Cryptosporidiosis and giardiasis are intestinal illnesses caused by microscopic pathogens which can be waterborne. Symptoms of infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals can overcome both of these diseases within a few weeks.

According to the EPA and the Centers for Disease Control and Prevention (CDC), it is unclear how most cases of cryptosporidiosis in the United States are contracted. The relative importance of various risk factors is unknown. Such factors include eating contaminated food, swallowing contaminated recreational water while swimming or camping, contact with animals, contact with human waste, certain sexual practices, or drinking contaminated water. Individuals who think they may have cryptosporidiosis or giardiasis should contact their health care provider.

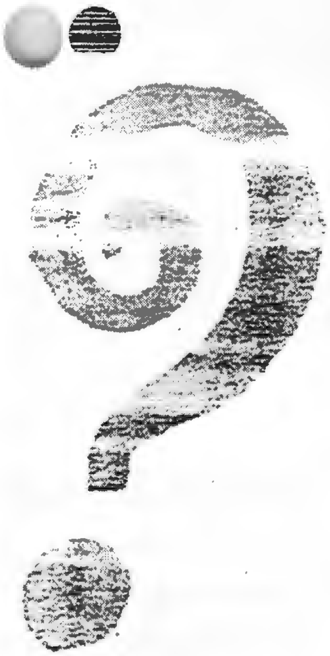
Some people may be more vulnerable to disease-causing microorganisms or pathogens in drinking water than the general population. Immuno-compromised persons, such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with Crohn's disease or HIV/AIDS or other immune system disorders, some elderly, and infants, can be particularly at risk from infections. These people should seek advice from their health care providers about their drinking water. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium, Giardia and other microbial contaminants are available from the EPA's Safe Drinking Water Hotline (800) 426-4791.

At times I can detect chlorine odors in tap water. What can I do about it?

Chlorine odors may be more noticeable when the weather is warmer. Chlorine is a disinfectant and is added to the water to kill germs. The following are ways you can remove the chlorine and its odor from your drinking water:

- Fill a pitcher and let it stand in the refrigerator overnight. (This is the best way.)
- Fill a glass or jar with water and let it stand in sunlight for 30 minutes.
- Pour water from one container to another about 10 times.
- Heat the water to about 100 degrees Fahrenheit.

Once you remove the chlorine, be sure to refrigerate the water to limit bacterial regrowth.



Does my
rinking water
contain
oride?

es, all New York
ontains fluoride.
accordance
ith Article
rk City Health
ode, DEP, as the
ew York City
ater supplier,
lds a fluoride
mpound which
ovides our water
pply with a con-
ntration of
rt per million
m) fluoride.

DEP's Monitoring for Pathogens

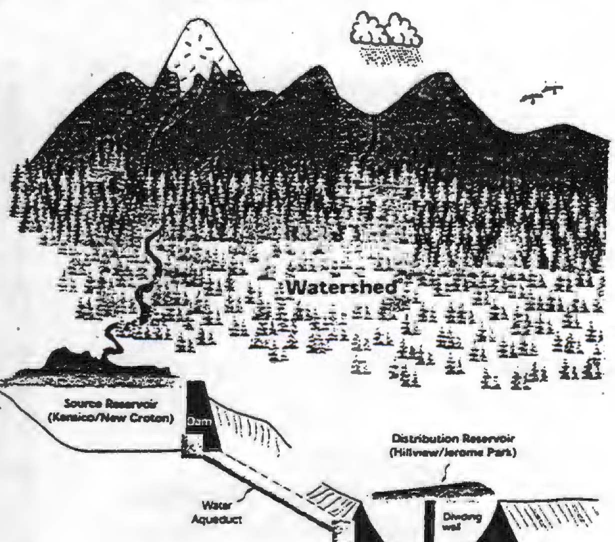
In 1992, the City added a pathogen monitoring component to its comprehensive watershed monitoring program. Since then, samples have been collected weekly from the effluents of Kensico and New Croton Reservoirs, before water is first chlorinated in the Catskill/Delaware and Croton Systems, respectively. In May 1999, DEP implemented a more sensitive analytical method which improved the Department's ability to detect both Giardia cysts and Cryptosporidium oocysts. Current test methods, however, are limited in that they do not allow us to determine if organisms identified are dead or if they are capable of causing disease.

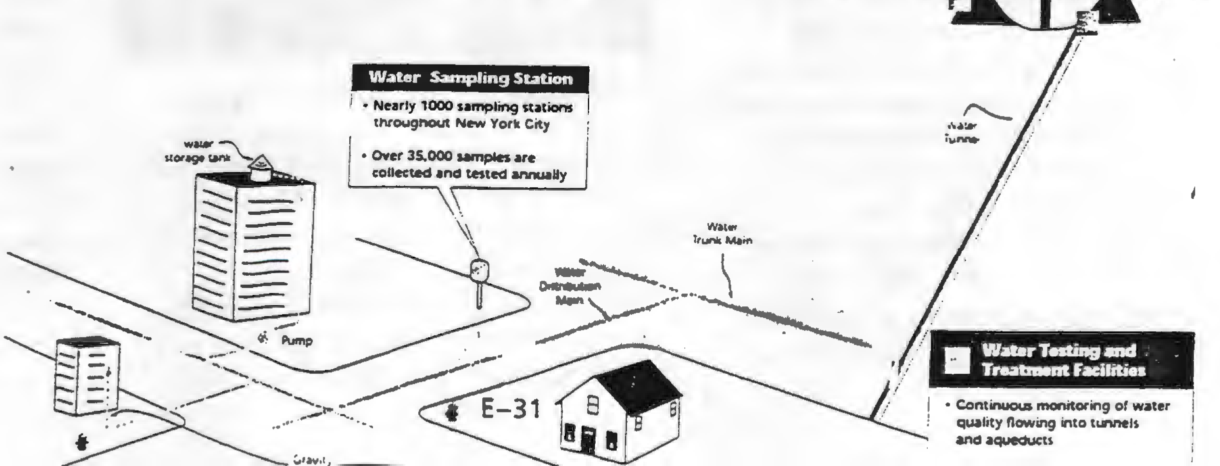
In 2000, as part of the routine sampling program, 105 samples of Kensico Reservoir effluent and 52 samples of New Croton Reservoir effluent were collected and analyzed for Giardia cysts and Cryptosporidium oocysts. Of the 105 Kensico Reservoir samples, 67 samples were presumed positive for Giardia and 10 samples were confirmed positive. Twelve samples were presumed positive for Cryptosporidium at Kensico with no samples confirmed positive. The New Croton Reservoir samples produced 24 presumed positive Giardia samples with two samples confirmed positive; and, of eight presumed positive Cryptosporidium samples, no samples confirmed positive. Weekly updates of DEP's Giardia and Cryptosporidium data from 1992 to the present can be viewed on our Web site www.nyc.gov/html/dep/html/pathogen.html.

New York City's Water Treatment

All surface water and groundwater entering New York City's distribution system is treated with chlorine, fluoride, orthophosphate, and, in some cases, sodium hydroxide. New York City uses chlorine to meet the New York State Sanitary Code and federal Safe Drinking Water Act disinfection requirements. Fluoride, at a concentration of one part per million, is added to help prevent tooth decay and has been added since 1964 in accordance with the New York City Health Code. Orthophosphate is added to create a protective film on pipes that reduces the release of metals, such as lead, from household plumbing. Sodium hydroxide is added to Catskill/Delaware water to raise the pH and reduce corrosivity.

A sequestering phosphate is applied at several wells to prevent the precipitation of naturally occurring minerals,





mostly iron and manganese, in the distribution mains and customers' household piping. Air stripper facilities operate at several wells to remove volatile organic chemicals.

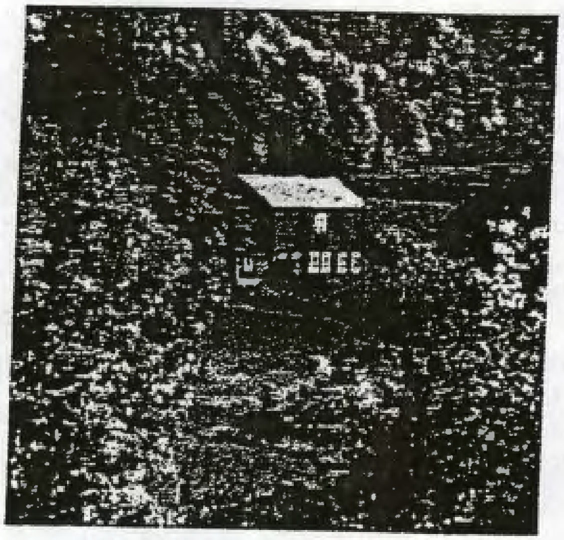
Ensuring a Safe and Sufficient Supply of Water

Watershed Programs
During 2000, New York City continued implementation of the watershed protection and partnership programs set forth in the January 1997 Watershed Memorandum of Agreement (MOA). These efforts focused on three key programs: the acquisition of watershed lands; the enforcement of strengthened Watershed Regulations; and the expansion of partnership programs that target specific sources of pollution in the watershed. In addition, DEP continued work on a number of water quality studies, and continued implementing upgrades of non-City-owned wastewater treatment plants (WWTPs).

Land Acquisition
In 2000, DEP met the goals for procuring watershed lands set forth in the 1997 Filtration Avoidance Determination (FAD) and the MOA. Specifically, DEP solicited 52,846 acres of watershed lands in designated priority areas. As of December 2000, DEP had 26,970 acres either acquired or under purchase contract for a cost of $76.5 million.

Watershed Regulations
On May 1, 1997, enhanced Watershed Regulations became effective, replacing regulations that had been in place since 1953. The Regulations are vital to water supply protection and provide a higher level of defense against modern-day threats to water quality. By vigorously enforcing the new regulations, DEP is ensuring that the City's source waters are protected. The steps taken to ensure a high quality water supply include: aggressive policing and inspection of the watersheds; greatly increased water quality monitoring; systematic inspections of wastewater treatment plants; investigations of other potentially polluting activities; and legal actions against polluters. Furthermore, in 2000, DEP staff reviewed more than 1,719 applications for new or remediated septic systems, 125 stormwater pollution prevention plans, and more than 200 proposals for other projects that included one or more regulated activities.

Partnership Programs
West of the Hudson River, many of the partnership programs are being administered by the Catskill Watershed Corporation (CWC), a non-profit corporation formed solely for that purpose. Together, CWC and DEP continued to implement programs that remediated 193 failing septic systems, completed construction of 29 winter road de-icing materials storage facilities, and identified a second group of best management practices to address existing stormwater runoff.



The Watershed Agricultural Program, funded by DEP and implemented by the Watershed Agricultural Council has become a national model. More than 90% of watershed farms have joined the program, which develops Best Management Practices to reduce agricultural pollution and enhance the economic viability of participating farms.

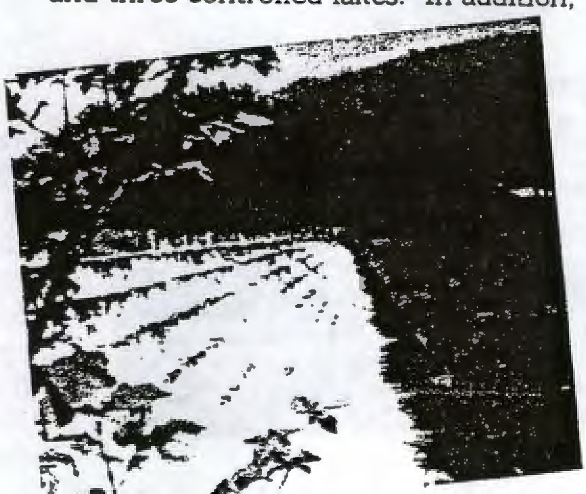
The aerators in my home are clogging with small pieces of a whitish material. What is causing this to occur?

This is a frequent complaint from consumers. The problem may be accompanied by a significant drop in water pressure at the affected faucet in addition to a decrease in your hot water supply. The culprit is the hot water heater's 'dip-tube'. This is a long internal tube which delivers cold water to the bottom of the hot water heater tank. The tube, which is composed of polypropylene, may disintegrate. The problem affects approximately 16 million water heaters manufactured between 1993 and 1996.

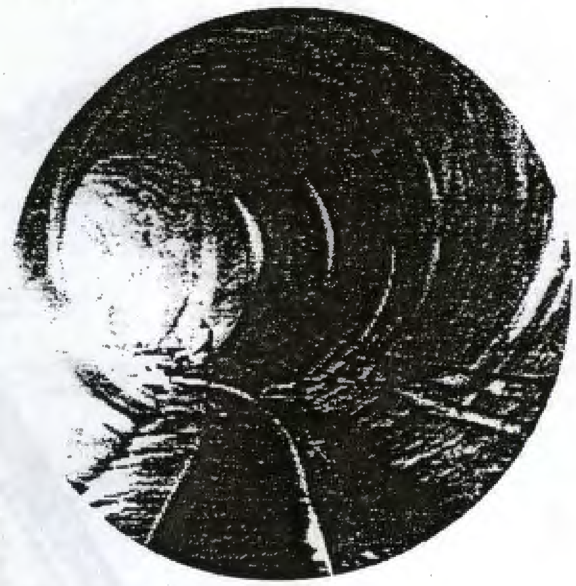
The Program includes a watershed forestry component and the Conservation Reserve Enhancement Program (CREP). Under CREP, the US Department of Agriculture pays enhanced annual rental rates and other incentives to agricultural landowners to take environmentally sensitive lands out of production. The City and USDA each pay half the cost of treating those lands with conservation practices. To date, more than fifty landowners have enrolled over 600 acres of riparian buffer lands into CREP.

Wastewater Treatment Plant Upgrades
The City continues to advance the program to upgrade all of the 102 non-City-owned wastewater treatment plants (WWTP) in the watershed. All facilities have signed agreements to participate in the upgrade program and have hired engineers to complete upgrade designs. Construction is expected to begin on the first of these upgrades in 2001. The City had upgraded its own watershed WWTPs in the late 1990s.

Upstate Capital Improvements
The City continued to implement a multi-year program to upgrade and improve its upstate water supply facilities, including gatehouses, aqueducts, water testing laboratories, and other facilities which are important to ensuring a safe and reliable supply of drinking water. An ongoing dam reconstruction program has also been in effect for rehabilitation of dams. In 2000, work was done on facilities at five reservoirs and three controlled lakes. In addition, work is expected to begin on five more reservoirs in 2001. Highlights of this year's work include the replacement of roller and sluice gates as well as the chlorination systems in Shaft 18 and the Catskill Screen Chamber, and repairs to the gate valve in Shaft 6 of the Delaware Aqueduct completed in the first week of December.



The Distribution System

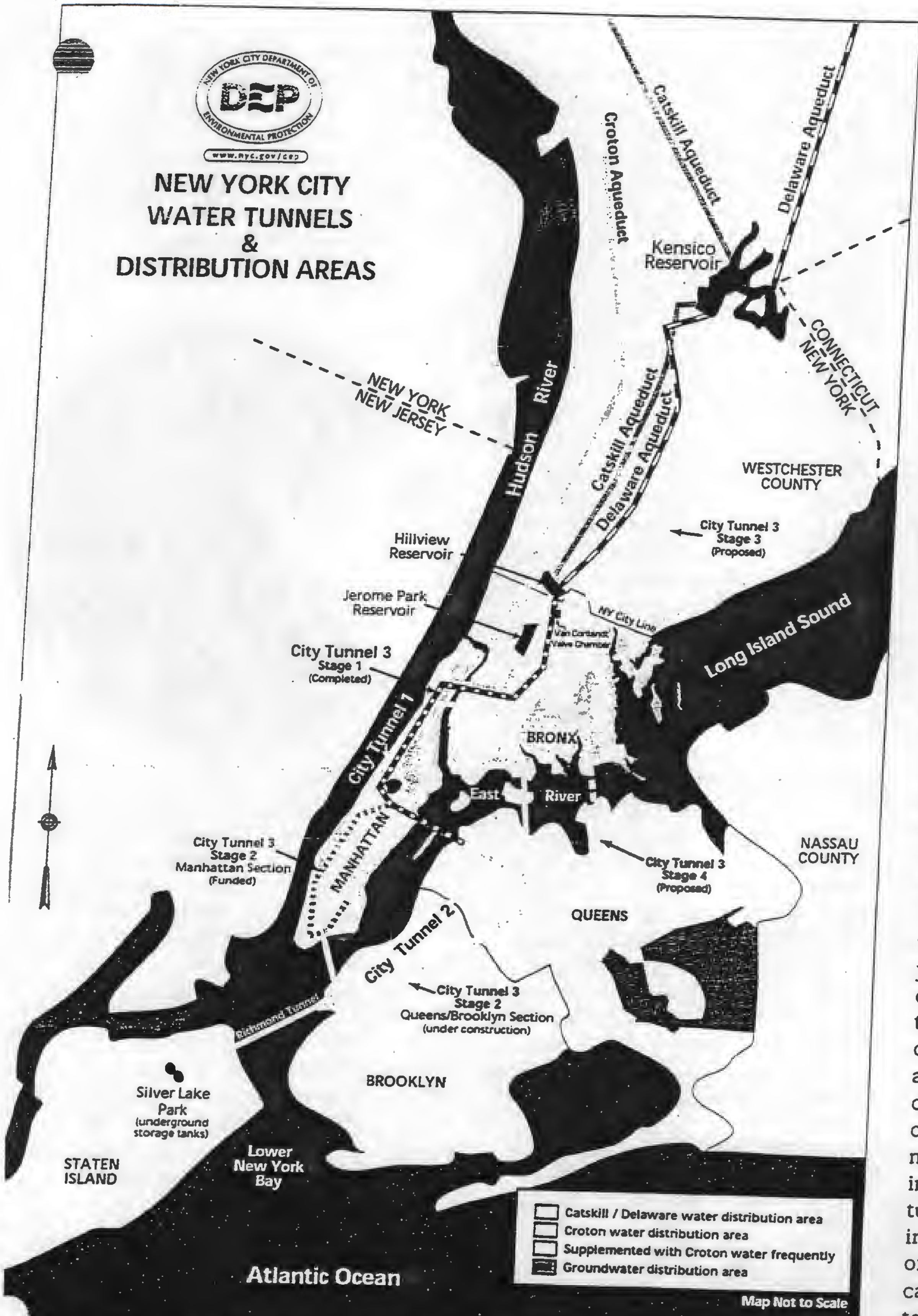


City Water Tunnel No. 3
The Third Water Tunnel, begun in 1970, is being built in stages. The first stage of Tunnel No. 3, which became operational in July 1998, has already helped to improve the reliability of the City's drinking water distribution system. Stage 2 of Tunnel No. 3 includes two sections, and is scheduled to be finished in 2008. The first section of Stage 2, which is in Brooklyn and Queens, is currently under construction and upon completion will improve service to Staten Island, Brooklyn and Queens. This will be followed by the construction of the Manhattan section of Stage 2.

When completed, Tunnel No. 3 will create a more flexible means of supplying drinking water to the entire City and will provide delivery alternatives in the event of disruption in any of the older tunnels. It will also permit New York City to drain, examine and rehabilitate City Tunnels No. 1 and 2.

At times, my
drinking water
often looks
milky" when
irst taken
rom a faucet,
ut then clears
Why?

ir becomes
apped in the
ater as it makes
long trip from
e upstate reser-
irs to the City.
a result,
crobubbles of
can sometimes
use water to
pear cloudy or
lky. This condi-
n is not a public
cloudiness is
porary and
rs quickly after
ter is drawn
m tap and
ased.



This map of the City indicates the general areas where water can be supplied by the Croton and Groundwater Systems when they are on line. It is possible to distribute Catskill/Delaware water through both the Croton and Groundwater Systems.

Sometimes my water is a rusty brown color. What causes this?

Brown water is commonly associated with plumbing corrosion problems inside buildings and from rusting hot water heaters. If you have an ongoing problem with brown water, it is probably due to rusty pipes. It is recommended that you run your cold water for 2 - 3 minutes if it has not been used for an extended period of time. This will flush the line. You can avoid wasting water by catching your "flush" water in a container and using it to water plants or for other purposes. In addition, brown water can result from street construction or water main work being done in the area. Any disturbance to the main, including the opening of a fire hydrant, can cause pipe sediment to shift, resulting in brown water. The settling time of the main will vary, depending on the size of the water main.

hould I buy
ottled water?

u do not need to
y bottled water
alth reasons
York City
ce our water
ets all federal
d State health-
sed drinking
ter standards.
o, bottled water
Sh up to 1,000
s more than
City's drinking
er.

Operations

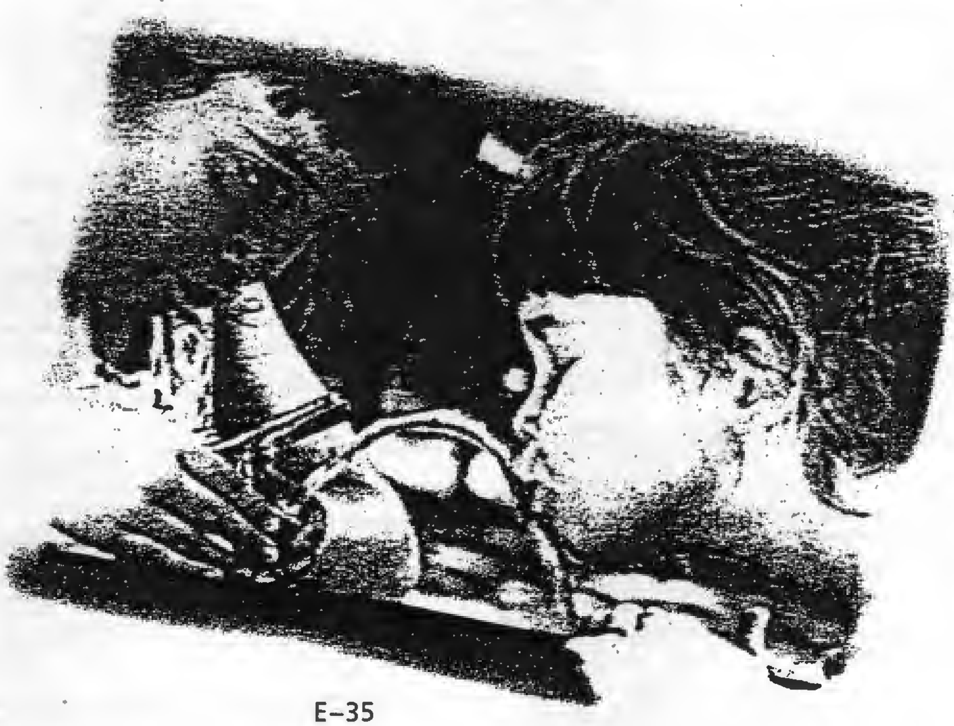
In our ongoing efforts to maintain the appropriate volume and high quality of water in the distribution system, there is some rotation in the water sources used by DEP. In the Groundwater System, wells are routinely removed and returned to service for maintenance or due to changes in demand. After Hurricane Floyd poured torrential rains on the watershed, the entire Croton System was shut down from September 17, 1999, through April 20, 2000, due to elevated levels of color (which is an aesthetic problem, not a public health concern) and to permit contract work in the Croton Aqueduct. On April 20, 2000, the Croton System was placed back in limited service when the Mosholu Pumping Station was activated, which pumped about 35 million gallons per day (MGD) of Croton water into Tunnel #1 of the Catskill/Delaware Supply through the end of the year. For the month of May and the first half of June the maximum pumped flow was 52.5 MGD. In addition about 14 MGD was distributed in the East Bronx from April 24 to June 13, 2000.

Croton Filtration Plant

The City is planning to build a treatment facility to filter water from the Croton System.

The federal Surface Water Treatment Rule (SWTR) requires that all water supplies be filtered by June 29, 1993, unless the system meets special criteria to receive a waiver. Even though Croton water quality is high, it experiences seasonal color problems and will be subjected to stricter standards for disinfection by-products in the near future. In November 1998, a Consent Decree, committing the City to design, construct, and operate a Croton filtration facility, was signed by the City, the United States and the State of New York. The facility is expected to reduce color levels in the Croton water supply and ensure compliance with stricter drinking water standards to be imposed in the future.

Until DEP begins to filter Croton water, we are required to make the following statement: Inadequately treated water may contain disease-causing organisms. These organisms include bacteria, viruses, and parasites, which can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.



New York City
Drinking Water Quality Testing Results 2000

DETECTED REGULATED PARAMETERS

PARAMETERS	NYS DOH MCL	US EPA MCLG	CATSKILL-DELAWARE SYSTEM PWSID NY7003493			CROTON SYSTEM PWSID NY7003666			GROUNDWATER SYSTEM PWSID NY7011735			SOURCE OF PARAMETER
			# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	
REGULATED CONVENTIONAL PHYSICAL AND CHEMICAL PARAMETERS												
Barium (mg/L)	2.00	2	193	0.013 - 0.027	0.018	3	0.024 - 0.026	0.025	57	ND - 0.097	0.018	Erosion of natural deposits
Chloride (mg/L)	250.0	-	227	6.4 - 20.8	9.5	3	39.1 - 48.8	45.6	207	8.3 - 91.8	34.8	Naturally occurring: road salt
Chromium (µg/L)	100	100	193	ND - 2*	ND	3	ND	ND	57	ND - 5	<2	Erosion of natural deposits
Color - entry points (color units)	15	-	1132	4 - 20	8	51	4 - 13	9	203	1 - 30	6	Iron and manganese: or organic sources, such as algal growth
Copper (mg/L)	1.3	1.3	265	ND - 0.070	0.009	4	0.003 - 0.027	0.014	210	ND - 0.155	0.019	Corrosion of household plumbing systems: erosion of natural deposits; leaching from wood preservatives
Fluoride (mg/L)	2.2	-	9803	0.2 - 1.5	1.1	73	0.7 - 1.1	1.0	1120	0.4 - 1.5	1.1	Erosion of natural deposits; water additive which promotes strong teeth: runoff from fertilizer
Gross Beta particle (pCi/L)	50	-	9	ND - 1.0	<0.7	3	1.2 - 2.1	1.7	1	1.8	1.8	Decay of natural deposits and man-made emissions
Iron (µg/L)	300	-	201	20 - 140	40	3	30 - 40	30	221	ND - 1710	290	Naturally occurring
Lead (µg/L)	15	0	273	ND - 18	<1	4	ND	ND	213	ND - 8	<1	Corrosion of household plumbing systems: erosion of natural deposits
Manganese (µg/L)	300	-	194	9 - 69	22	3	27 - 33	30	219	ND - 286	51	Naturally occurring
Nickel (µg/L)	100	-	193	ND	ND	3	ND	ND	51	ND - 3	<2	Naturally occurring, all detections were in Well 36 water only
Nitrate (mg/L nitrogen)	10	10	227	0.11 - 0.38	0.19	3	0.40 - 0.49	0.45	207	ND - 8.55	2.55	Runoff from fertilizer use: leaching from septic tanks, sewage: erosion of natural deposits
Nitrite (mg/L nitrogen)	1	1	193	ND - 0.003	<0.001	3	ND	ND	88	ND - 0.006	<0.001	Runoff from fertilizer use: leaching from septic tanks, sewage: erosion of natural deposits
Sodium (mg/L)	NDL	-	200	6.6 - 12.4	8.3	3	19.6 - 24.7	23.0	100	8.6 - 50.1	25.0	Naturally occurring: road salt: water softeners: animal waste
Sulfate (mg/L)	250.0	-	227	5.8 - 8.8	6.7	3	13.1 - 14.8	14.2	207	8.7 - 86.4	33.8	Naturally occurring
Turbidity - distribution system (NTU)	5	-	8706	0.50 - 10.00	1.06	23	0.80 - 2.50	1.24	1125	0.07 - 9.90	0.83	Soil runoff
Turbidity - entry points (NTU)	1	-	-	-	-	51	0.96 - 1.13	1.06	-	-	-	Soil runoff
Zinc (mg/L)	5	-	194	ND - 0.004	<0.002	3	ND	ND	219	ND - 0.545	0.059	Naturally occurring
REGULATED ORGANIC CONTAMINANTS												
Total Trihalomethanes (µg/L)	100	-	177	13 - 75	37	3	36 - 40	42	109	1 - 55	20	By-product of drinking water chlorination
Principal Organic Contaminants detected:												
Chlorodifluoromethane (µg/L)	5	-	177	ND	ND	3	ND	ND	109	ND - 1*	ND	Refrigerant: aerosol propellant: foaming agent
Hexachlorobutadiene (µg/L)	5	-	177	ND - 1*	ND	3	ND	ND	109	ND	ND	Used to make rubber compounds: used as a solvent, and to make lubricants: used as a heat transfer liquid and a hydraulic fluid
Tetrachloroethylene (µg/L)	5	0	177	ND	ND	3	ND	ND	109	ND - 3	<0.5	Discharge from dry cleaners
Toluene (µg/L)	5	1	177	ND	ND	3	ND	ND	109	ND - 1*	ND	Discharge from petroleum factories
Trichloroethene (µg/L)	5	0	177	ND	ND	3	ND	ND	109	ND - 2	<0.5	Residual of cleaning solvents and metal degreasers
Specified Organic Contaminants detected:												
Hexachlorocyclopentadiene (µg/L)	50	50	3	ND - 0.06	<0.05	-	-	-	6	ND	ND	Discharge from chemical factories
MICROBIAL PARAMETERS												
Total Coliform Bacteria (% samples positive/month)	5%	0	9807	0.0% - 0.6%	0.2%	72	ND	ND	1122	0.0% - 1.9%	0.6%	Naturally present in the environment
E. coli (CFU/100mL)		0	9807	ND	ND	72	ND	ND	1122	0.0% - 1%	0.1%	Human and animal fecal waste
Heterotrophic Plate Count (CFU/mL)	TT	-	6620	ND - 670	1	61	ND - 3	ND	763	ND - 251	1	Naturally present in the environment

LEAD AND COPPER RULE SAMPLING AT RESIDENTIAL WATER TAPS: January - June 2000

PARAMETERS	NYS DOH AL	US EPA MCLG	# SAMPLES	RANGE	90th PERCENTILE VALUES	# SAMPLES EXCEEDING ACTION LEVEL(AL)	SOURCE OF PARAMETER
Copper (mg/L)	1.3	1.3	107	0.011 - 0.514	0.202	0	Corrosion of household plumbing systems
Lead (µg/L)	15	0	107	ND - 657	13	10	Corrosion of household plumbing systems

CORRECTION

PARAMETERS	NYS DOH MCL	US EPA MCLG	CATSKILL-DELAWARE SYSTEM PWSID NY7003493			CROTON SYSTEM PWSID NY7003666			GROUNDWATER SYSTEM PWSID NY7011735			SOURCE OF PARAMETER
			# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	
Total Coliform Bacteria (% samples positive/month)	5%	0	9283	0.0% - 1.0%	0.2%	883	0.0% - 0.8%	0.1%	1222	0.0% - 2.0%	0.3%	Naturally present in the environment

1999 range of values for Total Coliform Bacteria in the Croton System was incorrectly reported in the New York City 1999 Drinking Water Supply and Quality Statement; these are the corrected numbers. The corrected values listed above show that no Total Coliform Bacteria violations occurred for any System during 1999.

DETECTED UNREGULATED PARAMETERS

PARAMETERS	NYS DOH MCL	CATSKILL-DELAWARE SYSTEM PWSID NY7003493			CROTON SYSTEM PWSID NY70036666			GROUNDWATER SYSTEM PWSID NY7011735			SOURCE OF PARAMETER
		# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	
UNREGULATED CONVENTIONAL PHYSICAL AND CHEMICAL PARAMETERS											
Alkalinity (mg/L $CaCO_3$)	-	278	5.9 - 23.8	13.2	4	32.2 - 49.6	42.9	227	6 - 188.6	54.1	Erosion of natural deposits
Aluminum (µg/L)	50 - 200	193	ND - 96	27	3	4 - 6	5	50	ND - 59	15	Erosion of natural deposits
Ammonia (µg/L nitrogen)	-	193	ND - 20	<20	3	ND	ND	61	ND - 20	<20	Animal waste and fertilizer runoff
Boron (µg/L)	-	193	ND - 118	51	3	40 - 60	50	50	ND - 224	89	Erosion of natural deposits
Calcium (mg/L)	-	272	4.0 - 10.2	6.3	4	15.6 - 22.6	19.5	241	5.3 - 75.4	22.3	Erosion of natural deposits
Carbon dioxide (mg/L)	-	12	1 - 2	1.4	1	3	3	-	-	-	Present in air
Chemical Oxygen Demand (mg/L O_2)	-	193	2.2 - 7.1	4.5	3	6.3 - 6.9	6.7	50	ND - 5.5	1.5	
Chlorine Residual, free (mg/L)	4	9838	0.1 - 1.3	0.6	74	0.4 - 1.1	0.7	1124	0.0 - 1.5	0.6	Water additive for disinfection
Color - distribution system (color units)	-	8705	2 - 50	8	23	5 - 16	10	1125	1 - 240	7	Presence of iron, manganese, and organics in water
Corrosivity (Langelier index)	0	193	-2.8 to -1.8	-2.4	3	-1.7 to -1.5	-1.6	92	-3.3 to 0.3	-1.4	
Dissolved Oxygen (mg/L)	-	12	8.8 - 15.8	11.9	1	9.7	9.7	-	-	-	
Foaming Agents (µg/L linear alkyl sulfonate)	500	193	ND - 20	<10	3	ND	ND	65	ND	ND	Residual of washing detergents
Hardness (grains/gallon [US] $CaCO_3$)	-	200	1.0 - 2.2	1.3	3	3.9 - 5.1	4.7	211	1.3 - 19.2	5.9	Erosion of natural deposits
Iodide (µg/L)	-	193	ND - 13*	ND	3	ND	ND	50	ND - 15*	ND	Erosion of natural deposits
Magnesium (mg/L)	-	201	1.1 - 3.0	1.5	3	5.7 - 7.5	6.9	237	1.6 - 34.2	10.9	Erosion of natural deposits
pH (pH units)	6.5 - 8.5	9838	6.8 - 7.9	-	74	6.9 - 7.3	-	1125	5.9 - 8.0	-	
Phosphate, Ortho- (mg/L)	-	9838	0.2 - 3.2	2	72	1.1 - 3.3	1.9	1124	0.3 - 3.3	1.7	Water additive for corrosion control
Phosphate, Total (mg/L)	-	193	1.2 - 2.8	1.8	3	1.9 - 2	1.9	93	0.2 - 12.4	2.1	Water additive for corrosion control
Potassium (mg/L)	-	200	0.5 - 10.2	0.8	3	1.5 - 2.0	1.8	52	0.6 - 3.4	1.2	Erosion of natural deposits
Silica (mg/L)	-	193	2.2 - 4.1	2.9	3	4.7 - 5.4	5.2	170	2.1 - 21.5	12.1	Erosion of natural deposits
Specific Conductance (µmhos/cm)	-	9838	67 - 178	85	74	190 - 318	250	1125	69 - 758	194	
Strontium (µg/L)	-	200	ND - 30	20	3	50 - 70	60	52	10 - 200	50	Erosion of natural deposits
Temperature (°F)	-	9832	34 - 74	54	74	46 - 63	52	1125	35 - 75	57	
Total Dissolved Solids (mg/L)	500	193	28 - 111	51	3	133 - 177	161	97	56 - 494	193	Metals and salts naturally occurring in the soil; organic matter
Total Organic Carbon (mg/L carbon)	-	193	1.1 - 2.0	1.4	3	2.2 - 2.7	2.5	50	ND - 1.3	0.5	Organic matter naturally present in the environment
Total Organic Halogen (µg/L)	-	187	98 - 315	166	3	220 - 259	242	50	ND - 176	76	By-product of drinking water chlorination
/ 254 Absorbency (absorbency unit)	-	193	0.026 - 0.038	0.032	3	0.053 - 0.059	0.057	50	0.005 - 0.045	0.020	Organic matter naturally present in the environment
.FIED ORGANIC CHEMICALS											
sinfection By-Products detected											
›mochloroacetic acid (µg/L)	50	153	ND - 2.5	1.3	-	-	-	43	ND - 2.7	0.9	By-product of drinking water chlorination
oral Hydrate (µg/L)	NA	87	3.2 -16.2	9.9	-	-	-	29	ND - 8.5	3.8	By-product of drinking water chlorination
oropicrin (µg/L)	NA	89	ND - 0.8	0.6	-	-	-	31	ND - 0.5	0.2	By-product of drinking water chlorination
›acetic acid 5 (HAA5) (µg/L)	60	129	16.1 - 64.0	34.9	-	-	-	38	0.3 - 33.7	14.3	By-product of drinking water chlorination
›acetonitriles (HANs) (µg/L)	50	88	2.0 - 4.6	3.5	-	-	-	31	0.2 - 4.1	2.4	By-product of drinking water chlorination
›genated ketones (HKs) (µg/L)	50	88	2.3 - 4.8	3.4	-	-	-	31	ND - 3.0	1.2	By-product of drinking water chlorination
specified Organic Chemicals detected											
'A (Dacthal) (µg/L)	5	3	ND	ND	-	-	-	2	0.52 - 0.95	0.74	Runoff from pesticide use
ıyl tert-butyl ether (MTBE) (µg/L)	50	177	ND - 3.9	<0.5	3	ND	ND	109	ND - 10.4	0.8	Additive to gasoline in the winter

›DETECTED PARAMETERS

›-DETECTED CONVENTIONAL PHYSICAL AND CHEMICAL PARAMETERS

ulated Conventional Physical and Chemical Parameters not detected:

mony, Arsenic, Asbestos, Beryllium, Cadmium, Cyanide, Gross Alpha particle, Mercury, Selenium, Silver, Thallium

egulated Conventional Physical and Chemical Parameters not detected:

mide, Chlorate, Lithium, Phenols, "Strontium - radiological", Tritium (H) - radiological

I-DETECTED ORGANIC CONTAMINANTS

cipal Organic Contaminants not detected:

ızene, Bromobenzene, Bromochloromethane, Bromomethane, n-Butylbenzene, sec Butylbenzene, tert-Butylbenzene, Carbon Tetrachloride, Chlorobenzene, Chloroethane, Chloromethane, 2-Chlorotoluene, 4-Chlorotoluene, ·romomethane, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethene, cis-1,2-Dichloroethylene, trans-1,2-Dichloroethylene, 1,2-Dichloropropane, Dichloropropane, 2,2 Dichloropropane, 1,1-Dichloropropene, cis-1,3-Dichloropropene, trans-1,3 Dichloropropene, Ethylbenzene, Isopropylbenzene, p-Isopropyltoluene, Methylene chloride, n-Propylbenzene, Styrene, .2-Tetrachloroethane, 1,1,2,2-Tetrachloroethane, 1,2,3-Trichlorobenzene, 1,2,4-Trichlorobenzene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, 1,2,3-Trichloropropane, Trichlorofluoromethane, 1,2,4-Trimethylbenzene, ›-Trimethylbenzene, m-Xylene, o-Xylene, p-Xylene

ified Organic Contaminants not detected:

hlor, Aldicarb (Temik), Aldicarb sulfone, Aldicarb sulfoxide, Aldrin, Atrazine, Benzo(a)pyrene, Butachlor, Carbaryl, Carbofuran (Furadan), Chlordane, 2,4-D, Dalapon, 1,2-Dibromo-3-chloropropane, Dicamba, Dieldrin, -ethylhexyl)adipate, Di(2-ethylhexyl) phthalate, Dinoseb, Diquat, Endothall, Endrin, Ethylene dibromide (EDB), Glyphosate, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, 3-Hydroxycarbofuran, Lindane, Methomyl, ıoxychlor, Metolachlor, Metribuzin, Oxamyl (Vydate), Pentachlorophenol, Picloram, Polychlorobiphenyls [PCBs], Propachlor, Simazine, Toxaphene, 2,4,5-TP (Silvex), Vinyl chloride

d Organic Chemicals not detected:

ene, Acenaphthylene, Acetochlor, Acifluorfen, Anthracene, Bentazon, Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[g,h,i]perylene, a-BHC, b-BHC, d-BHC, Bromocil, Bromodichloroacetic acid, benzylphthalate, Caffeine, a-Chlordane, g-Chlordane, Chlorobenzilate, Chloroneb, Chlorothalonil (Draconil, Bravo), Chrysene, 2,4-DB, p,p'DDD, p,p'DDE, p,p'DDT, Diazinon, Dibenz[a,h]anthracene, Di-n-Butyl phthalate, ›ichlorobenzoic acid, Dichlorprop, Diethylphthalate, Dimethoate, Dimethylphthalate, 2,4-Dinitrotoluene, Di-N-octylphthalate, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin aldehyde, Etridiazole, EPTC, Fluoranthene, ene, Indeno[1,2,3-cd] pyrene, Isophorone, Malathion, Methiocarb, MGK - 264, Molinate, Naphthalene, 4-Nitrophenol, trans-Nonachlor, Norflurazon, Paraquat, Parathion, Permethrin, Phenanthrene, Prometryn, Propoxur on), Pyrene, 2,4,5-T, Terbacil, Terbufos, Tetrachloroterephthalic acid, Thiobencarb, Trifluralin, Vernolate

FOOTNOTES

(1) Determination of MCL violation: If a sample exceeds 15 color units, a second sample must be collected from the same location within 2 weeks. If the average of the two results exceeds 15 color units, then an MCL violation has occurred. In the Catskill-Delaware System there were 4 color violations on 8/19/00, 9/9/00, 9/16/00, and 9/23/00. In the Groundwater System there were 5 color violations on 2/8/00, 7/12/00, 8/23/00, 9/13/00, and 10/4/00.

(2) Action Level (not an MCL) measured at the tap.

(3) Reported radiological data for gross alpha, gross beta, strontium 90, and tritium are for samples collected during 1997. Regulations stipulate that samples be taken every 4 years.

(4) New York State considers 50 pCi/L to be the level of concern for beta particles.

(5) If iron and manganese are present, the total concentration of both should not exceed 500 µg/L. Values in the groundwater system above the MCL are not a violation because the water at particular wells is treated, as allowed by the State, to meet aesthetic concerns.

(6) USEPA MCL; NYSDOH has not set an MCL for this parameter.

(7) Water containing more than 20 mg/L of sodium should not be used for drinking by people on severely restricted sodium diets. Water containing more than 270 mg/L of sodium should not be used for drinking by people on moderately restricted sodium diets.

(8) Turbidity is a measure of cloudiness of the water. Turbidity is monitored because it is a good indicator of water quality and can hinder the effectiveness of disinfection.

1CL is the monthly average. Data presented are individual sample results.

(10) This MCL only applies to the Croton System. The MCL and data presented are monthly averages. This MCL was not exceeded.

(11) MCL is the calculated quarterly running average. In 2000 the MCL was never exceeded. Data presented are the range of individual sampling results and the highest running average.

(12) If a sample and its repeat sample are both positive for coliform bacteria and one of the two samples is positive for E. coli, then an MCL violation has occurred.

(13) USEPA Secondary MCL; NYSDOH has not set an MCL for this parameter.

(14) Value represents MRDL which is a level of disinfectant added for water treatment that may not be exceeded at the consumer's tap without an unacceptable possibility of adverse health effects. The MRDL currently is not regulated but will become effective for DEP's surface water systems on January 1, 2002 and will be enforceable in the same manner as MCLs.

(15) A Langelier Index of less than zero indicates corrosive tendencies.

(16) Hardness of up to 3 grains per gallon is considered soft water; between 3 and 9 is moderately hard water.

(17) This contaminant is currently not regulated. The MCL presented becomes effective for the Catskill-Delaware and Croton Systems on January 1, 2002 and for the Groundwater System on January 1, 2004.

18) Reported asbestos data was collected in 1993. Regulations require this parameter to be sampled every 9 years.

* The contaminant was detected in only one sample. The level found was below the MCL.

Color - entry point values highlighted and bolded indicate a violation occurred, see footnote (1)

DEFINITION OF TERMS

Action Level (AL):

The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements that a water system must follow. An exceedence occurs if more than 10% of the samples exceed the Action Level.

Maximum Contaminant Level (MCL):

The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG):

The level of a contaminant in drinking water below which there is not known or expected risk to health. MCLGs allow for a margin of safety.

Maximum Residual Disinfectant Level (MRDL):

The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Treatment Technique (TT):

A required process intended to reduce the level of a contaminant in drinking water

90th Percentile Value:

The values reported for lead and copper represent the 90th percentile. A percentile is a value on a scale of 100 that indicates the percent of a distribution that is equal to or below the value. The 90th percentile is equal to or greater than 90% of the lead and copper values detected at your water system.

ABBREVIATIONS

NA = Not Applicable

ND = Laboratory analysis indicates that the constituent is not present

NDL = No Designated Limit

CFU/ml = colony forming units per milliliter

mg/L = milligrams per liter (10-3 grams per liter)

µg/L = micrograms per liter (10-6 grams per liter)

pCi/L = picocurie per liter (a measure of radioactivity)

NTU = Nephelometric Turbidity Units

µmho/cm = micromhos per centimeter

Water Conservation

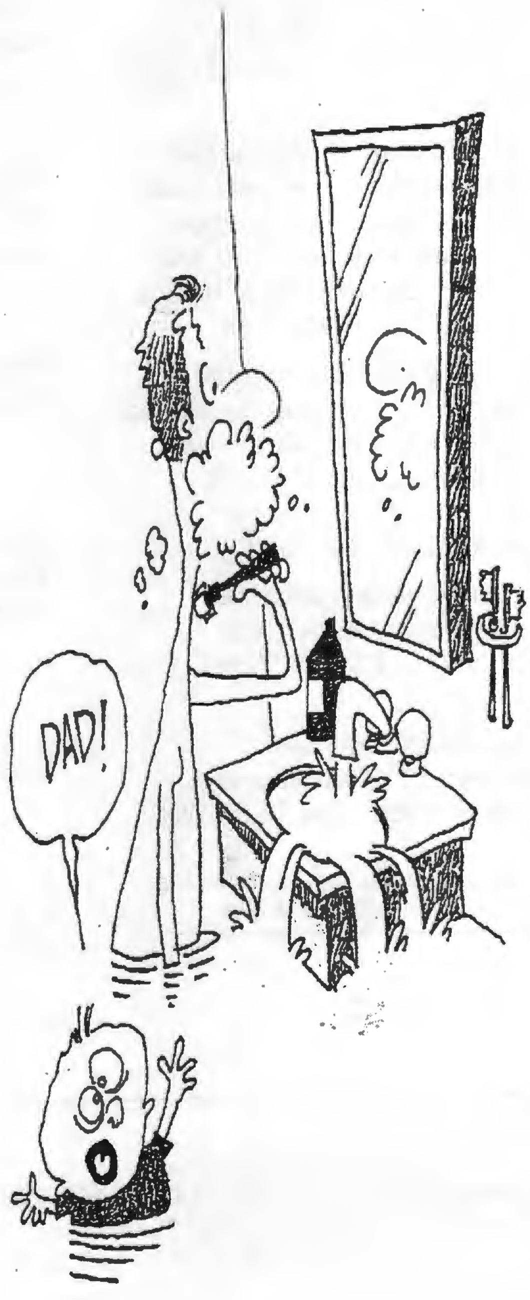
The average single family household in New York City uses approximately 100,000 gallons of water each year, at a cost of $1.31 per 100 cubic feet of water (748 gallons), or about $175.00 in the year 2000. Although New York City is fortunate to have a plentiful supply of reasonably priced drinking water, everyone should do their part to conserve this precious resource.

DEP's ongoing efforts to save water include: use of sonar equipment to survey all water supply piping for leaks; replacement of approximately 70 miles of old water supply pipe a year; equipping fire hydrants with special locking devices; and installing home water meters to encourage conservation.

These programs and others have proven successful and together have reduced water consumption in the City by approximately 200 million gallons per day in the last ten urs. This is more water than the City of Boston or Westchester County uses in a day.

You can help save water by ordering a Home or Apartment Water Saving Kit. If you are an apartment building owner/manager or a home owner, you can obtain a free leak survey. Call our Leak Survey contractor at (718) 326-9426 for information.

For additonal water saving tips follow *The Do's and Don'ts of Water Conservation* on the following page.



Contact Us

For a copy of this report, to report unusual water characteristics, or to request a free kit to test for lead in your drinking water, call DEP's 24-hour Help Center at (718) DEP-HELP (337-4357).

For more information on *Giardia* and *Cryptosporidium*, please contact the Parasitic Disease Surveillance Unit of the New York City DEP and New York City Department of Health (NYCDOH) at: (212) 788-4728.

To contact NYCDOH about other water supply health related questions call (212) 442-9666 or call the New York State Department of Health Bureau of Public Water Supply Protection at (518) 402-7650.

To report any polluting activities occurring in the watershed, call 1-888-DEP-NYC1 (1-888-337-6921), '-hours a day.

To view this 2000 Statement, announcements of public hearings, or other information, visit DEP's Web site at:

www.nyc.gov/dep

Este reporte contiene información muy importante sobre el agua que usted toma. Haga que se la traduzcan o hable con alguien que la entienda.

Ce rapport contient des informations importantes sur votre eau potable. Traduisez-le ou parlez en avec quelqu'un qui le comprend bien.

Rapò sa a gen enfòmasyon ki enpòtan anpil sou dlo w'ap bwè a. Fè tradwi-l pou ou, oswa pale ak yon moun ki konprann sa ki ekri ladan-l.

Ten raport zawiera bardzo istotną informacje o twojej wodzie pitnej. Przetłumacz go albo porozmawiaj z kimś kto go rozumie.

В этом материале содержится важная информация относительно вашей питьевой воды. Переведите его или поговорите с кем-нибудь из тех, кто понимает его содержание.

這個報告中包含有關你的飲用水的重要信息。
請將此報告翻譯成你的語言，或者詢問懂 得這份報告的人。

이 보고서는 귀하의 식수에 관한 매우 중요한 정보를 포함하고 있습니다. 이 정보에 대해 이해하는 사람에게 그 정보를 번역하거나 통역해 받으십시오.

New York City
Department of Environmental Protection
59-17 Junction Boulevard
Corona, New York 11368-5107

ATTACHMENT D
EXCERPT FROM OPERATION AND MAINTENANCE MANUALS - VILLAGE OF NEW PALTZ WTP

OM15-01A

INSTALLATION AND ASSEMBLY INSTRUCTIONS
TRIDENT® WATER TREATMENT PLANT

These instructions cover four TRIDENT® models:

TR-105A	350 gal/min maximum capacity
TR-210A	700 gal/min maximum capacity
TR-420A	1,400 gal/min maximum capacity
TR-840A	2,800 gal/min maximum capacity

These capacities are based on two-tank systems. They may be supplied in one, two, or three tank designs. All models are of rectangular, painted steel tank construction.

The standard Microfloc Products TRIDENT® water treatment plant consists of:

1. One, two or three tanks with adsorption clarifier and filter compartments in each tank.
2. Blower assembly.
3. Adsorption media with retaining mechanism.
4. Mixed Media filter media with support gravel and underdrain system.
5. Manual and automatic control valves.
6. Water level controllers for the filters.
7. Electrical controls for automatic operation with manual overrides.
8. AQUARITROL® coagulant feed controller, with on-line effluent turbidimeter.
9. Two chemical feed systems; one each for alum and polymer.

Any special instructions for your TRIDENT® are identified in this Owners Manual with the project number shown on the title page at the front of the Manual.

Only the items referenced in the Bills of Material for the drawings in the Drawing section of this Owners Manual are furnished by Microfloc Products.

The Jobsite Superintendent should review these instructions before the arrival of the equipment. THIS REVIEW IS IMPORTANT. Assembly should not be attempted without first understanding these instructions.

II. DESCRIPTION OF TRIDENT SYSTEM

A. Components

1. Chemical Feed Systems

The chemical feed package included in a standard Trident water system includes assemblies for feeding alum (or other primary coagulant) and polymer. Other chemical feed systems may be included on a case-by-case basis depending upon the particular water treatment scheme as determined by CPC-Microfloc Products or by the design engineer.

Each system consists of a solution storage tank, a mixer and a positive displacement diaphragm metering pump. On larger systems in which liquid alum solution is used, a mixer is not necessary and the storage tank is supplied by others. Polymer tanks also include a disperser to aid im mixing dry polymers. A separate polymer feed system is provided for each tank on the TRIDENT system.

The discharge of the metering pump goes into a larger line in which it is diluted with a larger flow of water. This mixture is then fed directly into the raw water feedline to the plant. The dilution water serves to help disperse th chemicals into the raw water and helps to even out th effect of the slugs of chemicals as discharged from the metering pumps. Mixing of the chemical solution is aided further by use of injectors in the pipeline. The ususl order of chemical feed into the raw water is the alum (and soda ash, if used) solution(s) first followed by the polymer solution. This allows time for initial formation of floc before the polymer is added. The polymer and soda ash are usually fed into the main line ahead of the the treatment system. Polymer is added into the the inlet of each tank after the flow is split, or into the main line, as required by the installation.

Refer to our "flow diagram" and chemical feed drawings for further details concerning the type of equipment supplied, the connections to make, etc.

2. Tankage

TRIDENT systems are constructed of welded steel tanks finished with a high quality epoxy paint. In multiple tank systems all tanks are usually identical. Each tank consists of two compartments--the clarifier and filter sections. Between them is a double wall to provide an air space separation between filtered and unfiltered water. This prevents any chance of untreated water from mixing with the filtered water. There is a weep hole at the bottom of the air space chamber to allow any leaked water to drain out.

The tanks include an integral trough that carries away clarifier and filter wastewater. It also acts as an emergency overflow device in case of system malfunction.

Component Sizes for Standard TRIDENT Systems

	Plan Area in Each Tank, sq.ft.	
Model	Clarifier	Filter
TR-105A	17.5	35
TR-210A	35	70
TR-420A	70	140
TR-840A	140	280

3. Adsorption Clarifier

The Adsorption Clarifier is an upflow process. It uses one-third of the total tank area. The clarification medium is placed in a bed about 4 ft. deep. It consists of irregularly shaped particles of chemically inert material. The material is less dense than water so it floats.

This media is contained within the clarifier by a removable retaining assembly. This consists of a stainless steel screen bonded to a non-corrosive grating. This retaining assembly is held in place by a series of bolts which are removable from above to allow the removal of sections of the screen for maintenance.

Near the bottom of the clarifier section is a series of air supply pipes fitted with diffusers. Air is injected into the bottom of the clarifier during a cleaning cycle. This agitates and expands the media bed and allows flushing of the solids removed during clarification.

Due to the large particle size used in this clarifier, the system has a very high solids storage capacity with relatively low headloss.

4. Mixed Media Filter

The CPC-Microfloc Products Mixed Media filter bed approaches the ideal filter design. Its unique combination of filter materials and sizes results in a bed that hydraulically grades coarse to fine in the direction of filtration. This allows true depth filtration and the associated benefits of high solids storage, high rates and high quality effluent.

Three materials are used: anthracite coal, silica sand and a special high density sand. The careful size and density ratio provide a filter bed that maintains a stable relationship between the grains during an indefinite period of use and backwash cycles. The coarse, low density grains remain at the top of the bed and the finely sized high density grains at the bottom. There is no distinct layer effect but a gradual decrease in average grain size from the top of the filter to the bottom.

The large grains at the top of the filter allow a great number of particles to be held before backwashing is required. The fine sand (0.2 mm) at the bottom of the filter provides a large surface area that is very effective in achieving high quality effluent. Only a small amount of this fine material is needed to provide efficient filtration resistance to flow surges and improved bed stability.

The filter bed is supported by several layers of gravel of various sizes which cover the header/lateral underdrain system. The filtered water is uniformly collected by the underdrain and flows to the clearwell. Backwash water is pumped into the underdrain system to reverse the flow when backwashing is required.

5. Flow and Level Controls

TRIDENT systems are designed to operate at a constant flowrate. The older units held the flowrate constant through the unit by use of a Griswold brand spring-loaded variable area orifice flow control valve. This valve maintains a non-adjustable fixed flow into each treatment

The newer generation units maintain a constant, but adjustable flowrate by means of a full flow control loop. The flowrate is held constant at all times in spite of fluctuations in headloss through the clarifier bed. This is accomplished through use of a flow controller connected to D/P transmitter (with integral square root extraction) and orifice plate in the influent line to each tank. The controller 4 - 20 mA output is directed to a current-to-pneumatic (I/P) transducer which has a 3 - 15 psi output.

The air supply to the I/P transducer is supplied through a solenoid valve SV-104 (SV-204,SV-304) which provides the on-off capabilities to the flow loop. The solenoid is controlled by programmable controller output 030 (050,070). For those plants which normally run at a reduced flow rate, an alternate, higher, flow rate is allowed by feeding the output pressure of pressure regulator PR-2 through solenoid SV106 (SV206, SV306) which prevents the output from the flow controller from reaching the valve positioner. During normal operation, solenoid SV106 (SV206, SV306) is de-energized, allowing the I/P converter output to reach the valve positioner.

The pneumatic level transmitter is located in each filter compartment. The water level in the filter chamber is lower than that in the clarifier. The level controller modulates the filter effluent valve to maintain a fixed level in this chamber. The level controller is allowed to run by SV301 (SV201, SV301) which is controlled by programmable controller output 031 (051,071) through the filter low level protection switch LSL101 (LSL201, LSL301).

6. Valves

The flow control valves used in the TRIDENT system are flange type butterfly valves with air operated actuators. The automatic throttling valves used for the effluent and influent (if equipped with influent flow control loops) flow control are equipped with positioners. The backwash and effluent valves are all equipped with speed controls to prevent rapid opening and closing of the valves.

7. Instrumentation and Controllers

Your TRIDENT system is equipped with a highly advanced instrumentation system that is designed to allow your plant to produce water of exceptionally high quality with the very minimum amount of operator attention. A detailed explanation of the control system is found in Section II.C of this manual. The major items will be described in this section to let you become familiar with the general concept.

Inside the control panel are the "brains" of the control system. TRIDENT systems use a G.E. Series One programmable controller for most of the control functions. This is a solid state device that replaces most of the relays, timers and other hardwired electrical circuitry used in many types of control systems. Although it may be at first a bit extremely versatile and usable control system. You should take the time to read the enclosed Owners Manual for this unit so that you can become comfortable with this system.

The chemistry of the water treatment process is controlled by your AQUARITROL system. This is a microprocessor-based coagulant control system. This continually optimizes the overall treatment process and, by doing so, it minimizes costs due to savings in chemicals and in your time.

The AQUARITROL receives a signal from the effluent turbidimeter and compares it to the plant setpoint (for example, 0.2 NTU). It then automatically controls the coagulant feed to maintain that setpoint. By doing so it saves you the time and expense involved in running numerous jar tests for determining optimum chemical doses.

ecology and environment engineering, p.c.
International Specialists in the Environment
BUFFALO CORPORATE CENTER 368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

Technical Memorandum

To: Robert M. Pender
U.S. Army Corps of Engineers – Kansas City District

From: John Fazzolari

Reviewed by: Don Miller, Rick Watt

Date: September 15, 2003

Subject: High Falls Water Treatment Plant - Raw Water Testing

---

Raw water samples were collected at the New York City Department of Environmental Protection's (NYSDEP's) Rondout Valley siphon house on June 23, 24, and 25, 2003, and analyzed for total and dissolved lead. The samples were collected at predetermined time intervals based on different turnover volumes in the siphon house riser pipe. Sampling intervals are described in the *Sampling Plan for Siphon House Water Sampling, Round 2, Revision 2* (E & E June 18, 2003). This sampling plan was approved by the United States Army Corps of Engineers (USACE), the United States Environmental Protection Agency (USEPA), and NYCDEP. Eight samples were analyzed for total (unfiltered) lead, dissolved lead (0.45-micron filtered), and lead filtered through 8- and 16-micron paper filters. Three raw water samples were also collected at different turnover volumes for bench-scale water treatment testing by USFilter.

Presampling Work

The most likely method for obtaining raw water for treatment at the High Falls water treatment plant (WTP) was discussed during the preparation of the operation and maintenance (O & M) estimate. It was determined that raw water would be obtained only during normal work hours (assumed to be 8 a.m. to 5 p.m., Monday through Friday), when the principal WTP operator would be at the facility. Consequently, the raw water supply pipe valve would be closed for at least 63 consecutive hours each weekend, allowing water in the riser pipe to be in contact with the riser pipe's lead lining.

In an attempt to mimic this situation, the riser pipe's sampling port valve was opened by NYCDEP personnel at 8 a.m. on Wednesday, June 18, and remained open until approximately 5 p.m., Friday, June 20, at which time NYCDEP closed the riser pipe sampling valve. This schedule resulted in approximately 25 turnovers volumes (approximately 135,000 gallons) of aqueduct water purged through the riser pipe prior to sampling. The weekend shutdown period of approximately 63 hours was followed by flushing of an additional 25 turnover volumes, during which time (June 23 to 25, 2003) E & E personnel conducted raw water sampling.

Maximum Contaminant Levels (MCLs) and Action Levels

Title 10 of the New York State Codes, Rules, and Regulations (NYCRR Title 10) sets the MCLs for individual parameters in drinking water systems. There are three MCLs for turbidity in the regulations. The first is set for the distribution system. A violation of this MCL occurs when the monthly average of the results of all distribution system samples collected in one month exceeds 5 nephelometric turbidity units (NTU). The second MCL is set for the entry point (defined in 10 NYCRR 5-1) as the representative sampling location after the last point of treatment but before the first consumer connection. A violation of the entry point turbidity MCL occurs when the average of all daily entry point analyses for the month exceeds 1 NTU. The third MCL is for filtered water turbidity and applies to the water immediately after the filtration process. This MCL is exceeded when the results for 5% of the composite samples collected in a month exceed the performance standard of 0.5 NTU.

Title 10 also sets the action level for lead, which is applied to the results of samples collected at the point of use (10 NYCRR 5-1.41). An action level is similar to an MCL, except that exceeding an action level is not a violation of the New York State Health Code. Exceeding the action level triggers a response from the New York State Department of Health requiring further action to correct the situation. The action level for lead is exceeded if the 90th percentile of all samples collected during any monitoring period exceeds 15 micrograms per liter (µg/L).

Based on the regulations discussed above, screening values used in this memorandum are 0.5 NTU for turbidity and 15 µg/L for lead.

Raw Water Lead Results

In accordance with the June 18, 2003, Sampling Plan, raw water samples were collected at approximate turnover volumes of 0, 0.5, 1, 4, 11, 14, 22, and 25. These turnover volumes are referenced to the time that sampling began <u>after</u> the weekend shutdown period; that is, these turnover volumes correspond to predetermined time intervals following the reopening of the riser pipe's sampling port valve. During flushing of the riser pipe and sampling of the riser pipe water, E & E collected the following raw water quality measurements: pH, temperature, conductivity, and total dissolved solids. The results of these field measurements are summarized in Table 1. The pH values of the raw water were similar to those recorded in April 2003, in that the initial sample collected after a period of shutdown had the lowest pH (5.81) and pH increased and stabilized in the range of 6.4 to 6.9 as the riser pipe was flushed.

Lead concentrations were measured in the field using a Hach field test kit in accordance with the Sampling Plan. These measurements were used to determine when flushing and collection of laboratory analytical samples would cease. Field test kit results are summarized in Table 2. Because total lead results measured in the field exceeded 5 µg/L (the threshold established in the Sampling Plan), sampling continued for three days until an additional 25 turnover volumes had been flushed. Raw water samples collected for total, filtered, and dissolved lead analyses were submitted to E & E's Analytical Services Center (ASC).

Table 1 Summary of Riser Pipe Raw Water Quality Readings, High Falls Siphon House

Date/Time	Flow Volume (gal)[a]	Sampling Turnover Volume[a]	pH	Temperature (°C)	Conductivity (µS/cm)	Total Dissolved Solids (mg/L)
6/23/2003 8:05	200	0.0[b]	5.81	13.8	65.6	43.00
6/23/2003 9:05	2,600	0.48	6.67	13.3	63.8	41.7
6/23/2003 10:45	6,600	1.2	6.86	14.6	64.4	42.1
6/23/2003 17:00	21,600	4.0	6.75	16.7	62.9	40.8
6/24/2003 8:45	59,400	11	6.42	14.2	64.9	42.3
6/24/2003 15:30	75,600	14	6.74	17.2	63.6	40.9
6/25/2003 9:30	118,800	22	6.60	16.7	65.4	42.7
6/25/2003 16:15	135,000	25[b]	6.74	15.8	61.8	40.5
		Max	6.86	17.2	65.6	43.0
		Min	5.81	13.3	61.8	40.5
		Average	6.57	15.3	64.0	41.8
		Median	6.71	15.2	64.1	41.9

Key:

°C = degrees Celsius
gal = gallons
mg/L = milligrams per liter
µS/cm = microSiemens per centimeter

[a] Volume flushed during this sampling event on June 23 – 25, 2003. Approximately 28,6000 gallons flushed during sampling in April 2003 and approximately 135,000 flushed on June 18 – 20, 2003 prior to this sampling event.

[b] Turnover volume sampled for bench-scale testing by USFilter.

Laboratory results of the lead analysis are summarized in Table 2. Lead concentrations in the unfiltered raw water samples ranged from a maximum of 210 µg/L at turnover 0 to a minimum of 18.3 µg/L at turnover 25. The sample collected at turnover 0 was collected 5 minutes after restarting the flow through the riser pipe. Lead concentrations dropped rapidly within the first four turnover volumes during the sampling period, and continued to drop, but at a lower rate, during subsequent turnover volumes. This reduction in the lead content of the raw water was probably due to the flushing process, which minimizes contact time of the water with the lead lining. The analytical results for the various filtered samples were similar to the results for the unfiltered samples, but with generally lower concentrations. The lead concentrations in the various filtered samples were very similar but slightly lower than those in the unfiltered samples (see Table 2). The rationale for selecting filter sizes is described in the Sampling Plan. The filtered and dissolved lead results indicate that in all but one sample the majority of the lead is in the dissolved form (i.e., less than 0.45 microns). That is, in most samples, the amount of dissolved lead was over 60% that of the filtered lead and as high as 75%. Chart 1 presents the total and dissolved lead data graphically, and Chart 2 presents the same data at a different scale to provide details regarding concentrations near the action level for lead (15 µg/L). Turnover volumes in both charts are referenced to the start of sampling on June 23, 2003.

Table 2 Riser Pipe Sampling Lead Results, High Falls Siphon House

Date/Time	Approx. Flow Volume (gallons)	Sampling Turnover Volume	Field Total Lead (Unfiltered) (µg/L)	Field Filtered Lead (16-µm Filter) (µg/L)	Field Filtered Lead (8-µm Filter) (µg/L)	Field Dissolved Lead (0.45-µm Filter) (µg/L)	Lab Total Lead (Unfiltered) (µg/L)	Lab Filtered Lead (16-µm Filter) (µg/L)	Lab Filtered Lead (8-µm Filter) (µg/L)	Lab Dissolved Lead (0.45-µm Filter) (µg/L)
6/23/2003 8:05	200	0.04	118	126	79	124	210	175	171	157
6/23/2003 9:05	2,600	0.48	41	30	43	32	73.1	71.5	79.5	55.4
6/23/2003 10:45	6,600	1.2	28	11	19	15	37.0	32.4	31.3	25.6
6/23/2003 17:00	21,600	4.0	15	14	11	3	28.6	26.4	26.3	18.7
6/24/2003 8:45	59,400	11	11	7	10	9	25.5 J	22.6	22.9	10.5
6/24/2003 12:00	67,200	12	14	12	10	8				
6/24/2003 15:30	75,600	14	12	11	8	7	23.3	19.3	16.6	14.2
6/25/2003 9:30	119,000	22	15	8	8	4	19.3	14.3	14.2	12.1
6/25/2003 16:15	135,000	25	9	12		7	18.3	16.8	15.1	11.7

Key:

J = estimated value
MDL = method detection limit
ND = not detected
RPD = relative percent difference
µg/L = micrograms per liter
µm = microns
[blank cell] Blank cell indicates that analysis was not performed.
24.5 Shaded values exceed the NYS Dept. of Health Action Level of 15 µg/L.

The results indicate that as the riser pipe is flushed, the lead level in the raw water typically decreases to approximately 15 to 25 µg/L and remains near that level. However, total lead levels remained above the action level of 15 µg/L throughout the entire set of tests. The results for the filtered samples indicate that a small amount of particulate lead was present in all samples. The portion of lead that is dissolved (i.e., passes through a 0.45-µm filter) drops below the action level after the pipe has been flushed 11 times.

Raw Water Herbicide Results

At turnover volume 25, one sample was collected for chlorinated herbicide analysis by GC Method 8151A. This sample was collected because previous analytical results for a raw water sample collected in April 2003 were rejected due to analytical error. The sample was analyzed at Severn Trent Laboratories in Pittsburgh, Pennsylvania. All herbicide results were usable and nondetect.

USFilter Bench-Scale Testing

During this sampling event, E & E also collected 10-gallon raw water samples at turnover volumes 0, 4, and 25. USFilter used these raw water samples to conduct bench-scale treatability tests to determine the following:

- The levels of turbidity, color, and pH in the drinking water that could reasonably be achieved after treatment at the High Falls WTP;
- The effect of different chemicals on the treatment efficiency for turbidity, color, and pH. (USFilter conducted jar tests at six doses of each of five chemicals on all three raw water samples, totaling 90 discrete samples);
- The optimum dose determination for each of five treatment chemicals;
- Concentrations of lead in chemically treated samples as well as the maximum trihalomethane formation potential of the chemically treated water; and
- An estimate of the volume of the sludge that will be produced during operation of the WTP.

USFilter conducted bench-scale tests in July 2003. Following the tests, USFilter prepared samples of chemically treated water and shipped the samples to E & E's ACS for lead analysis. USFilter also generated a written report summarizing the procedures used during the bench-scale tests and the results as they relate to the effects of various doses of five treatment chemicals on water pH, turbidity, and color (see Appendix A). The results of USFilter's tests were as follows:

- The raw (untreated) water exhibited levels of turbidity and color below MCLs (less than 0.5 nephelometric turbidity unit (NTU) and 15 color units, respectively).
- All five chemicals tested (polyaluminum chloride [PAC], aluminum chlorohydrate [ACH], alum, ferric chloride, and cationic polymer) were effective in further reducing turbidity

(below 0.1 NTU) and color (below 5 color units). Dosages were recommended for each of the five chemicals, based on resulting turbidity and color levels.

- Each of the five chemicals tested has a concentration-dependent affect on turbidity. At low to medium doses, turbidity decreased as the amount of chemical added increased. However, as the dose increased beyond a certain concentration, an "overdose" of chemical occurred. That is, at relatively high chemical doses, turbidity of the water generally increased. Therefore, USFilter recommended that medium doses be used to treat the raw water (i.e., 1.0 to 1.5 milligrams per liter [mg/L] of cationic polymer, or 6 to 9 mg/L of the other four chemicals).

E & E analyzed the samples provided by USFilter for lead and maximum trihalomethane formation potential (MTP). One sample was collected from each of the three raw water samples for each of the five chemical types based on a low, medium, and high dose, for a total of 45 samples. One sample was collected for each chemical from the final raw water sample (turnover 25 after the weekend shutdown) and analyzed for MTP. The results for these samples are summarized below.

Treated Lead and Turbidity Results

Of the 45 treated samples, lead concentrations in 11 samples were above the action level of 15 µg/L, and the results for 16 samples were below the detection limit of 1.65 µg/L. Turbidity levels ranged from 0.039 to 1.010 NTU, with an average of 0.165 NTU. Each chemical treated the raw water to different levels of lead and turbidity, as discussed below. Charts 3 through 7 depict turbidity and lead concentration responses to treatment chemical dose. (Note that in these charts the numbers in the legends refer to the turnover volume flushed since the weekend shutdown of June 20 to 22, 2003. For example, "Turbidity-0" refers to the first sample collected on June 23, 2003, at turnover volume 0, and "Lead-25" refers to the last sample collected on June 25, 2003, at turnover volume 25.)

PAC

In five of the nine samples treated with PAC, the lead concentration was below the detection limit, and in one sample the concentration was above the action level for lead (see Chart 3). The results that were above detection limits were either for samples taken from the initial raw water sample (which had a lead concentration of 210 µg/L) or were the result of too high a dose of chemical (15 parts per million [ppm] of PAC in the final sample). On average, PAC

No. of Pipe Volume Turnovers	PAC Concentration (ppm)	Turbidity (NTU)	Lead Concentration (µg/L)
0	3	0.060	15.9
0	12	0.062	4.99
0	15	0.082	5.01
4	3	0.076	ND
4	15	0.234	ND
4	18	0.118	ND
25	3	0.100	ND
25	6	0.067	ND
25	15	0.092	4.37

Key:
ND = not detected
PAC = polyaluminum chloride
ppm = parts per million.

achieved a 97% reduction in lead; to an average result of 3.36 µg/L. Turbidity results were below the MCL for all 18 samples tested. When the recommended dose of 6 to 9 ppm of PAC was used, the average turbidity was 0.067 NTU.

ACH

The lead results for six of the nine samples treated with ACH were below the detection limit, and the results for two of the samples were above the action level for lead (see Chart 4). The results that were above the detection limit and AL were for samples collected from the initial raw water sample (210 µg/L of lead). On average, ACH reduced lead concentrations by 98% and achieved an average effluent concentration of 5.06 µg/L. Turbidity results exceeded MCLs in four of the 18 samples (two in the turnover 0 sample and two in the turnover 25 sample). These exceedances occurred at higher relative doses of ACH (see Chart 4). When added at the recommended dose of 6 to 9 mg/L, ACH reduced turbidity to 0.057 NTU.

No. of Pipe Volume Turnovers	ACH Concentration (ppm)	Turbidity (NTU)	Lead Concentration (µg/L)
0	3	0.049	18.6
0	6	0.064	7.01
0	15	0.505	19.9
4	3	0.068	ND
4	6	0.048	ND
4	15	0.348	ND
25	3	0.067	ND
25	6	0.060	ND
25	15	0.462	ND

Key:
ACH = aluminum chlorohydrate
ND = not detected
ppm = parts per million.

Cationic Polymer

The results for two of the three raw water samples treated with cationic polymer were below the lead action level of 15 µg/L (see Chart 5). The lead results for the sample collected prior to flushing ranged from 31.8 to 54.7 µg/L. The lead results for the two samples collected after flushing ranged from ND to 2.56 µg/L. Cationic polymer achieved results of nondetect in four of the nine samples. Turbidity levels were all below the MCL in the samples treated with cationic polymer. The highest turbidity result for the 18 samples treated with cationic polymer was 0.327 NTU, which was detected in a sample treated with a medium dose of polymer.

Ferric Chloride

Ferric chloride reduced lead concentrations to an average of 15 µg/L in the nine samples tested (see Chart 6). When added at the recommended dose of between 6 and 9 mg/L, ferric chloride reduced the lead concentration to an average of 2.03 µg/L. However, when under- or overdosed, lead concentrations were as high as 95.5 µg/L. In addition, ferric chloride achieved nondetect in only one of the nine samples. The turbidity level in all but one of the 18 samples treated with ferric chloride was below the MCL for turbidity, with an average of 0.055 NTU at the recommended dose. The only exceedance (0.595 NTU) occurred at a high dose rate of ferric chloride (see Chart 6).

Alum

Lead was detected in all nine samples treated with alum, and the results in three samples were above the action level for lead (see Chart 7). The average result for lead was approximately 12 μg/L, and the maximum was 42.1 μg/L. The turbidity levels in all the samples were below 0.180 NTU. The average turbidity level in samples treated with the recommended dose of alum was 0.055 NTU.

Maximum Trihalomethane Formation Potential (MTP)

Five samples collected from the final raw water sample (turnover volume 25 after the weekend shutdown) and treated with the highest dose of each treatment chemical were analyzed for MTP. The samples were tested by adding a high dose of chlorine (in the form of sodium hypochlorite) to each sample to achieve a residual free chlorine concentration of 10 ppm or higher. The samples were maintained at 25 ± 2°C for seven days after chlorination to allow trihalomethanes to form. After the seven-day period, the water samples were tested for free and total chlorine concentrations, and all the results were determined to be above 10 ppm. Additional bottles from each sample lot were then analyzed for VOCs by EPA Drinking Water Method 524.2. The analytical results for four analytes (chloroform, dibromochloromethane, bromodichloromethane, and bromoform) were summed to determine the total trihalomethane concentration. The purpose of the testing described herein was to determine the maximum formation potential (i.e., the worst-case scenario for the formation of disinfection by-products) by satisfying the chlorine demand of the treated water.

The current MCL for total trihalomethanes is 100 μg/L; however, New York State is considering adopting a lower limit of 80 μg/L. The MTP results for all five samples were above the MCL for trihalomethanes. The lowest concentration (140 μg/L) was detected in the sample treated with ferric chloride, and the highest concentration (211 μg/L) was detected in the sample treated with cationic polymer. The average concentration was 176 μg/L. In all five samples, the analyte detected at the highest concentration was chloroform, which was detected at an average concentration of 169 μg/L. A summary of the positive analytical results for the VOC analysis is provided in Table 3.

At the residual chlorine levels anticipated to be required at the High Falls WTP (approximately one-fifth of that tested), trihalomethane concentrations should be within MCLs and similar to concentrations at other WTP's treating Catskill Aqueduct water. Low levels of trihalomethanes (within MCLs) were verified at the New Paltz WTP (personal communication with Bruce Keeping, New Paltz Water Treatment Plant Operator, August 7, 2003).

Thallium Analysis

In accordance with the June 18, 2003, Sampling Plan, treated water samples were selected for thallium analysis. This analysis was planned because thallium was detected in the raw water from the riser pipe at an estimated concentration above the MCL (2 μg/L) during the April 2003 sampling round. The Sampling Plan specified that one thallium test be conducted per raw water sample based on the highest lead concentration that was still below the action level. Therefore, the following samples were selected (lead concentration in parentheses):

- 0-ACH-M (7.01 μg/L), representing riser pipe sampling turnover volume 0 collected June 23, 2003 and a medium relative dose of ACH;

Table 3 Summary of Positive Analytical Results for Volatile Organic Analysis

Analyte — Sample ID: / Date:	25-ACH-H 07/21/03	25-ALUM-H 07/21/03	25-FERRIC-H 07/21/03	25-PAC-H 07/21/03	25-POLY-H 07/21/03	25-POLY-H/D 07/21/03	TRIP BLANK 07/21/03
VOCs by GC/MS Method 524.2 (μg/L)							
Trihalomethanes							
Bromodichloromethane	7.54	6.71	6.39	7.32	6.85	6.51	0.5 U
Chloroform	186	154	133	169	202	205	0.5 U
Chloromethane	0.123 J	0.121 J	0.327 J	0.149 J	0.202 J	0.190 J	0.5 U
Dibromochloromethane	0.464 J	0.330 J	0.284 J	0.405 J	0.310 J	0.317 J	0.5 U
Total Trihalomethanes	194	161	140	177	209	212	-
Other VOCs							
2-Butanone	11.9	11.3	13.9	10.9	10.6	9.94	5 U
4-Methyl-2-pentanone	8.19	7.74	9.41	8.99	6.83	6.29	5 U
Acetone	16.0	17.2	23.3	19.1	14.7	15.5	5 U
Carbon disulfide	0.5 U	0.5 U	0.5 U	0.231 J	0.5 U	0.5 U	0.5 U
Carbon tetrachloride	0.692	0.881	0.803	0.620	0.656	0.965	0.5 U
Chloroethane	0.5 U	0.5 U	0.150 J	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	2.63	2.51	2.66	2.68	2.47	2.19	0.5 U
Toluene	0.631	0.575	0.561	0.661	0.582	0.510	0.0900 J

Key:

GC/MS = Gas chromatography/mass spectrometry.
J = Estimated value.
U = Not detected (quantitation limit shown).
VOC = Volatile organic compound.
μg/L = Micrograms per liter.
/D = Duplicate sample.

ACH = aluminum chlorohydrate
ALUM = aluminum potassium sulfate
FERRIC = ferric chloride
PAC = polyaluminum chloride
POLY = cationic polymer

001002.UP02.03.06
Mohonk Road EPA524.2.xls: 9/16/2003

- 4-ALUM-L (7.45 µg/L), representing sampling turnover volume 4 collected June 23, 2003 and a low relative dose of alum; and
- 25-FERRIC-H (8.57 µg/L), representing sampling turnover volume 25 collected June 25, 2003 and a high relative dose of ferric chloride.

E & E also selected two additional samples for analysis. The results of the bench-scale treatability testing by USFilter show that different treatment chemicals have different effects on the resulting turbidity and lead levels. Two chemicals, PAC and ACH, showed better results than the other treatment chemicals and will most likely be the chemicals used in the water treatment process. Therefore, 4-PAC-M and 25-PAC-H were also selected for analysis. At sampling turnover volume 4, lead results for PAC and ACH were all non-detect; therefore, the medium dosage sample was selected because USFilter recommended this concentration for water treatment. At turnover volume 25, the only detectable lead was in the high dosage sample of PAC (25-PAC-H).

The five samples described above were submitted to E & E's ASC for thallium analysis by inductively coupled plasma / mass spectrometer Method 200.8. This method was selected to achieve detection limits low enough to meet the MCL of 2 µg/L. Analytical results are summarized in the following table:

Table 4 Analytical Results for Thallium

Sample ID	Thallium Concentration (µg/L)
0-ACH-M	0.096 J
4-ALUM-L	0.15 J
4-PAC-M	0.054 U
25-FERRIC-H	0.063 J
25-PAC-H	0.054 U

Key:
J = Estimated value (detected below the quantitation limit).
µg/L = Micrograms per liter.
U = Not detected (quantitation limit shown).

Two of the samples contained no detectable concentration of thallium (both samples treated with PAC). The other three samples contained only low-level thallium, below the MCL of 2 µg/L.

Sludge Production

USFilter estimated that the daily sludge production at the High Falls WTP would be between 2.6 and 13.4 pounds. This would equate to an annual sludge production of up to 5,000 pounds. Assuming that all lead will be removed from the water and backwashed to the lagoons with the sludge, E & E estimated the levels of lead expected to be in the sludge. Based on an influent lead concentration of 28 µg/L (the raw water lead level after four turnover volumes of the riser pipe was flushed), sludge lead levels would be as high as 7,700 mg/kg (dry weight), resulting in an estimated sludge production of 7 pounds per year.

Conclusions

Lead levels were highest in the raw water sample that was collected prior to flushing. After four flushes, lead levels were low enough to be treated below the action level of 15 µg/L in all cases with the exception of a high dose of ferric chloride. The USFilter Trident treatment system is capable of treating even the high concentration of lead detected in the initial raw water sample provided that the proper dose of the proper treatment chemical is added.

Two of the chemicals tested (PAC and ACH) were effective in reducing lead levels to below the action level. These chemicals reduced lead levels to below the action level for lead when added at the recommended dose for all raw water samples, and they produced the highest number of nondetect results. The other three chemicals tested (cationic polymer, ferric chloride, and alum) reduced lead levels to a lesser extent.

The dosages recommended by USFilter produced the lowest levels of turbidity and lead. However, increasing the chemical dose above the recommended value resulted in increased levels of turbidity and lead in the treated sample.

The treated water has the potential to generate disinfection by-products above New York State MCLs. This does not mean that treating the water will result in an MCL violation, but the potential to generate trihalomethanes exists if too much chlorine is added.

The treatment chemicals Alum, PAC, ACH, and ferric chloride were all effective at removing thallium from the raw water to concentrations below the MCL. PAC was most effective, resulting in non-detect levels in the two samples tested.

Recommendations

Recommendations will be included under separate cover in the Engineering Design Report.

Data Validation

An E & E quality control chemist reviewed all analytical data discussed in this memorandum for precision, accuracy, representativeness, completeness, and comparability. All analytical data are considered usable. No data qualifiers were added during validation with the exception of two sets of field duplicates that had poor relative percent differences for lead. Raw water samples 11-U and 11-U/D contained lead at 25.5 and 46.3 µg/L, respectively. Treated water samples 0-POLY-H and 0-POLY-H/D contained lead at 44.9 and 29.2 µg/L, respectively. Due to the variability in these results, all four results were flagged "J" as estimated. A data validation memorandum and original laboratory reports for the lead, chlorinated herbicide, and VOC analyses were provided under separate cover on August 7, 2003. USACE acknowledged acceptance of the data in correspondence dated August 19, 2003. A data validation memorandum and original laboratory report for the thallium analysis were provided under separate cover on August 19, 2003. USACE acknowledged acceptance of the data in correspondence dated August 26, 2003.

Chart 1
Total and Dissolved Lead Concentrations in Raw Water Riser Pipe Samples
Laboratory Analytical Results for June 23 - 25, 2003

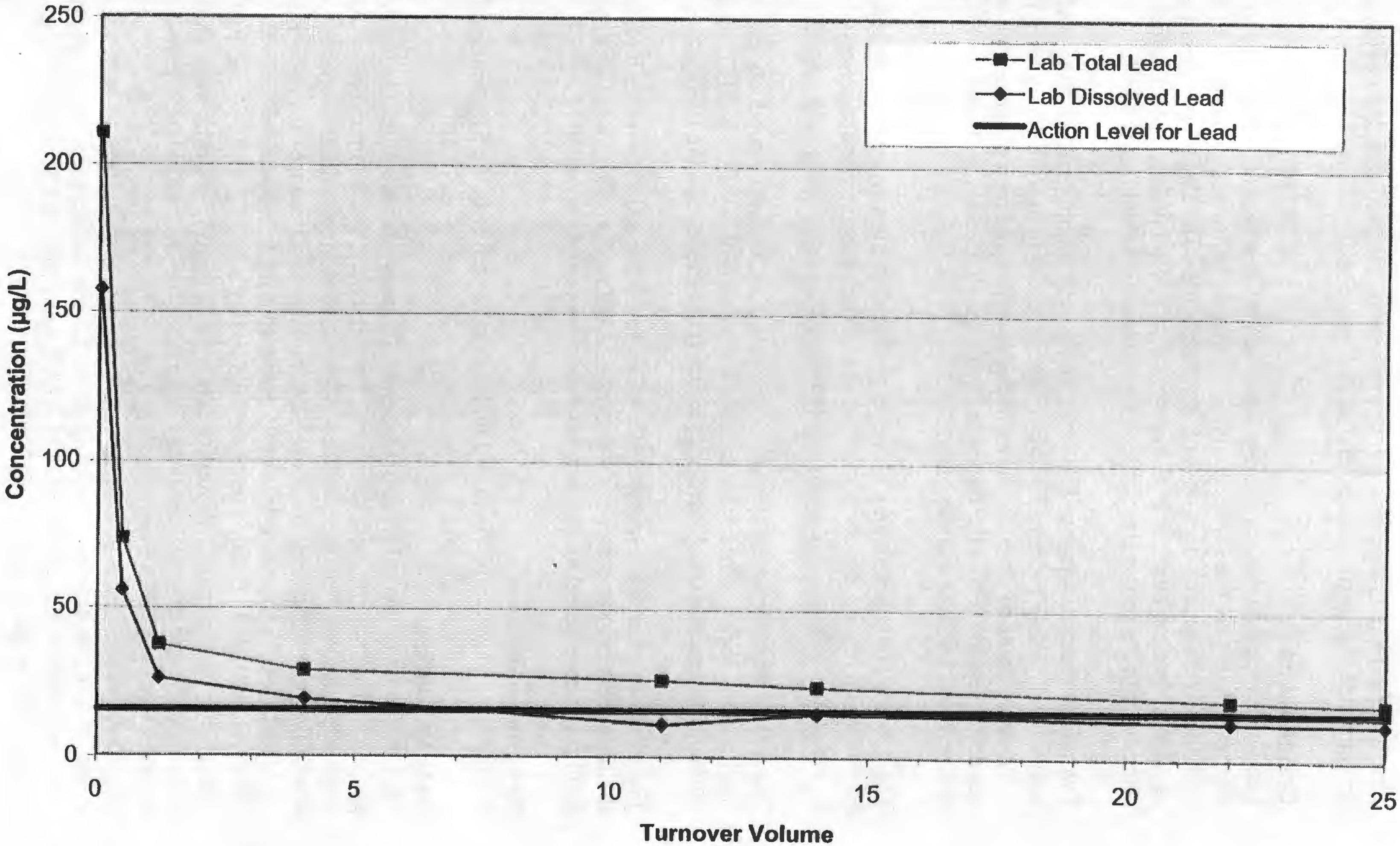
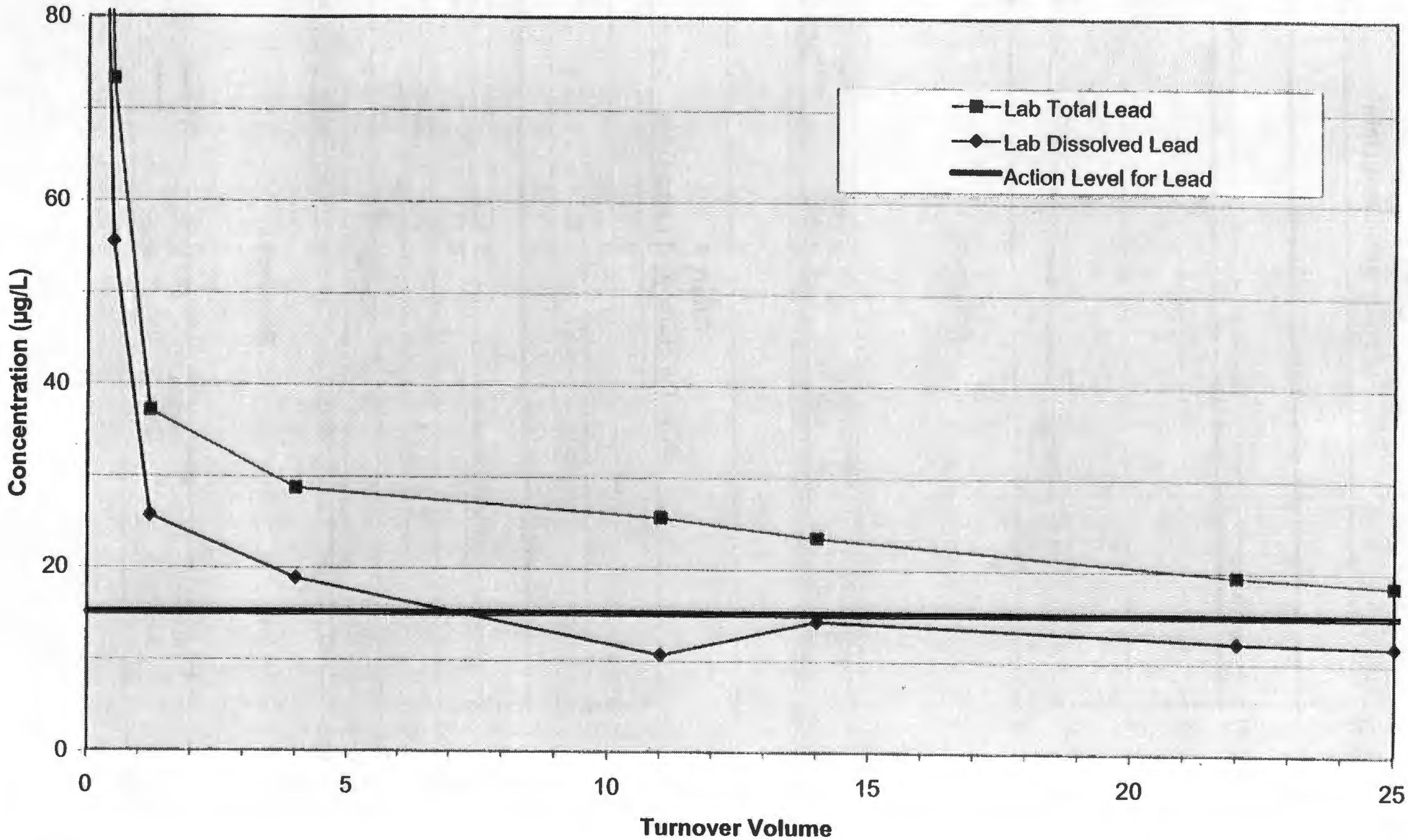
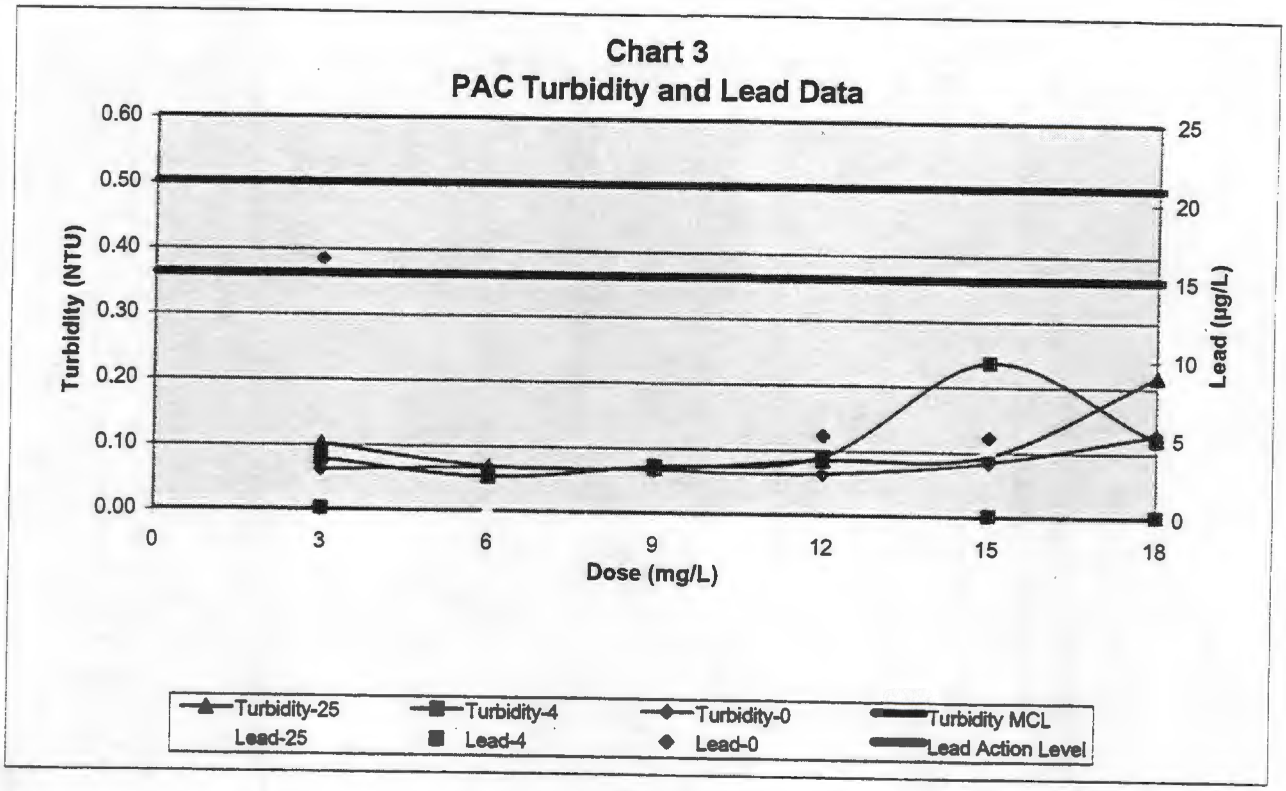


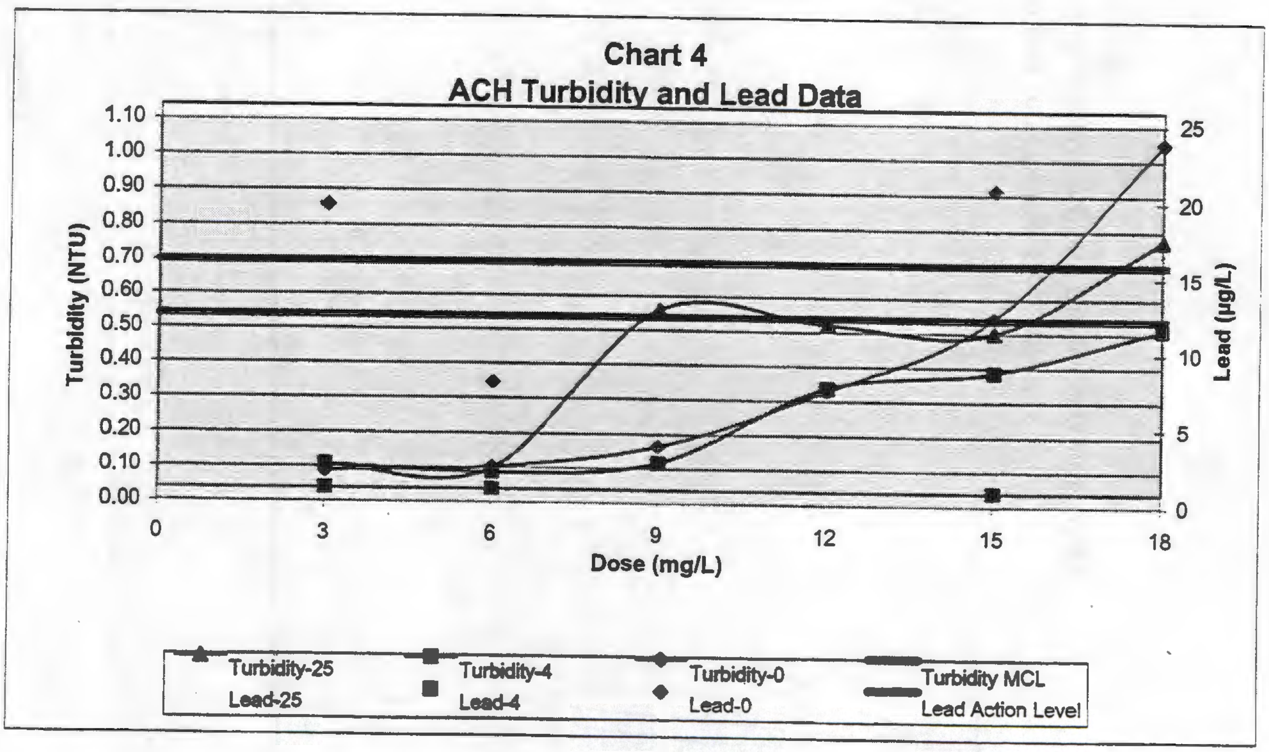
Chart 2
Total and Dissolved Lead Concentrations in Raw Water Riser Pipe Samples
Laboratory Analytical Results for June 23 - 25, 2003



E-61

001002.UP02.03.06
LeadData2.xls: 9/16/2003





001002.UP02.03.06
Turb and Lead Data.xls: 9/16/2003

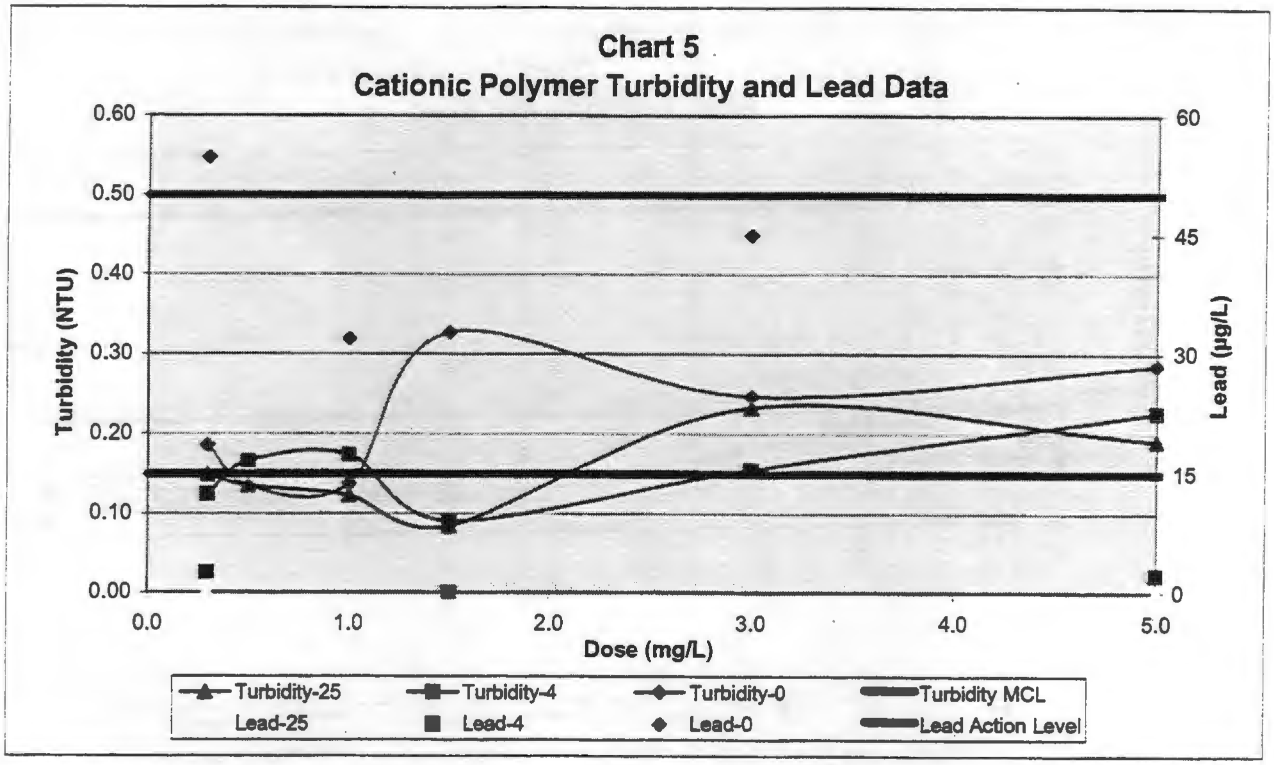


Chart 5
Cationic Polymer Turbidity and Lead Data
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Turbidity (NTU)
60
45
30
15
0
Lead (µg/L)
0.0
1.0
2.0
3.0
4.0
5.0
Dose (mg/L)
Turbidity-25
Turbidity-4
Turbidity-0
Turbidity MCL
Lead-25
Lead-4
Lead-0
Lead Action Level

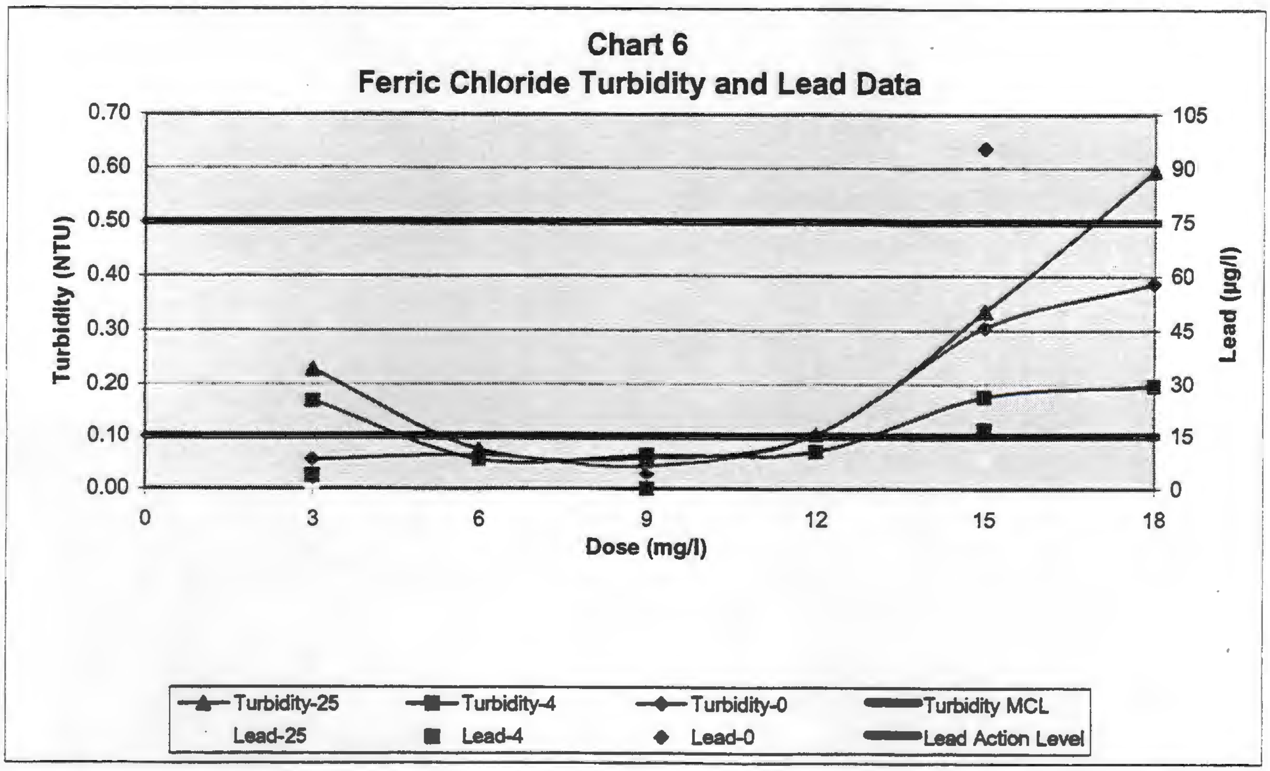
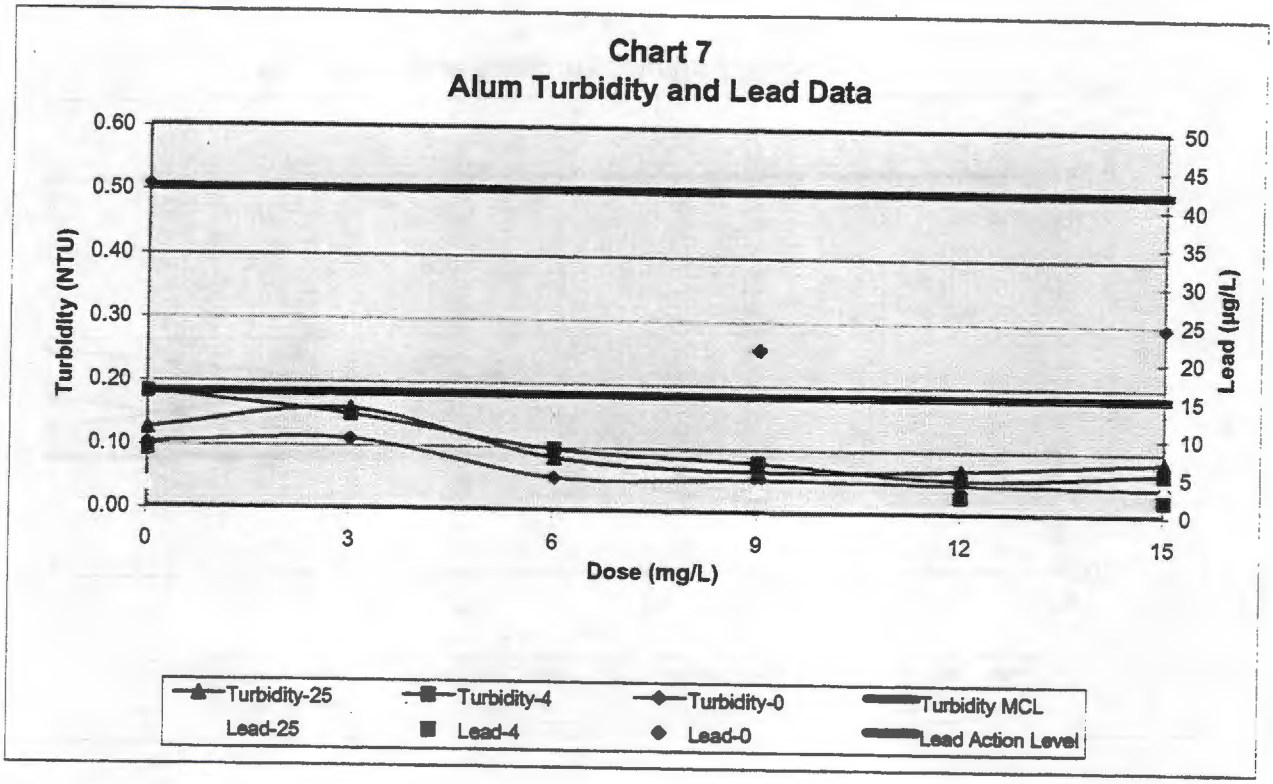


Chart 6
Ferric Chloride Turbidity and Lead Data
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Turbidity (NTU)
105
90
75
60
45
30
15
0
Lead (µg/l)
0
3
6
9
12
15
18
Dose (mg/l)
Turbidity-25
Turbidity-4
Turbidity-0
Turbidity MCL
Lead-25
Lead-4
Lead-0
Lead Action Level



001002.UP02.03.06
Turb and Lead Data.xls: 9/16/2003

Appendix A

USFilter Raw Water Analyses and Trident Treatability Report

USFilter

Raw Water Analyses & Trident Treatability Report

High Falls, NY

for

Ecology and Environment Engineering, P.C.

Prepared by:

Gerry Baker – Process Engineer

USFilter/Memcor – Ames, IA

Date:

July 29, 2003

USFilter Sample Nos. #03220, #03221, #03222

VEOLIA Environment

Table Of Contents

1 Introduction

The Town of High Falls is currently investigating treatment processes for the treatment of reservoir source, one of which is USFilter's Trident package treatment system. The existing piping that would be utilized for the proposed water treatment plant is lead-lined and has been determined to introduce lead into the water source at concentrations exceeding the maximum contaminant level (MCL). As a result of this condition, laboratory testing was conducted by USFilter in Ames, Iowa to investigate the effectiveness of the Trident treatment process to treat the lead in the surface water source.

A Trident treatability study was conducted on three raw water samples collected from the Ashokan Reservoir via the Catskill Aqueduct Siphon House in High Falls, NY. The samples were collected at three pipe turnover volumes (gallons) conditions. Results and conclusions based on the data are presented in this laboratory report.

2 Raw Water Qualities

Three raw water samples collected from the Ashokan Reservoir via the Catskill Aqueduct Siphon House in High Falls, NY following an initial flushing and shut down period. Once flow was resumed, three samples were collected at 135,200, 156,600, and 270,000 gallons of flow volume. The scope of the testing was to investigate coagulants for effective treatment, primarily for lead, under the Trident treatment process.

Initially, water analyses were performed on the three samples. The three samples general measured very similar water qualities. Table 1 summarizes the water qualities were measured:

Table 1 – Raw Water Qualities

Water Quality	0-U 6/23/03 08:05 USF # 03220	4-U 6/23/03 17:00 USF #03221	25-U 6/25/03 USF #03222
Turbidity; NTU	0.681	0.789	0.825
Color (App / True); cu	10 / 4	12 / 4	14 / 4
Iron; mg/L	0.009	0.014	0.017
Manganese; mg/L	0.015	0.015	0.014
pH	6.42	6.76	6.85
Alkalinity; mg/L (as $CaCO_3$)	24	24	24

Reference Appendix B - Water Analyses Report for complete details of the water samples.

3 Experiment

A laboratory testing/sampling protocol was established by Ecology and Environmental Engineering for the treatability investigation of the water source. The Jar Test method compared up to six water sample jars under various coagulants / dosages. Coagulants dosage range tested were based on the raw water quality. The following procedure was performed in conducting the treatability study.

- The Jar Test is conducted on a six-placed and Bird stirring apparatus.
- Beakers are filled with 500 ml of raw water.
- Various dosages of chemicals are quantitatively added to each beaker, followed by a 30-second rapid mix at high speed at 100 rpm.
- Six (6) minutes of slow mix flocculation at 20 rpm.
- Mixing is stopped; floc quality is observed and recorded.
- Treated water samples are then filtered through No. 2 Whatman filter paper, which simulates the mixed media filter used in the Trident system.
- The samples of filtrate are analyzed for turbidity, color, and pH.

Upon measurement of the filtrate water quality, based on turbidity and color, collection of samples for lead analysis were made at a low, medium, and high coagulant dosage for each of the five coagulants tested. Additionally, samples were collected for Trihalomethane formation potential (TMP) analyses from the high dosage for each of the five coagulants. The lead and TMP analyses were completed by Ecology and Environmental Engineering.

Reference Appendix A Ecology and Environmental Engineering's SAMPLING PLAN - SIPHON HOUSE WATER SAMPLING, ROUND 2; Mohonk Road Industrial Plant (MRIP) Site; High Falls, NY; Revision 2 June 18, 2003 for complete sampling and lab testing protocol details.

The jar test procedure is only a simulation of the treatment process. The jar test can provide information on effective chemicals and dosages for the treatment of the water being tested, but only a general estimation of clarifier and filter run lengths.

4 Results and Discussion

Jar tests were completed on the 0-U, 4-U, and 25-U samples to investigate five different coagulants for effective treatment of lead. Reference Appendix C for data sheets and graphs from the testing completed at USFilter/Ames laboratory.

The following is a listing of the five coagulants tested.

<u>Coagulants</u>

- Alum
- Ferric Chloride ($FeCl_3$)
- PAC (Westchlor FA 900S)
- ACH (Sumalchlor 50)
- Poly (EC 462)

Notes:
Alum; dry product
$FeCl_3$ – Ferric Chloride; Liquid 40% active & SG 1.4
PAC – Polyaluminum Chloride (PACl); Westchlor FA 900S; Liquid 30% active & SG 1.24
ACH – Aluminum Chlorohydrate; Sumalchlor 50; Liquid 50% active & SG 1.34
Poly – Technical Products EC 462; cationic polymer blend; low MW; Liquid 50%

Results:

Tables 2, 3, & 4 summarize the coagulant dosage selections for sample collection and the water qualities measured for the three water samples tested.

Table 2: 0-U 6/23/03 08:05 Sample

Coagulant	Dosage	Filtrate Qualities		
		Turbidity NTU	Color cu	pH
Alum	Low – 0 mg/L	0.100	3	6.88
	Med – 9 mg/L	0.049	0	6.47
	High – 15 mg/L	0.039	0	6.20
$FeCl_3$	Low – 3 mg/L	0.055	1	6.54
	Med – 9 mg/L	0.043	1	6.00
	High – 15 mg/L	0.305	17	4.43
PAC – FA 900S	Low – 3 mg/L	0.060	3	6.75
	Med – 12 mg/L	0.062	3	6.56
	High – 15 mg/L	0.082	3	6.52
ACH – Sumalchlor 50	Low – 3 mg/L	0.049	1	6.79
	Med – 9 mg/L	0.125	1	6.65
	High – 15 mg/L	0.505	4	6.60
Poly – EC 462	Low – 0.3 mg/L	0.186	5	6.77
	Med – 1.0 mg/L	0.137	2	6.70

	High – 5 mg/L	0.249	4	6.67

Table 3: 4-U 6/23/03 17:00 Sample

Coagulant	Dosage	Filtrate Qualities		
		Turbidity NTU	Color cu	pH
Alum	Low – 0 mg/L	0.180	5	6.88
	Med – 12 mg/L	0.051	0	6.34
	High – 15 mg/L	0.063	1	6.28
$FeCl_3$	Low – 3 mg/L	0.167	10	6.75
	Med – 6 mg/L	0.056	3	6.48
	High – 15 mg/L	0.175	6	4.52
PAC – FA 900S	Low – 3 mg/L	0.076	0	6.74
	Med – 6 mg/L	0.051	1	6.73
	High – 18 mg/L	0.118	1	6.52
ACH – Sumalchlor 50	Low – 3 mg/L	0.068	0	6.72
	Med – 6 mg/L	0.048	0	6.67
	High – 15 mg/L	0.348	1	6.71
Poly – EC 462	Low – 0.3 mg/L	0.125	4	6.89
	Med – 1.5 mg/L	0.091	2	6.79
	High – 5 mg/L	0.226	4	6.80

Table 4: 25-U 6/25/03 16:15 Sample

Coagulant	Dosage	Filtrate Qualities		
		Turbidity NTU	Color cu	pH
Alum	Low – 0 mg/L	0.123	4	6.85
	Med – 9 mg/L	0.062	2	6.58
	High – 15 mg/L	0.080	1	6.24
$FeCl_3$	Low – 3 mg/L	0.228	14	7.14
	Med – 9 mg/L	0.058	2	6.12
	High – 15 mg/L	0.335	12	4.68
PAC – FA 900S	Low – 3 mg/L	0.100	1	6.87
	Med – 6 mg/L	0.067	0	6.70
	High – 15 mg/L	0.092	1	6.62
ACH – Sumalchlor 50	Low – 3 mg/L	0.067	0	7.20
	Med – 6 mg/L	0.060	0	7.02
	High – 15 mg/L	0.462	2	6.78
Poly – EC 462	Low – 0.3 mg/L	0.149	4	6.95
	Med – 1.5 mg/L	0.084	2	6.93
	High – 5 mg/L	0.191	3	6.81

Discussion:

From the testing completed on the three samples, the following conclusions were made:

- All five coagulants achieved filtered water qualities of < 0.10 NTU turbidity and < 5 cu color.
- The optimum coagulant dosages were determined to be in the following ranges based on filtered turbidity and color levels:
    - Alum 6 – 9 mg/L
    - FeCl3 6 – 9 mg/L
    - PAC - FA 900S 6 – 9 mg/L
    - ACH - Sumalchlor 50 6 – 9 mg/L
    - Poly – EC 462 1.0 – 1.5 mg/L
- Ferric chloride had the most pH suppression effect of all the coagulants tested. EC 462 measured the least impact to pH.
- Floc formation was observed to be minimal to none. Alum and ferric chloride generally produced the most visible floc formation.
- Lead and TMP results were not available at the time of this report.
- A nonionic high MW filter aid polymer is typically used along with a coagulant in Trident applications to assist in floc formation and filterability. Dosages typically range from 0.0[illegible] 0.3 mg/L.

5 Summary

The water analyses for the three water samples collected under increasing pipe turnover conditions measured similar water quality; all generally low in turbidity, color, iron and manganese. Based on the jar test results for the testing completed on the three samples, all five coagulants achieved excellent treatment performance under a simulated Trident treatment process, with turbidities < 0.10 NTU and colors < 5 cu. Iron and manganese were not found to be treatment issue. Effective dosages for alum, ferric chloride, FA 900S PACl, and Sumalchlor 50 ACH were determined to be in the range of 6 – 9 mg/L. EC 462 cationic polymer coagulant dosage was in the range of 1.0 – 1.5 mg/L.

Conclusions of the treatment performance of lead and TMP are to be determined based on completion of the analyses by Ecology and Environmental Engineering.

Again, the jar testing conducted is only a simulation of the treatment process. Typically, equal or better effluent quality results with the full-scale treatment system. On-site chemical demands typically differ as compared to those identified through jar testing, resulting in the need to fine-tune the chemical dosages for optimum on-site performance. Proper monitoring of the chemical feed usually ensures acceptable effluent qualities are met and maintained.

6 Sludge Projection Estimation

Based on the jar test results and conclusions, some general estimation was made for sludge production for the proposed Trident treatment system at High Falls, NY. While this is a conservative estimation, it should be emphasized that this is only an estimation. The actual sludge production will likely differ based on the actually on-site raw water conditions, chemical treatment scheme, and operational performance of the full-scale unit.

For this project, the sludge production estimation was based on the following:

- Raw water qualities from USFilter Analyses #03220, #03221, & #03222; i.e. 1.0 NTU, 5 true cu, 0.02 mg/L iron, and 0.015 mg/L manganese.
- Coagulants of alum, ferric chloride, FA 900S PAC, & Sumalchlor 50 ACH at dosages of 6 mg/L and 15 mg/L. EC 462 at 1.0 mg/L and 1.5 mg/L.
- Trident TR-105A Treatment System – 17.5 sqft Clarifier & 35 sqft Filter
- 85,000 gpd (60 gpm) flow rate.
- 70% removal rate through clarifier.
- 24 hour clarifier flush frequency & 48 hour filter runs.
- Clarifier flush @ 10 gpm/sqft for 10 minutes; Filter backwash @ 15 gpm/sqft for 8 minutes.

Based on the assumptions outlined above, sludge production volume would be estimated at:

- Clarifier flush volume per flush: 1,750 gallons; 3,500 gallons per filter run
- Filter backwash volume: 4,200 gallons
- Total waste volume per run cycle: 7,700 gallons
- Clarifier flush waste percentage: 2.0%

- Filter backwash waste percentage: 2.5%
- Total waste volume percentage: 4.5%
- Coagulated solids: 3.6 – 18.6 mg/L
- Total solids: 2.6 – 13.4 lbs/day

Note: Ferric chloride at the higher dosages would increase sludge production, along with reduce clarifier and filter run lengths, the most of all the coagulants tested.

APPENDIX A

Ecology & Environment Engineering - SAMPLING PLAN

(Not included as part of the EDR)

APPENDIX B

Raw Water Analyses – 0-U, 4-U, & 25-U

WATER ANALYSIS REPORT

USFilter

Ames, IA

Job Name: High Falls NY

Distribute Report to: Ecology And Environment, Inc.

USF Sample No.:		03220	03221	03222			
Date Collected		6/23/03	6/23/03	6/25/03			
Calcium	mg/L as CaCO3	12	12	12			
Magnesium	mg/L as CaCO3	4	4	8			
Sodium	mg/L as CaCO3	35.2	37.2	35			
Alkalinity (M)	mg/L as CaCO3	24	24	24			
Alkalinity (P)	mg/L as CaCO3	0	0	0			
Sulfate	mg/L as CaCO3	16	18	17			
Chloride	mg/L as CaCO3	11.2	11.2	14			
Total Hardness	mg/L as CaCO3	16	16	20			
Non Carbonate Hardness	mg/L as CaCO3	0	0	0			
Free Carbon Dioxide	mg/L as CO2	7	7	16			
Iron (Total)	mg/L as Fe	0.009	0.014	0.017			
Manganese (Total)	mg/L as Mn	0.015	0.015	0.014			
pH		6.42	6.76	6.85			
pH of Saturation*		9.81	9.81	9.81			
Turbidity	NTU	0.681	0.789	0.825			
Apparent Color	PtCo	10	12	14			
True Color (0.45 μm)		4	4	4			
TDS	mg/L	32.7	30.6	30			

*As received at USF/Ames

Sample Description for: 03220 Raw - 0-U; 6/23/03 08:05

Sample Description for: 03221 Raw - 4-U; 6/23/03 17:00

Sample Description for: 03222 Raw - 25-U; 6/25/03 16:15

VEOLIA Environment

Analyst	Date
DRH	6/27/03

APPENDIX C

Jar Test Data Sheets & Graphs – 0-U, 4-U, & 25-U

JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
USF Sample Number: #03220
Sample Description: 0-U; Raw - 6/23/03 @ 08:05
Jar Test No. 4
Test Objective: Trident Treatment Process

		Chemical dosages in ppm																					
		Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	ACH									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
19	1	3									1	C		0.049	6.79	1							
20	2	6									1	C		0.064	6.72	1							
21	3	9									1	C		0.125	6.65	1							
22	4	12									1	C		0.289	6.74	3							
23	5	15									1	C		0.505	6.60	4							
24	6	18									1	C		1.010	6.64	6							

Flash mix time 30 seconds @ 100 rpm
500 mL samples
Sample Temperature; °C 23
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: ACH - Aluminum Chlorohydrate
ACH - Sumalchlor 50; Liquid, 50% & 1.34 SG
Jar #1 - 3 mg/L ACH sample collected for L dose lab sample
Jar #3 - 9 mg/L ACH sample collected for M dose lab sample
Jar #5 - 15 mg/L ACH sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

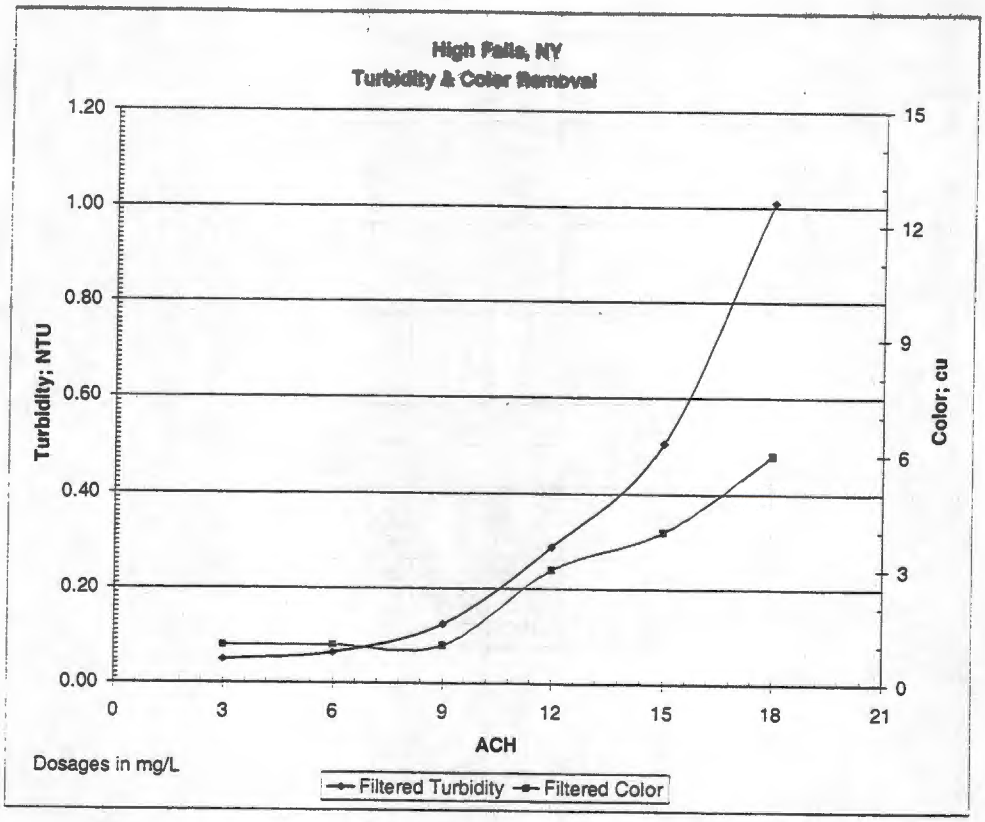
7/15/2003
Date

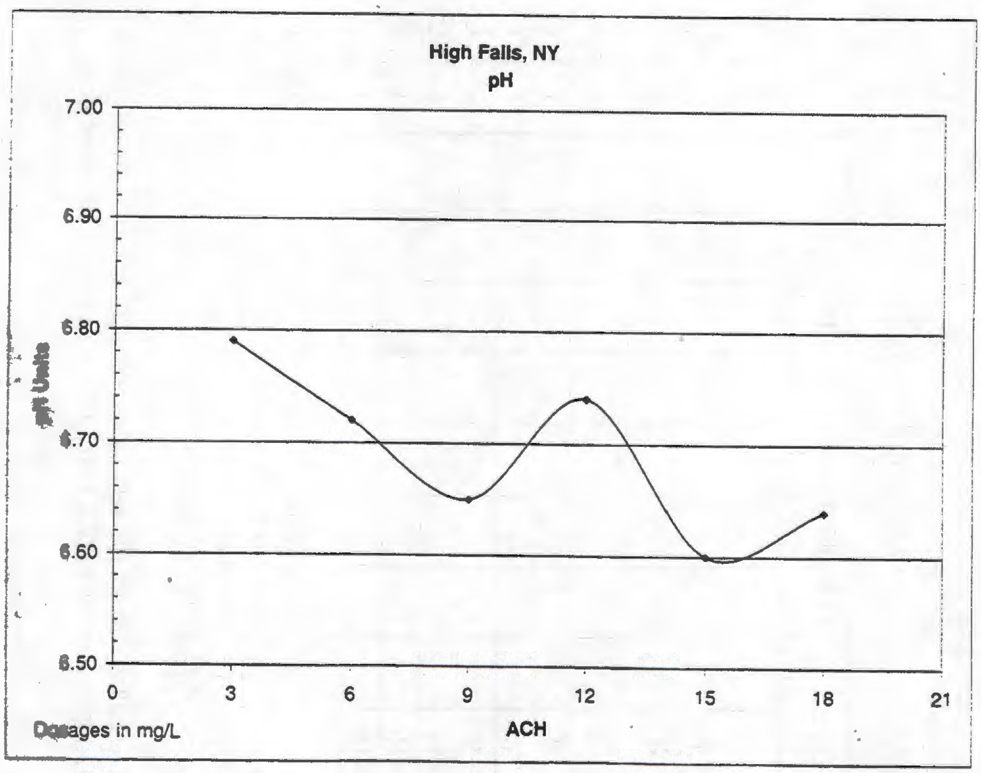
Sheet: 4 of 5

High Falls, NY Sample 0-U; 6/23/03 08:05

USFilter Sample No. 03220

Jar Testing with ACH (Sumalchlor 50) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 0-U; Raw - 6/23/03 @ 08:05
Test Objective: Trident Treatment Process

USF Sample Number: #03220
Jar Test No. 1

		Chemical dosages in ppm									Observations			Analysis Results										
		Coagulants			Oxidants		pH/Alk Adj		Polymers															
Test #	Jar #	Alum									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo								
1	1	0									1	C		0.100	6.88	3								
2	2	3									1	C		0.107	6.84	2								
3	3	6									2	C		0.049	6.70	1								
4	4	9									1-2	C		0.049	6.47	0								
5	5	12									1-2	C		0.044	6.35	0								
6	6	15									2	C		0.039	6.20	0								

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:
Alum - Dry product; Dosing based on 0.5% by wt solution
Jar #1 - 0 mg/L alum sample collected for L dose lab sample
Jar #4 - 9 mg/L alum sample collected for M dose lab sample
Jar #6 - 15 mg/L alum sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

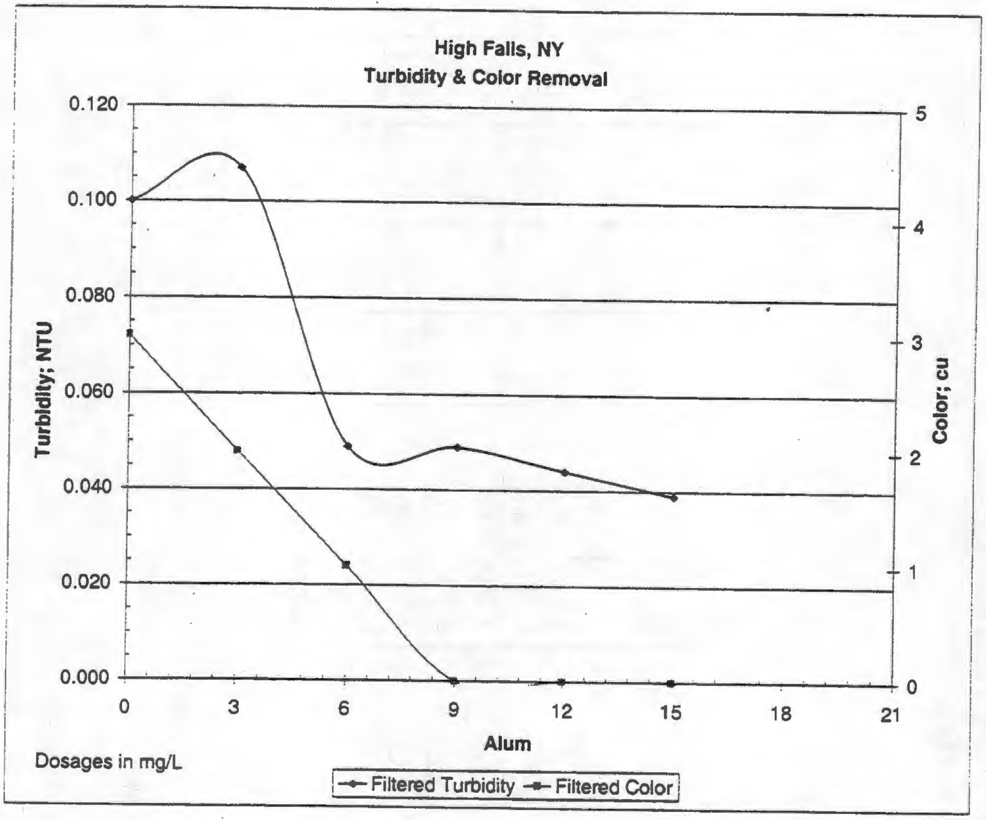
7/14/2003
Date

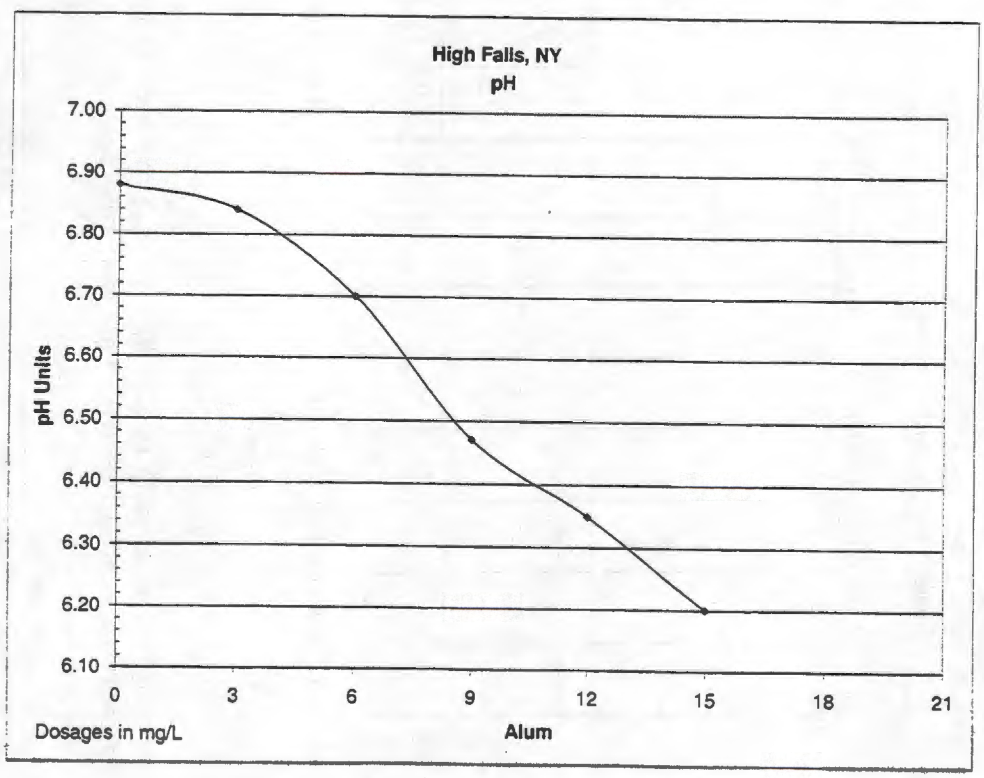
Sheet: 1 of 5

High Falls, NY Sample 0-U; 6/23/03 08:05

USFilter Sample No. 03220

Jar Testing with Alum coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY

USF Sample Number: #03220

Sample Description: 0-U; Raw - 6/23/03 @ 08:05

Jar Test No. 2

Test Objective: Trident Treatment Process

		Chemical dosages in ppm																					
		Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	Ferric Chloride									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
7	1	3									1	C		0.055	6.54	1							
8	2	6									1	C		0.064	6.47	1							
9	3	9									1	C		0.043	6.00	1							
10	4	12									1	C		0.102	4.58	7							
11	5	15									1	C		0.305	4.43	17							
12	6	18									1	C		0.386	3.87	17							

Flash mix time 30 seconds @ 100 rpm

Floc mix time 6 minutes @ 20 rpm

Settling time 0 minutes @ 0 rpm

Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)

**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:

Ferric Chloride ($FeCl_3$) - Liquid; 39% & 1.43 SG

Jar #1 - 3 mg/L ferric sample collected for L dose lab sample

Jar #3 - 9 mg/L ferric sample collected for M dose lab sample

Jar #5 - 15 mg/L ferric sample collected from H dose lab sample

Little to no floc formation observed

DRH
Analyst

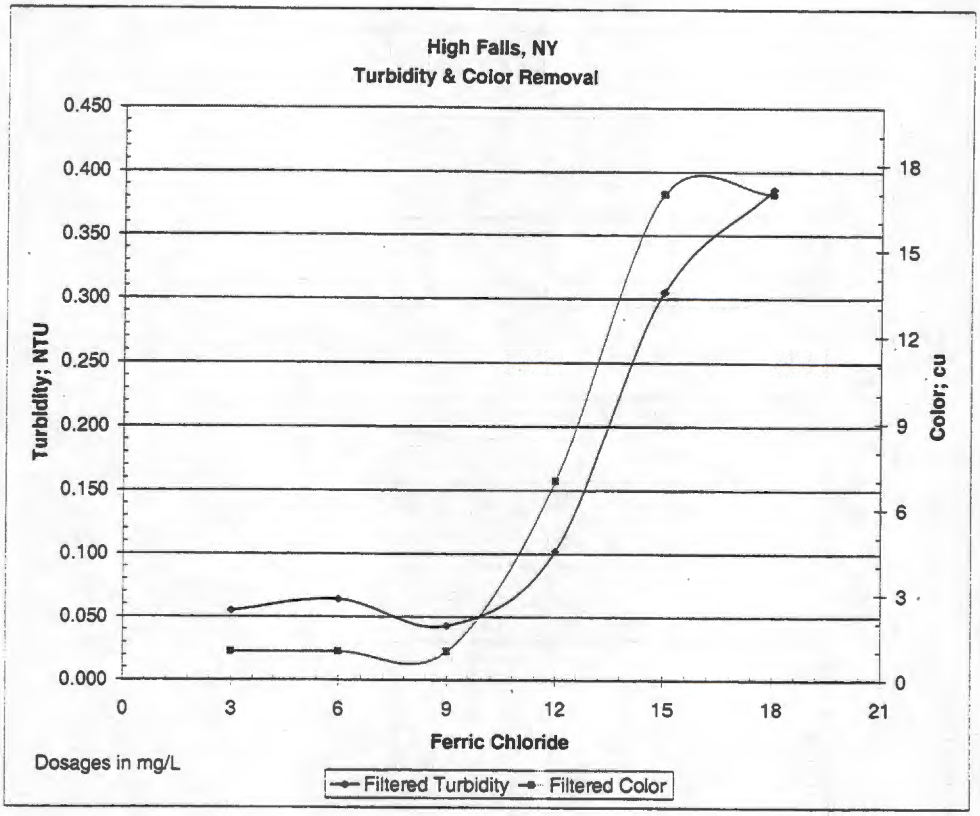
7/14/2003
Date

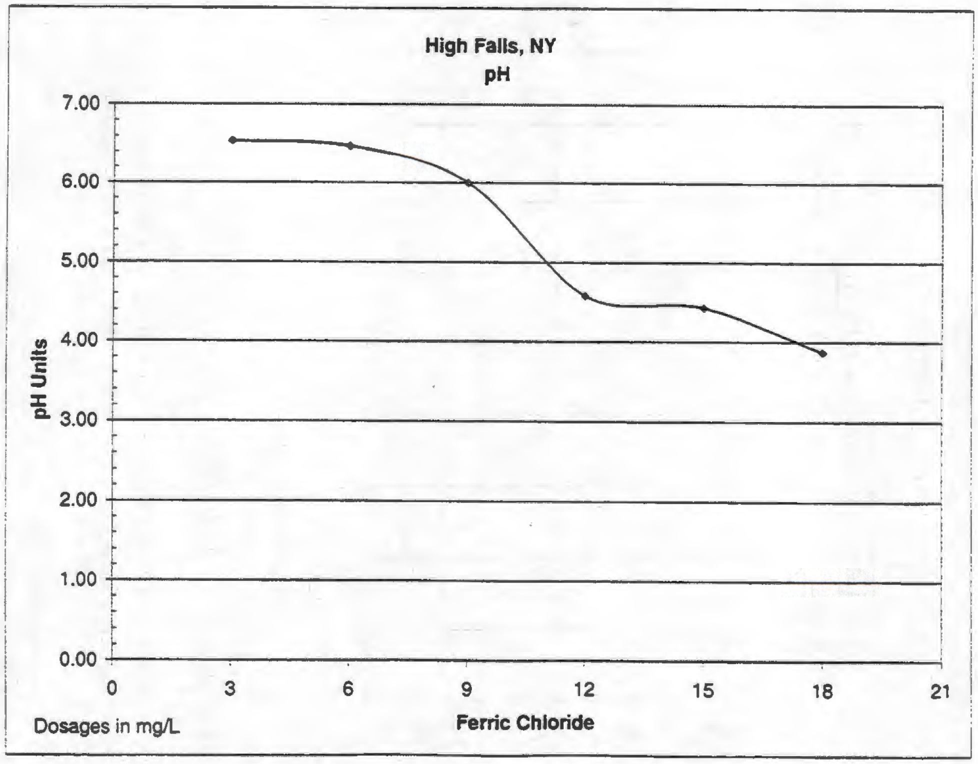
Sheet: 2 of 5

High Falls, NY Sample 0-U; 6/23/03 08:05

USFilter Sample No. 03220

Jar Testing with Ferric Chloride coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 0-U; Raw - 6/23/03 @ 08:05
Test Objective: Trident Treatment Process

USF Sample Number: #03220
Jar Test No. 3

		Chemical dosages in ppm									Observations			Analysis Results									
		Coagulants			Oxidants		pH/Alk Adj		Polymers														
Test #	Jar #	PAC									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
13	1	3									1	C		0.060	6.75	3							
14	2	6									1	C		0.065	6.80	3							
15	3	9									1	C		0.064	6.61	3							
16	4	12									1	C		0.062	6.56	3							
17	5	15									1	C		0.082	6.52	3							
18	6	18									1	C		0.126	6.43	3							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: PAC - Polyaluminum Chloride (PACl)
PACl - Westchlor FA 900S; Liquid, 20-40% & 1.24 SG; 30% Assumed!!
Jar #1 - 3 mg/L PAC sample collected for L dose lab sample
Jar #4 - 12 mg/L Pac sample collected for M dose lab sample
Jar #5 - 15 mg/L PAC sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

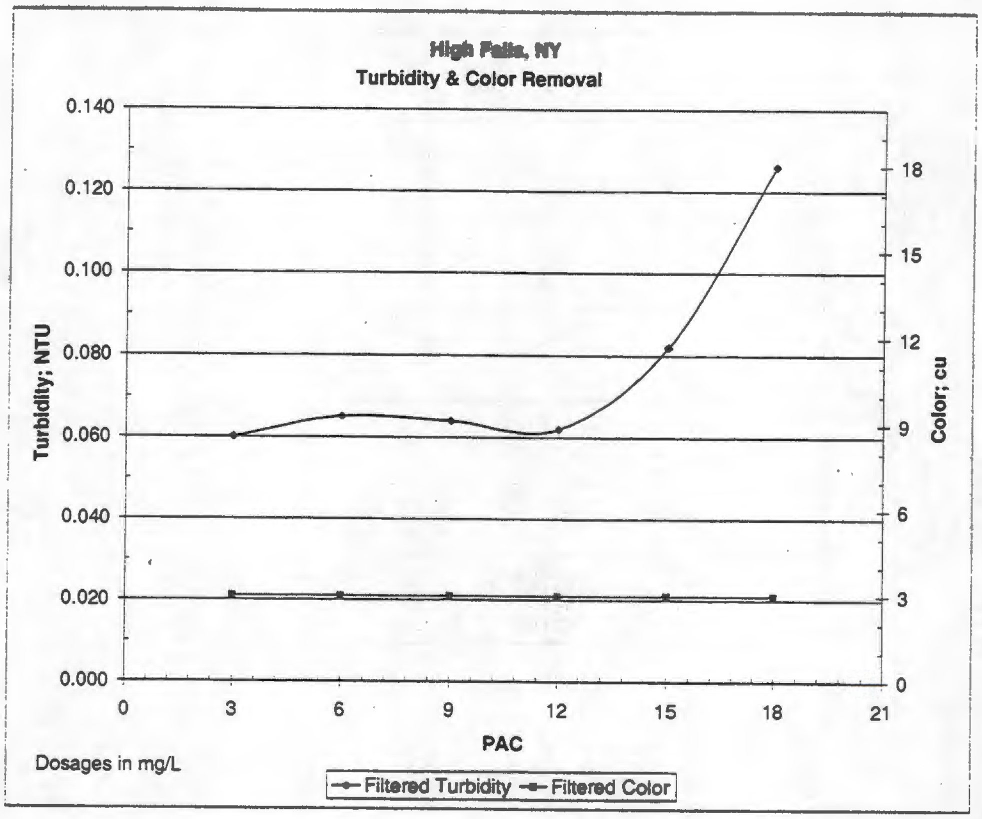
7/16/2003
Date

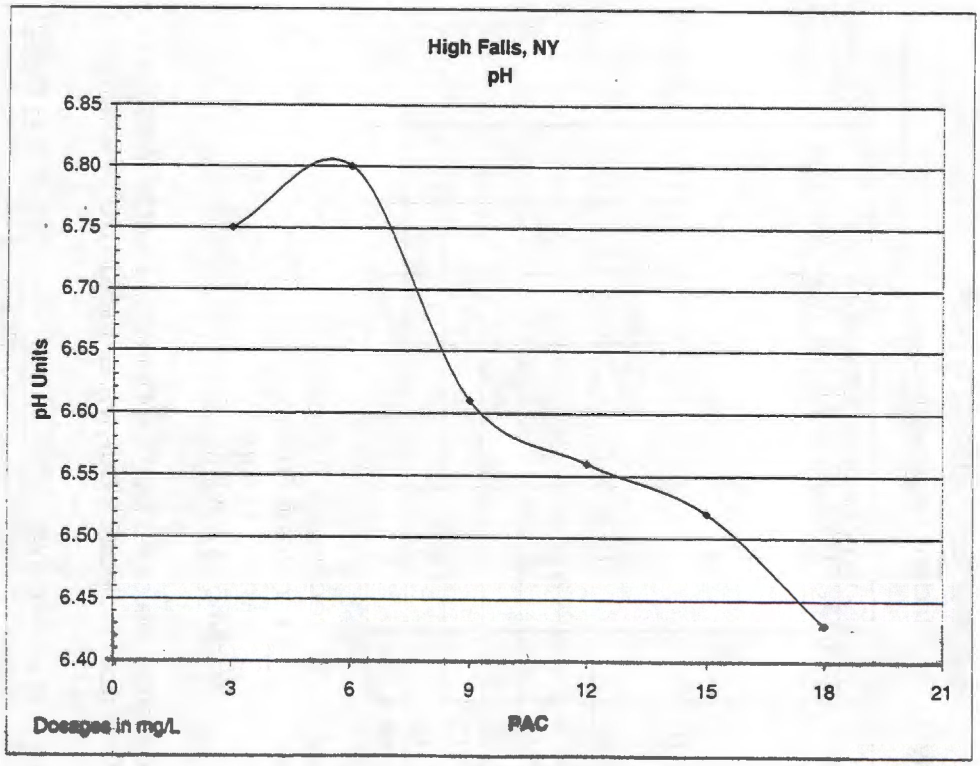
Sheet: 3 of 5

High Falls, NY Sample 0-U; 6/23/03 08:05

USFilter Sample No. 03220

Jar Testing with PACl (FA 900S) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 0-U; Raw - 6/23/03 @ 08:05
Test Objective: Trident Treatment Process

USF Sample Number: #03220
Jar Test No. 5

		Chemical dosages in ppm: Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	Poly									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
25	1	0.3									1	C		0.186	6.77	5							
26	2	0.5									1	C		0.135	6.67	3							
27	3	1.0									1	C		0.137	6.70	2							
28	4	1.5									1	C		0.327	6.67	4							
29	5	3.0									1	C		0.247	6.67	4							
30	6	5.0									1	C		0.285	6.67	4							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: Poly - Cation Polymer Coagulant
Poly - EC 462; Liquid, 50% & 1.22 SG
Jar #1 - 0.3 mg/L poly sample collected for L dose lab sample
Jar #3 - 1.0 mg/L Poly sample collected for M dose lab sample
Jar #5 - 3.0 mg/L Poly sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

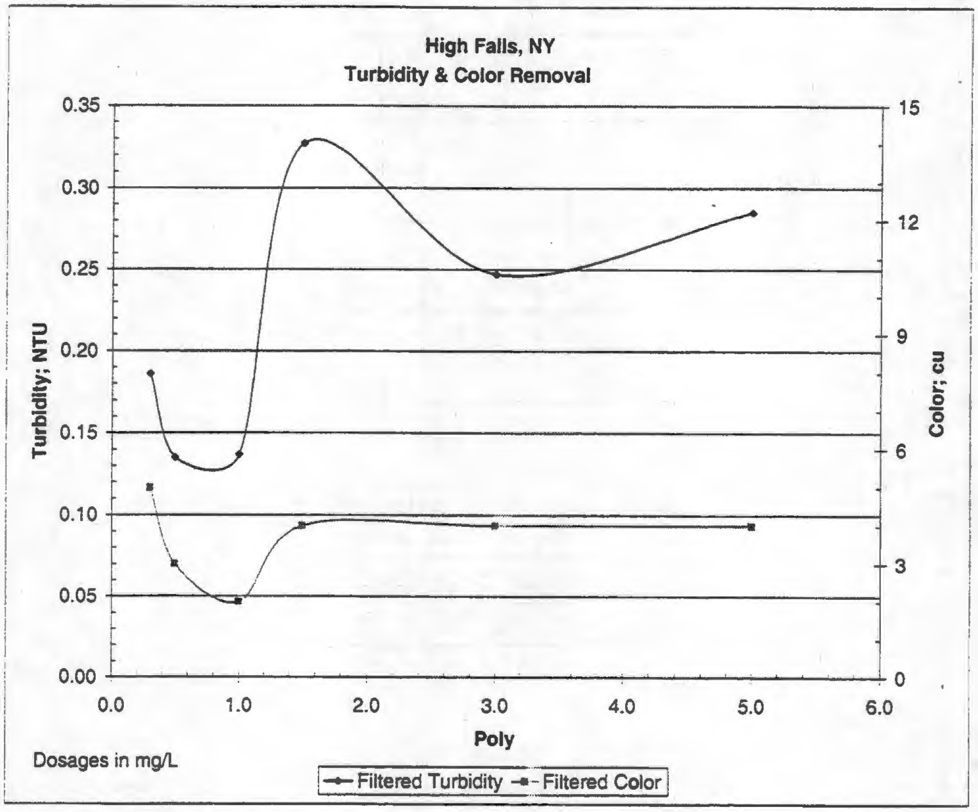
7/15/2003
Date

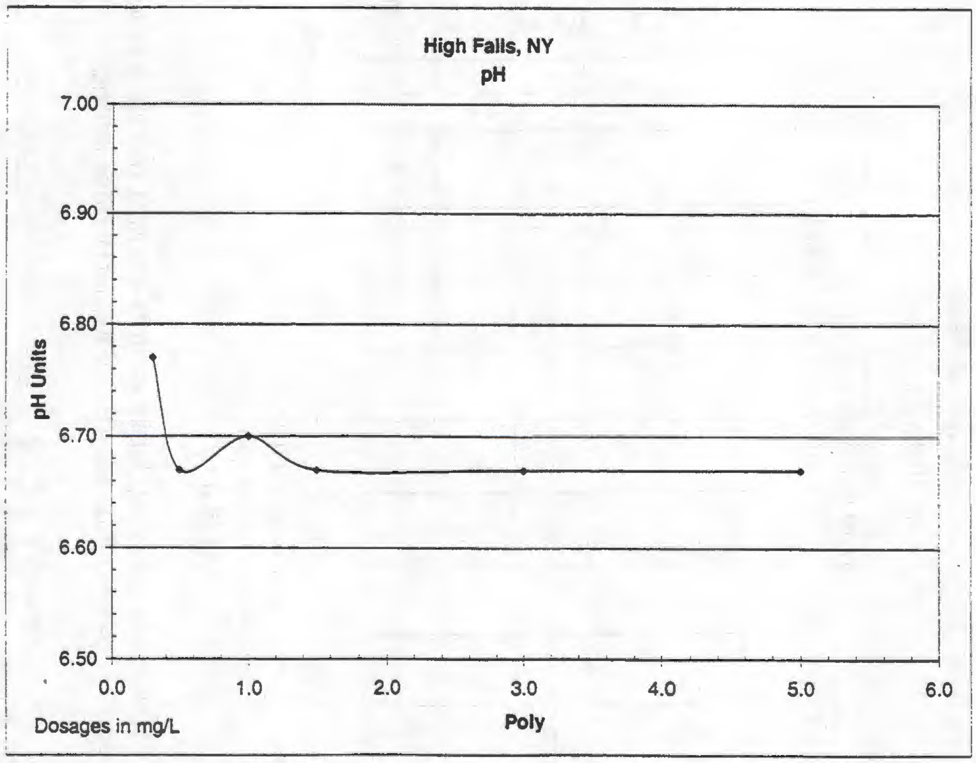
Sheet: 5 of 5

High Falls, NY Sample 0-U; 6/23/03 08:05

USFilter Sample No. 03220

Jar Testing with Poly (Technical Products EC 462) Cation Polymer coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
USF Sample Number: #03222
Sample Description: 25-U; Raw - 6/25/03 @ 16:15
Jar Test No. 4
Test Objective: Trident Treatment Process

		Chemical dosages in ppm									Observations			Analysis Results									
		Coagulants			Oxidants		pH/Alk Adj		Polymers														
Test #	Jar #	ACH									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
19	1	3									1	C		0.067	7.20	0							
20	2	6									1-2	C		0.060	7.02	0							
21	3	9									1-2	C		0.521	6.82	2							
22	4	12									1-2	C		0.483	6.86	2							
23	5	15									1-2	C		0.462	6.78	2							
24	6	18									1-2	C		0.735	6.69	3							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: ACH - Aluminum Chlorohydrate
ACH - Sumalchlor 50; Liquid, 50% & 1.34 SG
Jar #1 - 3 mg/L ACH sample collected for L dose lab sample
Jar #2 - 6 mg/L ACH sample collected for M dose lab sample
Jar #5 - 15 mg/L ACH sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

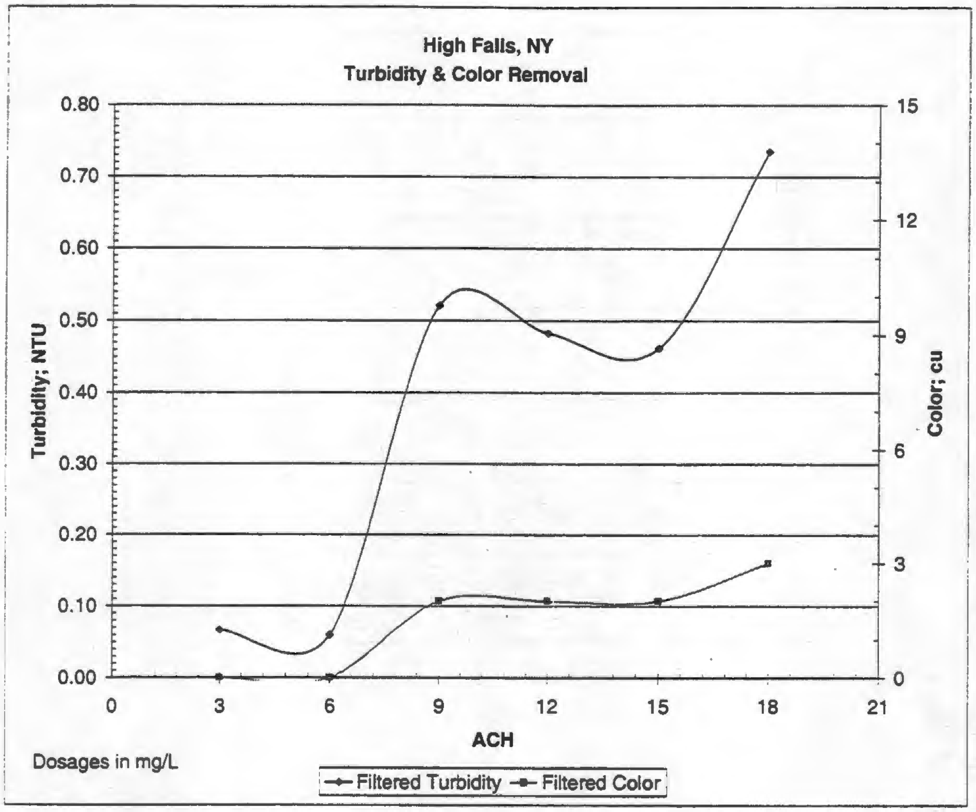
7/21/2003
Date

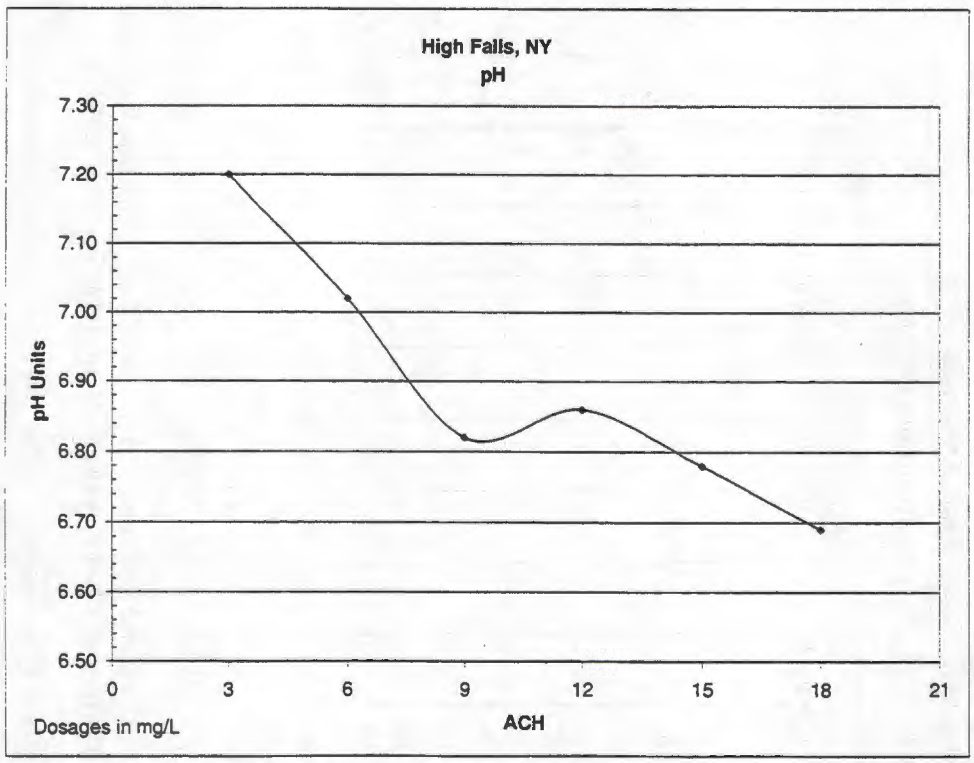
Sheet: 4 of 5

High Falls, NY Sample 25-U; 6/25/03 16:15

USFilter Sample No. 03222

Jar Testing with ACH (Sumalchlor 50) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 25-U; Raw - 6/25/03 @ 16:15
Test Objective: Trident Treatment Process

USF Sample Number: #03222
Jar Test No. 1

		Chemical dosages in ppm									Observations			Analysis Results									
		Coagulants			Oxidants		pH/Alk Adj		Polymers														
Test #	Jar #	Alum									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
1	1	0									1	C		0.123	6.85	4							
2	2	3									1	C		0.154	6.74	4							
3	3	6									1-2	C		0.080	6.65	2							
4	4	9									1-2	C		0.062	6.58	2							
5	5	12									2	C		0.066	6.45	2							
6	6	15									1-2	C		0.080	6.24	1							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:
Alum - Dry product; Dosing based on 0.5% by wt solution
Jar #1 - 0 mg/L alum sample collected for L dose lab sample
Jar #4 - 9 mg/L alum sample collected for M dose lab sample
Jar #6 - 15 mg/L alum sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

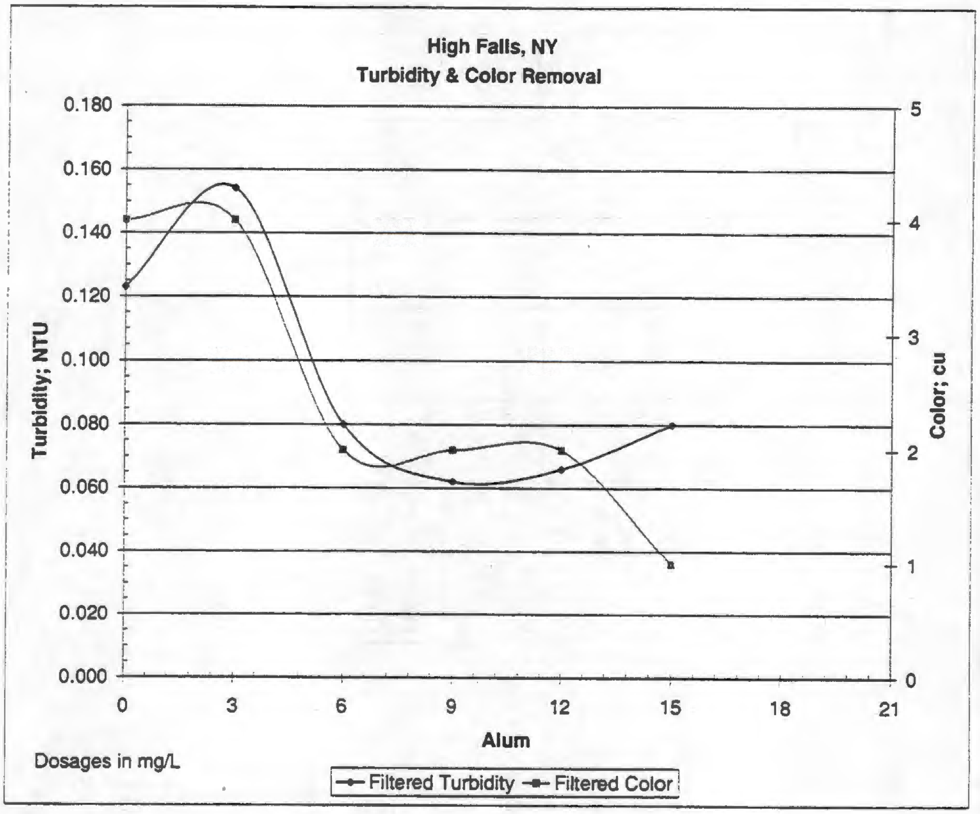
7/21/2003
Date

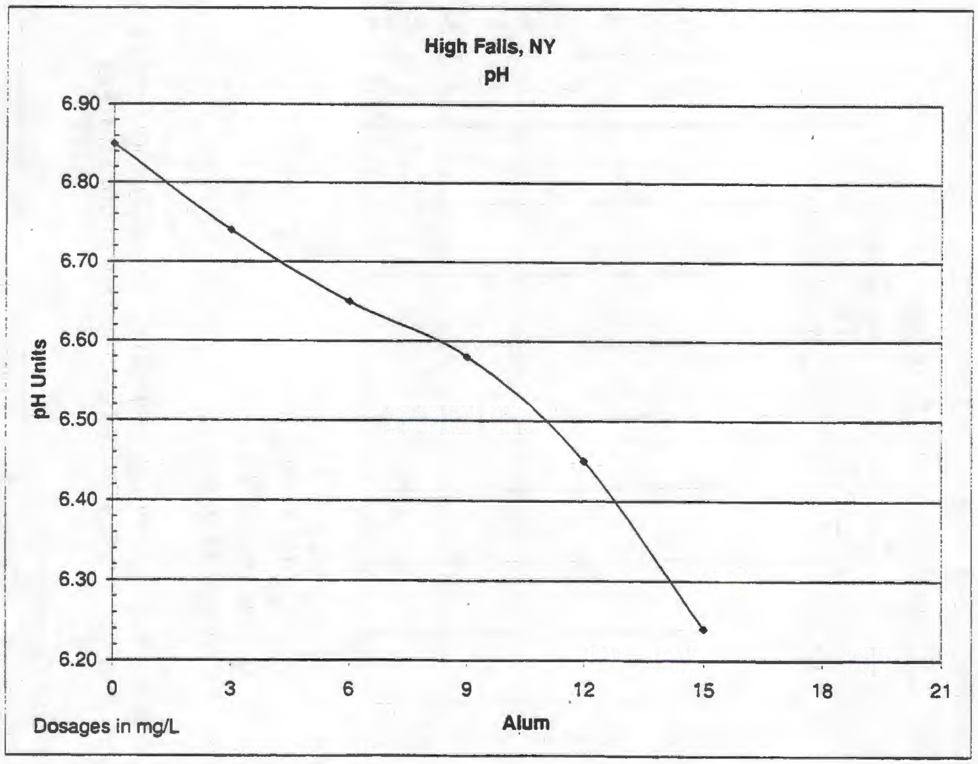
Sheet: 1 of 5

High Falls, NY Sample 0-U; 6/25/03 16:15

USFilter Sample No. 03222

Jar Testing with Alum coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 25-U; Raw - 6/25/03 @ 16:15
Test Objective: Trident Treatment Process

USF Sample Number: #03222
Jar Test No. 2

		Chemical dosages in ppm									Observations			Analysis Results									
		Coagulants			Oxidants		pH/Alk Adj		Polymers														
Test #	Jar #	Ferric Chloride									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
7	1	3									1	C		0.228	7.14	14							
8	2	6									1	C		0.075	6.80	2							
9	3	9									1-2	C		0.058	6.12	2							
10	4	12									1-2	C		0.103	5.56	1							
11	5	15									1-2	C		0.335	4.68	12							
12	6	18									1	C		0.595	4.25	30							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:
Ferric Chloride ($FeCl_3$) - Liquid; 39% & 1.43 SG
Jar #1 - 3 mg/L ferric sample collected for L dose lab sample
Jar #3 - 9 mg/L ferric sample collected for M dose lab sample
Jar #5 - 15 mg/L ferric sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

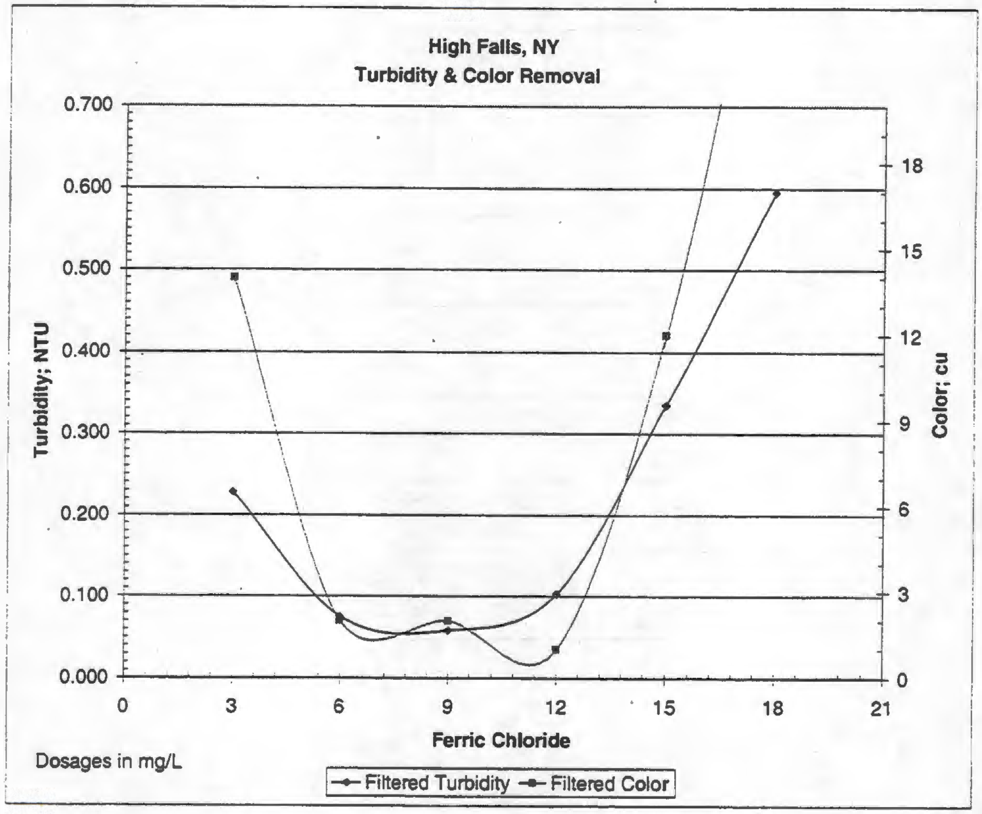
7/21/2003
Date

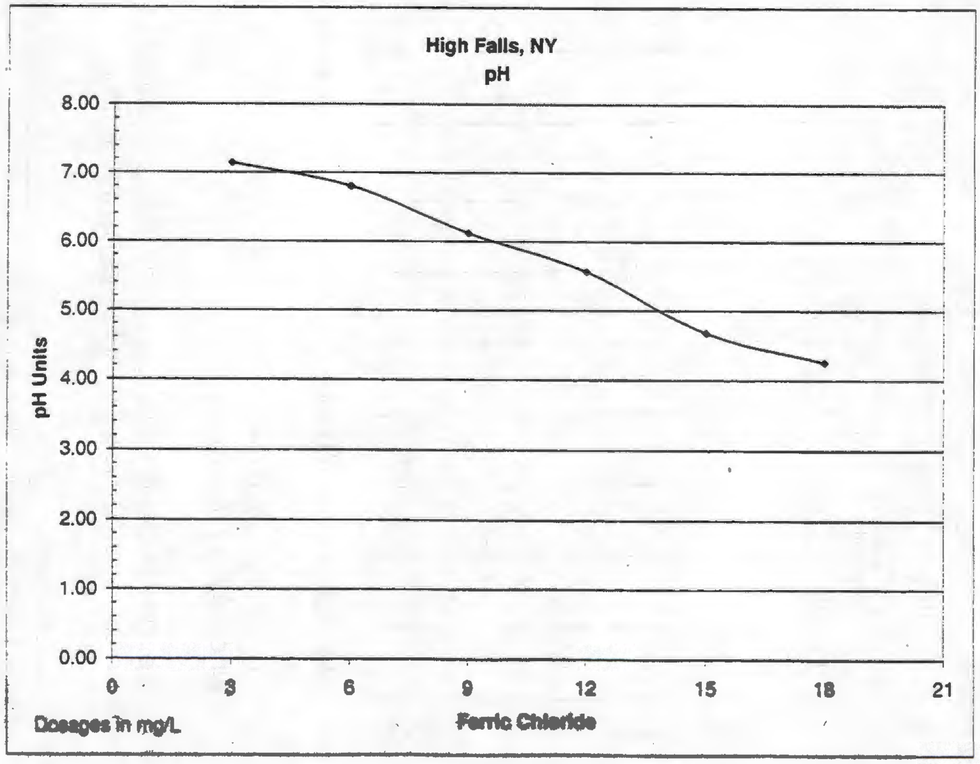
Sheet: 2 of 5

High Falls, NY Sample 25-U; 6/25/03 16:15

USFilter Sample No. 03222

Jar Testing with Ferric Chloride coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 25-U; Raw - 6/25/03 @ 16:15
Test Objective: Trident Treatment Process

USF Sample Number: #03222
Jar Test No. 3

		Chemical dosages in ppm: Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	PAC									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
13	1	3									1	C		0.100	6.87	1							
14	2	6									1-2	C		0.067	6.70	0							
15	3	9									2	C		0.067	6.71	0							
16	4	12									1-2	C		0.083	6.67	0							
17	5	15									1-2	C		0.092	6.62	1							
18	6	18									1	C		0.214	6.59	2							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: PAC - Polyaluminum Chloride (PACl)
PACl - Westchlor FA 900S; Liquid, 20-40% & 1.24 SG; 30% Assumed!!
Jar #1 - 3 mg/L PAC sample collected for L dose lab sample
Jar #2 - 6 mg/L Pac sample collected for M dose lab sample
Jar #5 - 15 mg/L PAC sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

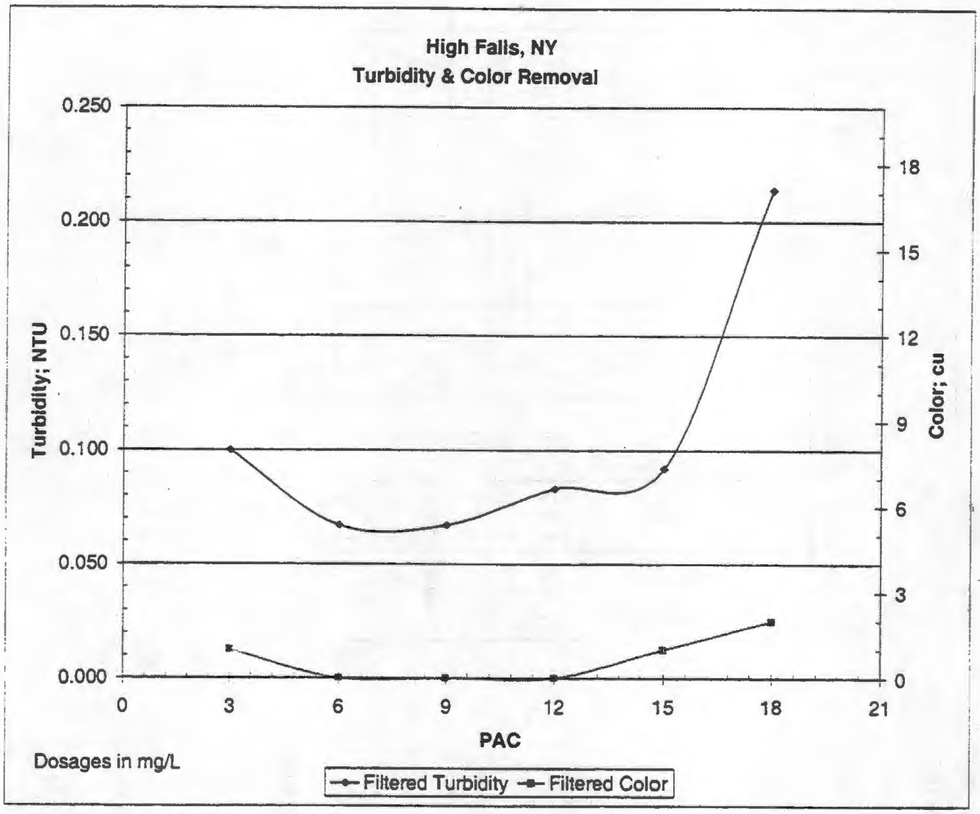
7/21/2003
Date

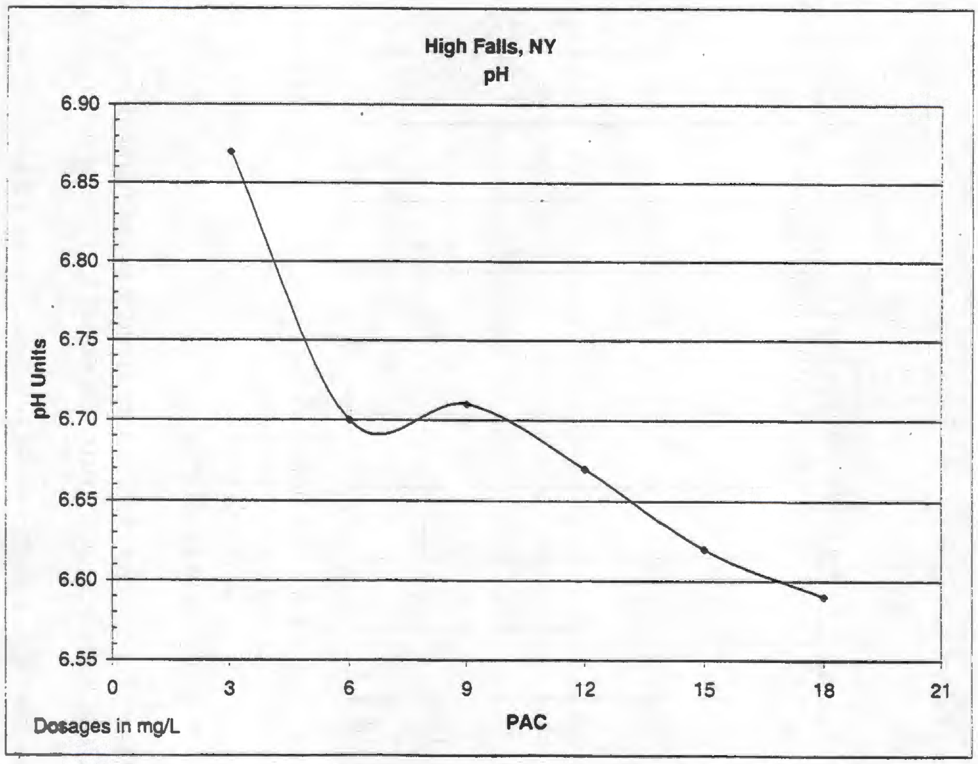
Sheet: 3 of 5

High Falls, NY Sample 25-U; 6/25/03 16:15

USFilter Sample No. 03222

Jar Testing with PACl (FA 900S) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
USF Sample Number: #03222
Sample Description: 25-U; Raw - 6/25/03 @ 16:15
Jar Test No. 5
Test Objective: Trident Treatment Process

		Chemical dosages in ppm: Coagulants			Oxidants		pH/Alk Adj.		Polymers		Observations			Analysis Results									
Test #	Jar #	Poly									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
25	1	0.3									1-2	C		0.149	6.95	4							
26	2	0.5									1-2	C		0.135	6.87	3							
27	3	1.0									1-2	C		0.123	6.83	3							
28	4	1.5									1-2	C		0.084	6.93	2							
29	5	3.0									1-2	C		0.233	6.92	3							
30	6	5.0									1-2	C		0.191	6.81	3							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: Poly - Cation Polymer Coagulant
Poly - EC 462; Liquid, 50% & 1.22 SG
Jar #1 - 0.3 mg/L poly sample collected for L dose lab sample
Jar #4 - 1.5 mg/L Poly sample collected for M dose lab sample
Jar #6 - 5.0 mg/L Poly sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

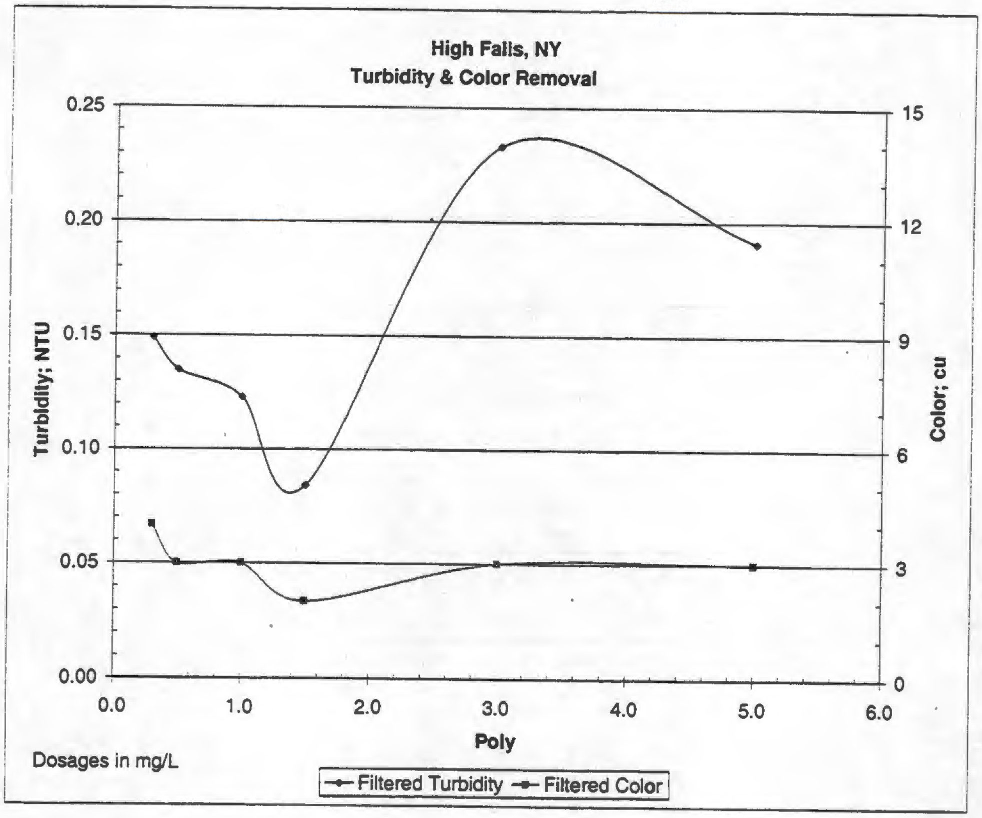
7/21/2003
Date

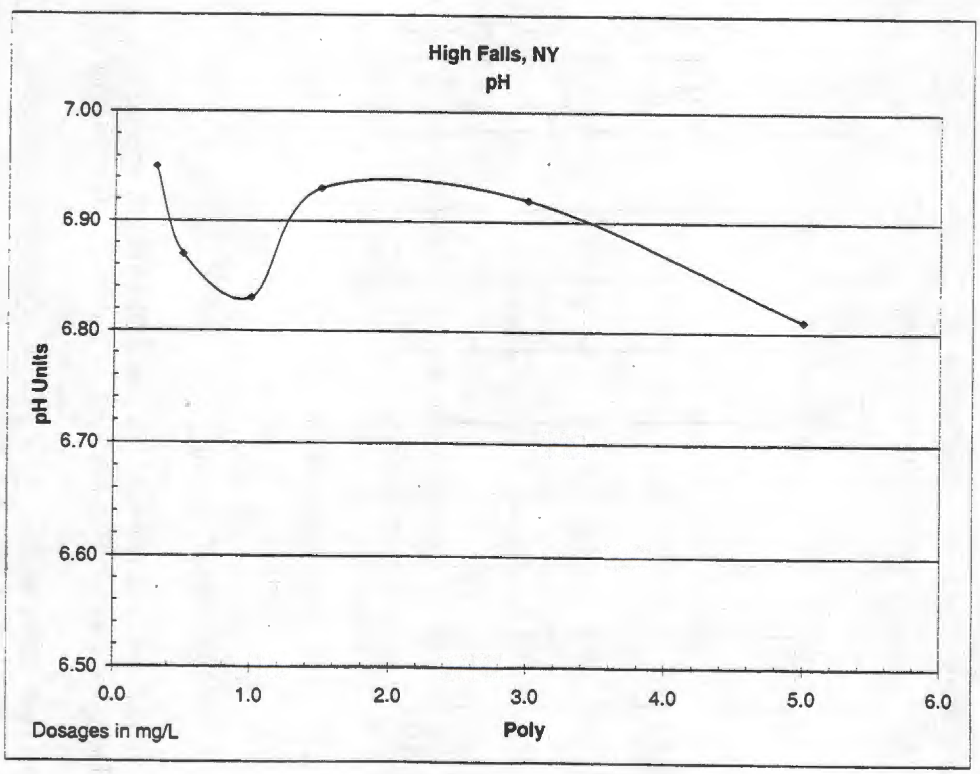
Sheet: 5 of 5

High Falls, NY Sample 25-U; 6/25/03 16:15

USFilter Sample No. 03222

Jar Testing with Poly (Technical Products EC 462) Cation Polymer coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 4-U; Raw - 6/23/03 @ 17:00
Test Objective: Trident Treatment Process

USF Sample Number: #03221
Jar Test No. 4

		Chemical dosages in ppm									Observations			Analysis Results									
		Coagulants			Oxidants		pH/Alk Adj.		Polymers														
Test #	Jar #	ACH									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
19	1	3									1	C		0.068	6.72	0							
20	2	6									1-2	C		0.048	6.67	0							
21	3	9									1-2	C		0.078	6.70	0							
22	4	12									1-2	C		0.298	6.65	1							
23	5	15									1-2	C		0.348	6.71	1							
24	6	18									1-2	C		0.473	6.58	2							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: ACH - Aluminum Chlorohydrate
ACH - Sumalchlor 50; Liquid, 50% & 1.34 SG
Jar #1 - 3 mg/L ACH sample collected for L dose lab sample
Jar #2 - 6 mg/L ACH sample collected for M dose lab sample
Jar #5 - 15 mg/L ACH sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

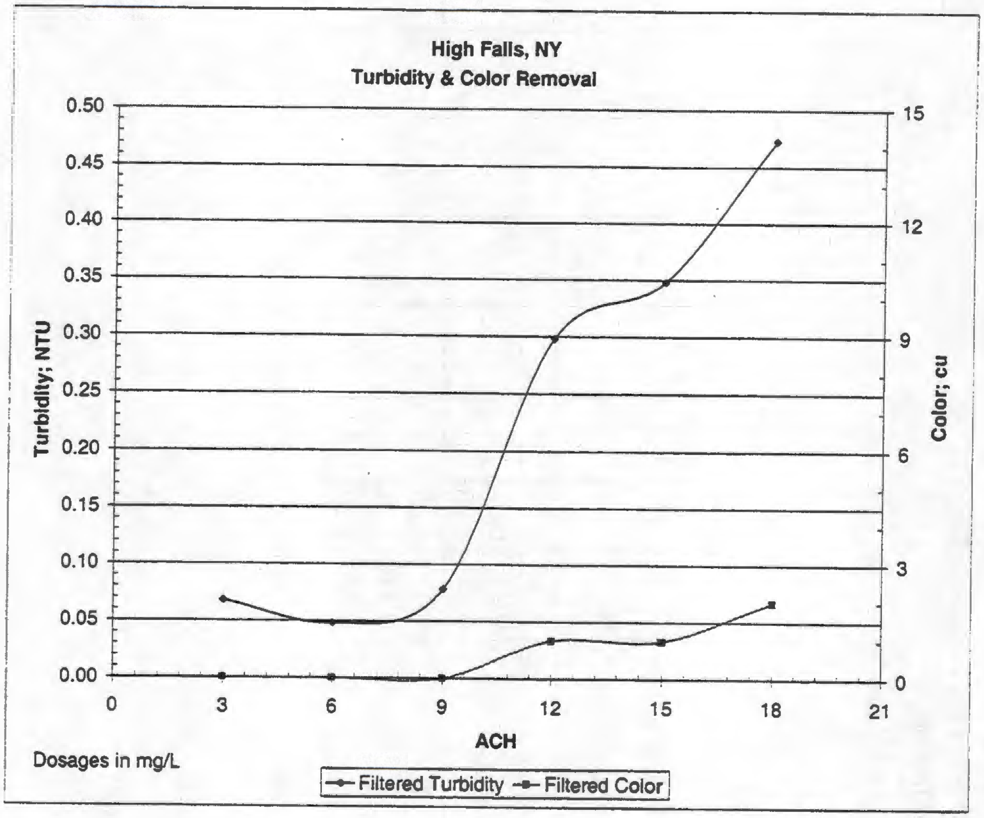
7/17/2003
Date

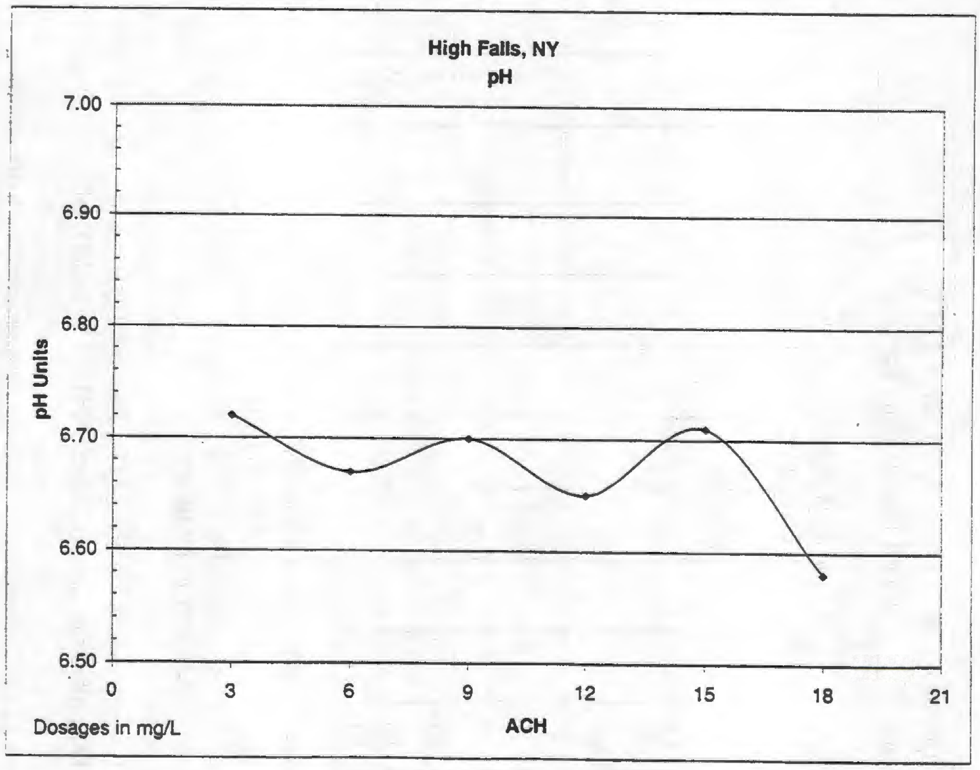
Sheet: 4 of 5

High Falls, NY Sample 4-U; 6/23/03 17:00

USFilter Sample No. 03221

Jar Testing with ACH (Sumalchlor 50) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
USF Sample Number: #03221
Sample Description: 4-U; Raw - 6/23/03 @ 17:00
Jar Test No. 1
Test Objective: Trident Treatment Process

		Chemical dosages in ppm									Observations			Analysis Results										
		Coagulants			Oxidants		pH/Alk Adj		Polymers															
Test #	Jar #	Alum									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo								
1	1	0									1	C		0.180	6.88	5								
2	2	3									1	C		0.146	6.70	2								
3	3	6									1	C		0.094	6.74	1								
4	4	9									1-2	C		0.075	6.55	2								
5	5	12									1-2	C		0.051	6.34	0								
6	6	15									1-2	C		0.063	6.28	1								

Flash mix time 30 seconds @ 100 rpm
500 mL samples
Sample Temperature; °C 23
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:
Alum - Dry product; Dosing based on 0.5% by wt solution
Jar #1 - 0 mg/L alum sample collected for L dose lab sample
Jar #5 - 12 mg/L alum sample collected for M dose lab sample
Jar #6 - 15 mg/L alum sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

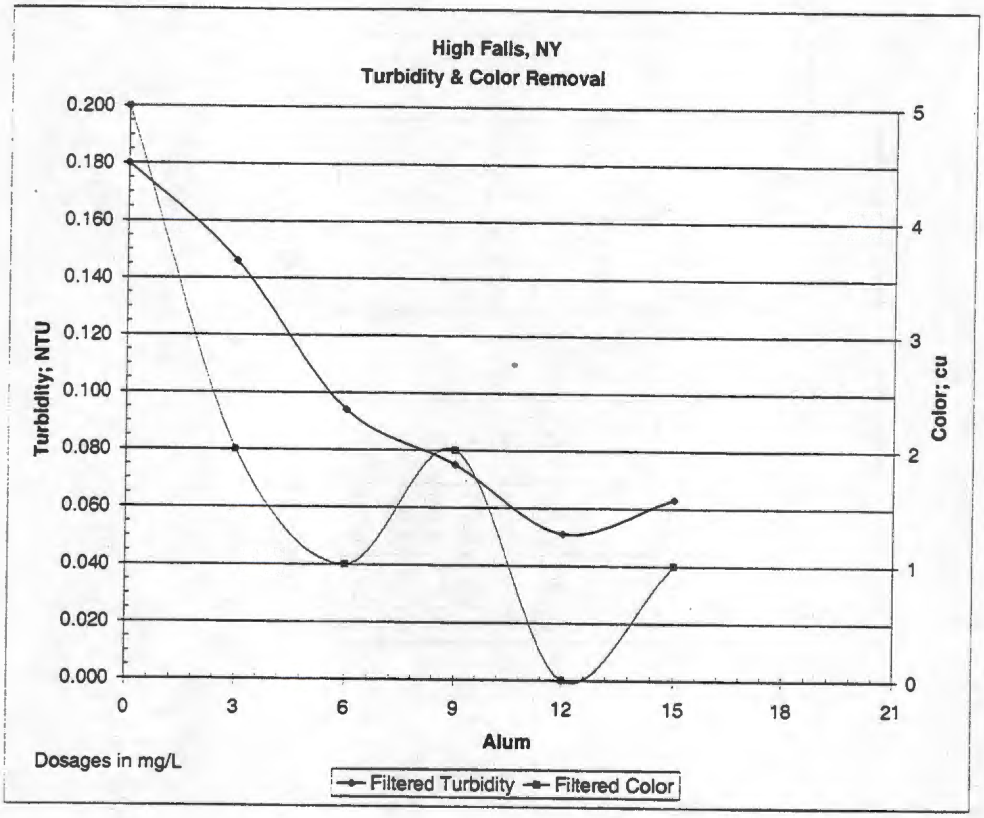
7/16/2003
Date

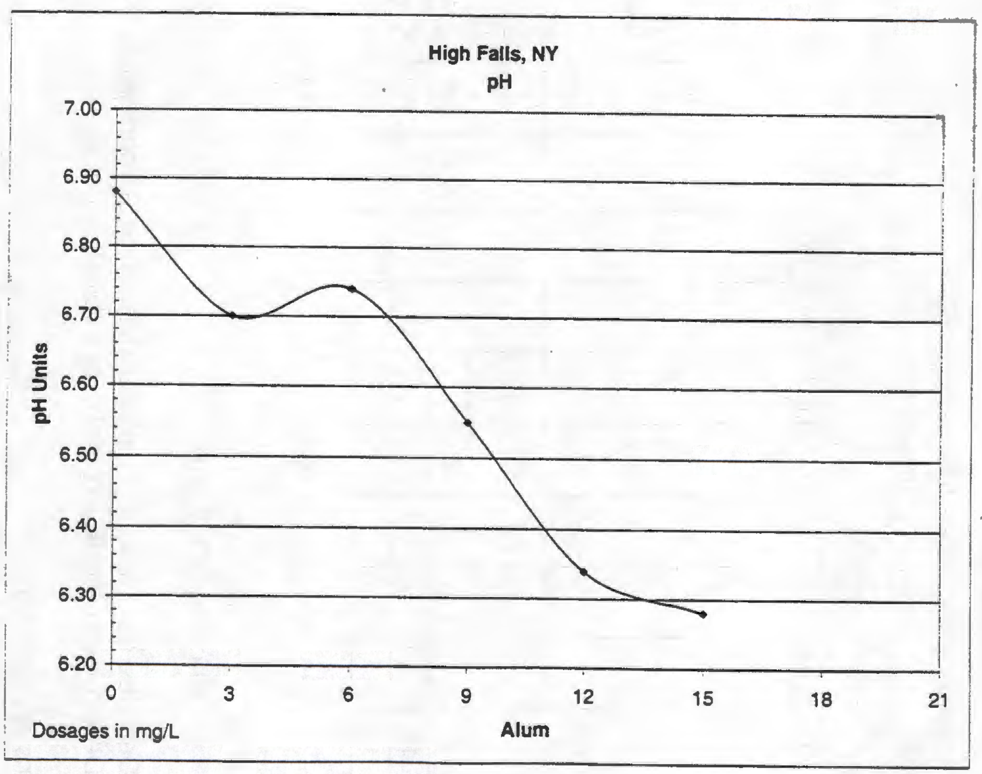
Sheet: 1 of 5

High Falls, NY Sample 4-U; 6/23/03 17:00

USFilter Sample No. 03221

Jar Testing with Alum coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 4-U; Raw - 6/23/03 @ 17:00
Test Objective: Trident Treatment Process

USF Sample Number: #03221
Jar Test No. 2

		Chemical dosages in ppm																					
		Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	Ferric Chloride									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
7	1	3									1	C		0.167	6.75	10							
8	2	6									1	C		0.056	6.48	3							
9	3	9									1-2	C		0.064	6.00	4							
10	4	12									1-2	C		0.071	5.41	5							
11	5	15									1	C		0.175	4.52	6							
12	6	18									1	C		0.196	4.40	12							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 µm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments:
Ferric Chloride ($FeCl_3$) - Liquid; 39% & 1.43 SG
Jar #1 - 3 mg/L ferric sample collected for L dose lab sample
Jar #2 - 6 mg/L ferric sample collected for M dose lab sample
Jar #5 - 15 mg/L ferric sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

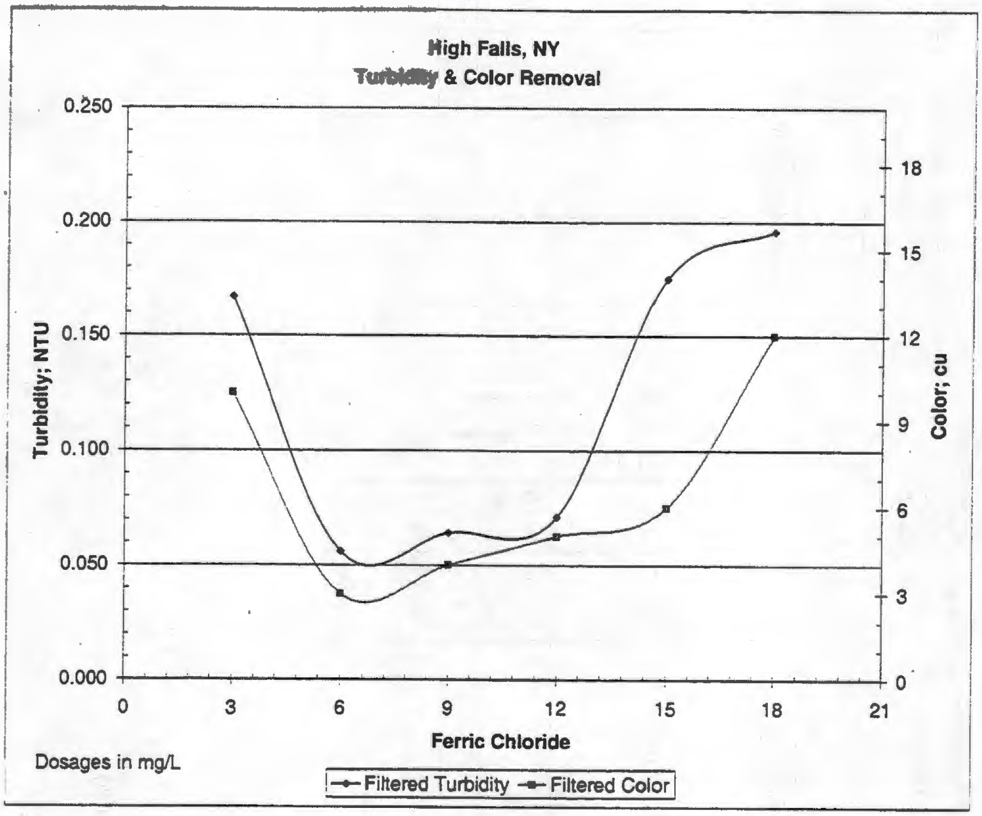
7/17/2003
Date

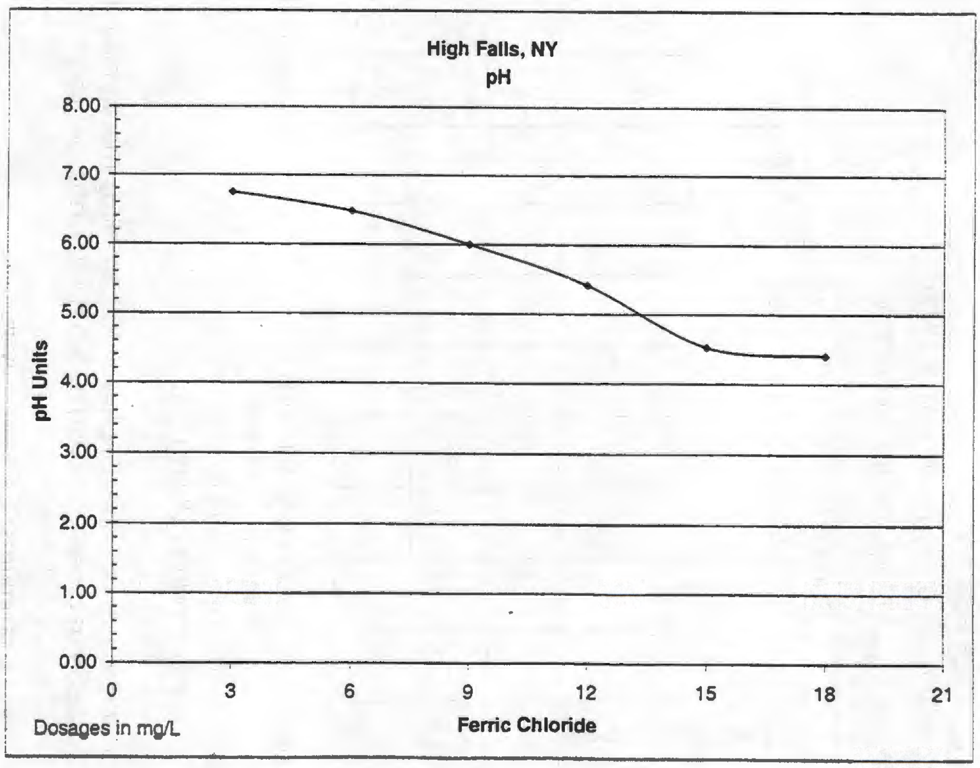
Sheet: 2 of 5

High Falls, NY Sample 4-U; 6/23/03 17:00

USFilter Sample No. 03221

Jar Testing with Ferric Chloride coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 4-U; Raw - 6/23/03 @ 17:00
Test Objective: Trident Treatment Process

USF Sample Number: #03221
Jar Test No. 3

		Chemical dosages in ppm																					
		Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	PAC									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
13	1	3									1	C		0.076	6.74	0							
14	2	6									1-2	C		0.051	6.73	1							
15	3	9									1-2	C		0.070	6.70	1							
16	4	12									2	C		0.088	6.65	1							
17	5	15									1	C		0.234	6.61	2							
18	6	18									1	C		0.118	6.52	1							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: PAC - Polyaluminum Chloride (PACl)
PACl - Westchlor FA 900S; Liquid, 20-40% & 1.24 SG; 30% Assumed!!
Jar #1 - 3 mg/L PAC sample collected for L dose lab sample
Jar #2 - 6 mg/L Pac sample collected for M dose lab sample
Jar #6 - 18 mg/L PAC sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

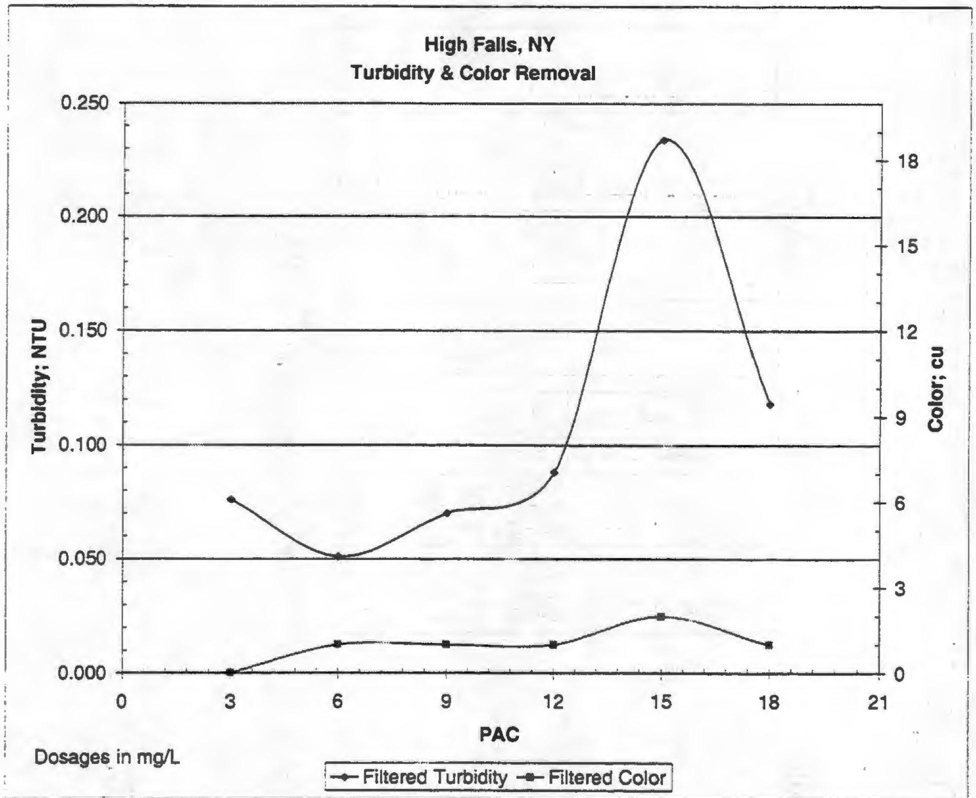
7/17/2003
Date

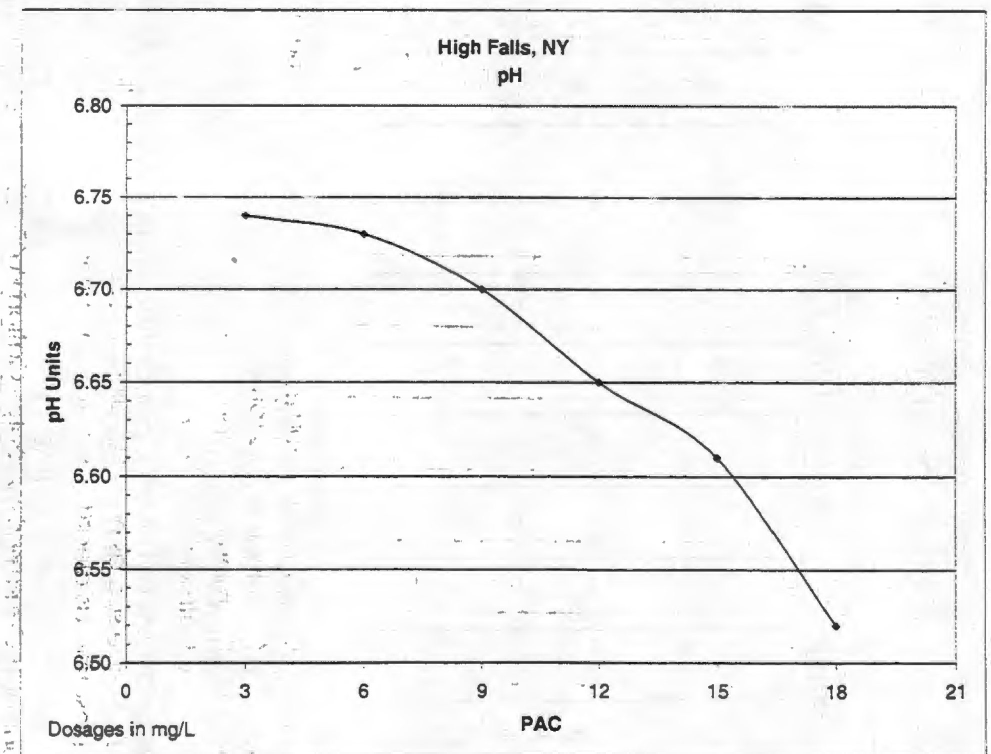
Sheet: 3 of 5

High Falls, NY Sample 4-U; 6/23/03 17:00

USFilter Sample No. 03221

Jar Testing with PACl (FA 900S) coagulant





JAR TEST REPORT

U S FILTER
AMES, IOWA

Job Name: High Falls, NY
Sample Description: 4-U; Raw - 6/23/03 @ 17:00
Test Objective: Trident Treatment Process

USF Sample Number: #03221
Jar Test No. 5

		Chemical dosages in ppm																					
		Coagulants			Oxidants		pH/Alk Adj		Polymers		Observations			Analysis Results									
Test #	Jar #	Poly									Floc *	Clarity **	Comments	Turbidity, NTU	pH	Color, PtCo							
25	1	0.3									1	C		0.125	6.89	4							
26	2	0.5									1	C		0.166	6.82	6							
27	3	1.0									1	C		0.174	6.81	4							
28	4	1.5									1-2	C		0.091	6.79	2							
29	5	3.0									1-2	C		0.155	6.78	3							
30	6	5.0									1	C		0.226	6.80	4							

Flash mix time 30 seconds @ 100 rpm
Floc mix time 6 minutes @ 20 rpm
Settling time 0 minutes @ 0 rpm
Filtered w/ Whatman #2 (8 μm)

500 mL samples

Sample Temperature; °C 23

* Floc - Describe size as none(1), pinpoint(2), small(3), medium(4), large(5)
**Clarity - Describe as clear(C), hazy(H), or turbid(T); after settling

Observations and Comments: Poly - Cation Polymer Coagulant
Poly - EC 462; Liquid, 50% & 1.22 SG
Jar #1 - 0.3 mg/L poly sample collected for L dose lab sample
Jar #4 - 1.5 mg/L Poly sample collected for M dose lab sample
Jar #6 - 5.0 mg/L Poly sample collected from H dose lab sample
Little to no floc formation observed

DRH
Analyst

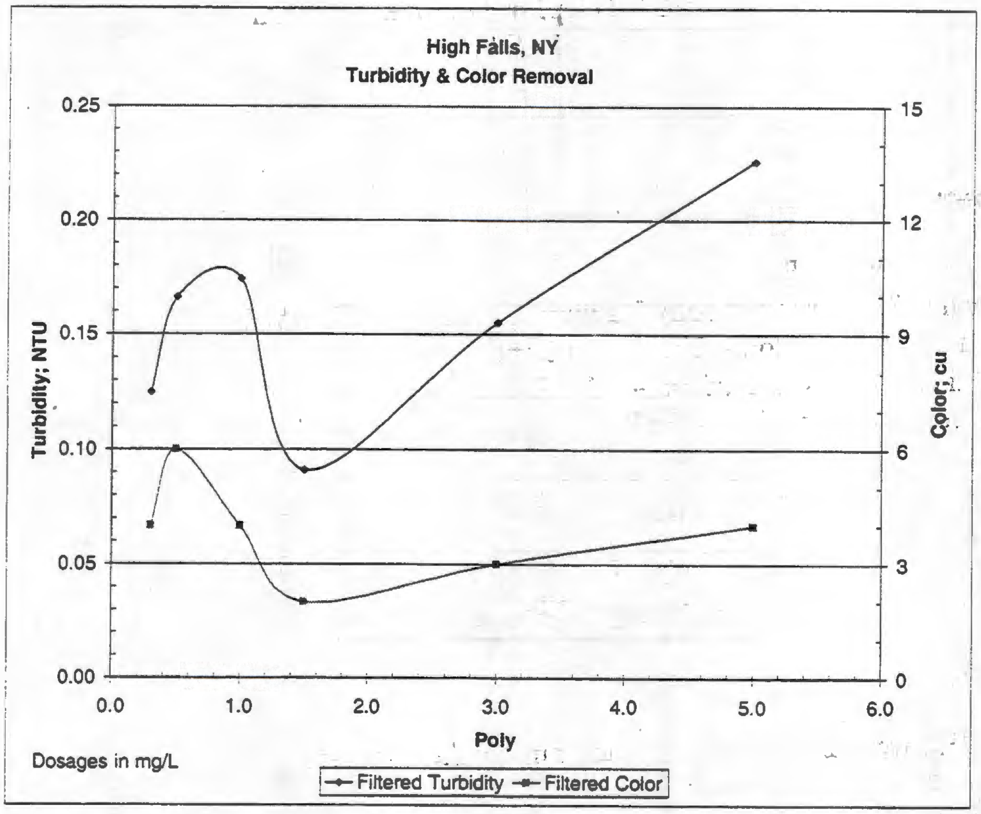
7/18/2003
Date

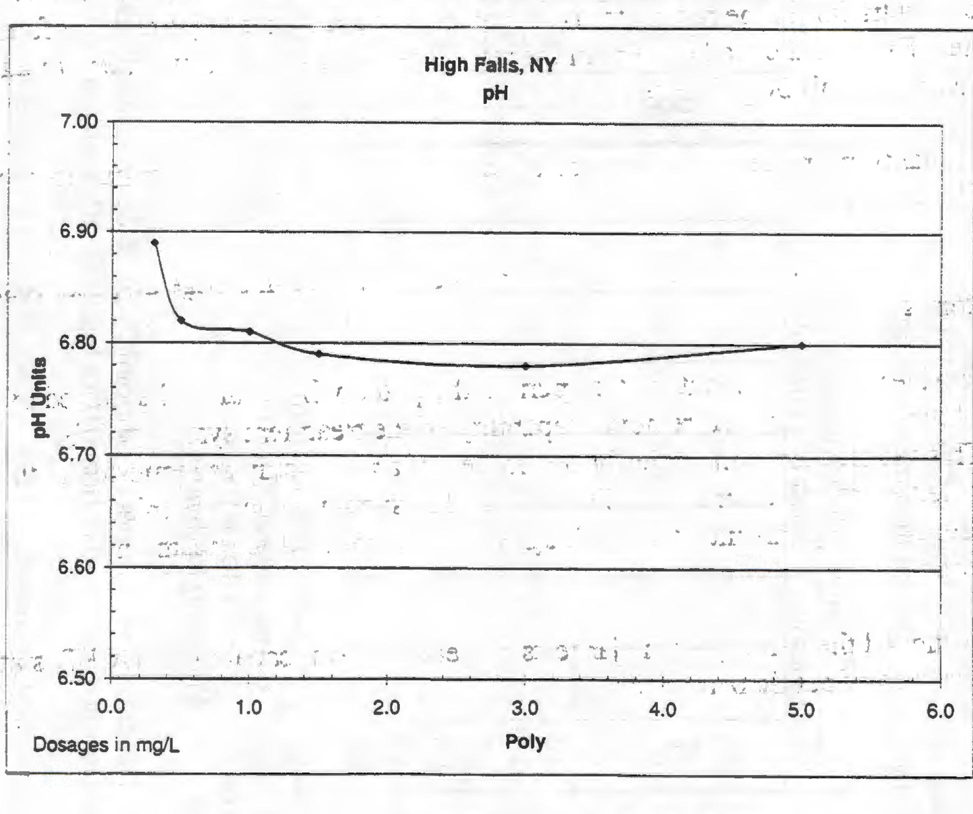
Sheet: 5 of 5

High Falls, NY Sample 4-U; 6/23/03 17:00

USFilter Sample No. 03221

Jar Testing with Poly (Technical Products EC 462) Cation Polymer coagulant





DRAFT

MRIP Telephone Conference Call
JAN 9, 2004

Attendees:

Sal Badalamenti -- EPA
Bob Pender, Paul Speckin, Amy Darpinian, Frank ?? -- US ACE
Alan Dumas, Dean Talon -- UC Health Dept
Shane Finch, Knudsen, Hudson -- NYS DOH
Don Miller, John Fazzolari -- E&E

Objective of Meeting:

A. Discuss the alternate tie-in point
B. Discuss the lead issue and the riser pipe

Summary:

Both DOH's were unaware of the lead lining in the riser pipe.

The proposed water treatment process will remove the lead to below non-detect levels if the lead concentration in the raw water is 30 ppb or less according to jar tests performed by USFilter. The average lead content in the raw water stored in the raw water storage tank will be below this 30 ppb level.

The water quality from the proposed plant should be the same as the water quality from the New Paltz plant.

The only impact that the lead will have is the possible increase in sludge disposal costs and monitoring.

During the water treatment plant start up period, the plant will be run and adjusted by USFilter. At that time, the lead removal capability of the treatment system will be verified. This verification will be performed in lieu of a pilot study as requested in the NYS DOH letter dated December 19, 2003. The EPA should respond to this correspondence stating this intention. All agreed to this method for treatment demonstration.

No one questioned the validity of the jar tests for lead removal capability. UCHD stated their concern was of public perception.

☞ CONTACT REPORT ☜	
☎ Telephone <ȣ> ☺ Conference < > = Other < >	
CONTACT:	Dave Phillips (NYS DOH)
TO:	Project File
FROM:	J. Fazzolari
DATE:	9/03/04
SUBJECT:	New Paltz WTP Startup
CC:	

COMMENTS:

I called Dave to speak to him about treatment plant startup requirements. In the process of writing specifications, E&E intends to set the requirements for the contractor to operate the plant for a designated period of time and collect samples for demonstration of treatment system effectiveness.

I asked Dave if there was a standard duration for startup operation or for testing. Dave said that there is no standard for either; it is up to the engineer to determine the proper duration and testing and submit a report to the health department. I asked if two weeks was appropriate, or if two months was required. Dave said that two months was excessive, and two weeks was probably more than sufficient.

I stated that E&E plans to include only basic monitoring (e.g. ph, turbidity, color) in the daily monitoring, with one day of a full suite of sampling (organics, etc). Dave said that was fine, DOH is looking primarily for turbidity and bacteriological data. I told Dave we would include bacteriological testing as well.

Dave mentioned that one issue with the High Falls WTP is lead in the raw water and asked what was going to be done to address this. I mentioned that USACE agreed to conduct a pilot after construction to demonstrate lead removal. This pilot would likely run concurrently with the startup testing and include lead testing of raw and finished water. Dave said that would probably be fine.